NBS TECHNICAL NOTE 1140

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

Uncertainty in Determining Thermal Performance of Liquid-Heating Flat-Plate Solar Collectors

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UNCERTAINTY IN DETERMINING THERMAL PERFORMANCE OF LIQUID-HEATING FLAT-PLATE SOLAR COLLECTORS

By

E.R. Streed and D. Waksman

ABSTRACT

Thermal performance measurements of eight liquid-heating flat-plate solar collectors were conducted with two to four collectors of each type at four outdoor test sites. Tests were performed in accordance with the procedure prescribed by ASHRAE Standard 93-77. Statistical analysis of data sets for each collector type within test sites and between test sites was done using ASTM recommended methods to evaluate test method measurement uncertainty. Illustrations of the influence of thermal performance data uncertainty are presented for collector material degradation, collector rating and calculated system performance.

KEY WORDS: Collector rating; measurement; solar collector; standards; thermal performance; uncertainty.

PREFACE

The Department of Energy (DoE) is conducting an Interim Solar Collector Testing Program to stimulate the establishment of a permanent collector testing/certification program. Elements of the program are related to the verification of test procedures, evaluation and improvement of test laboratory capabilities, and the measurement and distribution of reliable performance data for solar collectors. This study of collector thermal performance data uncertainty was conducted by the National Bureau of Standards (NBS) in support of this DoE test program.

This report is intended to be informative and instructive; it is not meant to be an evaluation of products or facilities. In no case does such identification imply recommendation or endorsement by the National Bureau of Standards, nor does it imply that the products are necessarily the best available for the purpose.

The cooperation of the following people is greatly appreciated: Richard D. Whitaker and William Dokos, DSET Laboratories, Inc.; Ross McCluny, James Huggins and James Rowland, Florida Solar Energy Center; Roger Wedell and Ronald Dammann, Lockheed Palo Alto Research Laboratory; Ken Shih and Mark Rallas, Wyle Laboratories; and Aaron Dawson, Virginia Polytechnic Institute and State University. The devoted effort of Dr. John Mandel in performing the statistical analysis, instrument calibration by John Jenkins, data collection by Cathy Scarbrough and Patricia Christopher, and computerized calculations by William May, all at NBS, contributed significantly to the evaluation and presentation of the data.

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SI CONVERSION UNITS

In view of the present accepted practice in this country for building technology, common U.S. units of measurement have been used in the data appendix. In recognition of the position of the United States as a signatory to the General Conference of Weights and Measures, which gave official status to the metric SI system of units in 1960, assistance is given to the reader interested in making use of the coherent system of SI units by giving conversion factors applicable to U.S. units used in this document.

Length
1 in = 0.0254 meter (exactly)
1 ft = 0.3048 meter (exactly)

Area
1 in^2 = 6.45 x 10^{-4} $meter^2$
1 ft^2 = 0.09290 $meter^2$

Volume
1 in = 1.639 x 10^{-5} $meter^3$
1 gal (U.S. liquid) = 3.785 x 10^{-3} $meter^3$

Mass
1 ounce-mass (avoirdupois) = 2.834 x 10^{-2} kilogram
1 pound-mass (avoirdupois) = 0.4536 kilogram

Pressure or Stress (Force/Area)
1 inch of mercury (60°F) = 3.377 x 10^3 pascal
1 pound-force/$inch^2$ (psi) = 6.895 x 10^3 pascal

Energy
1 foot-pound-force (ft·lbf) = 1.356 joule
1 Btu (International Table) = 1.055 x 10^3 joule
1 kilowatt-hour = 3.600 x 10^6 joule = 3.412 x 10^3 Btu

Power
1 watt = 1 x 10^7 erg/second
1 Btu/hr = 0.2929 watt

Temperature
$t_{°C}$ = 5/9 ($t_{°F}$ - 32)

Heat
1 Btu·in/h·ft^2·°F = 1.442 x 10^{-1} W/m·K (thermal conductivity)
1 Btu/lbm·°F = 4.184 x 10^3 J/kg·K (specific heat)
1 langley = 4.184 x 10^4 J/m^2 = 1 cal/cm^2 = 3.69 Btu/ft^2

1. INTRODUCTION

1.1 Background

The Department of Energy (DoE) and the Department of Housing and Urban Development (HUD) are committed to the demonstration of building solar heating and cooling applications in the United States. One of the objectives of the demonstration program involves the development of standardized procedures and methods for testing and evaluating solar collectors. As stated in the "National Program for Solar Heating and Cooling of Buildings" [1], the National Bureau of Standards (NBS) is working with industry and professional organizations to develop nationally recognized consensus test procedures.

The ASHRAE Standard 93-77 [2] has been adopted in the United States (U.S.) as a consensus test method for determining the thermal performance of solar collectors and is generally recognized as an adequate procedure. Initial development of the test procedure [3] and experimental evaluation for selected flat-plate, evacuated tubular and low concentrating collectors [4] have been reported by NBS. A round robin type study of the basic test procedure was conducted utilizing 21 test facilities with two types of flat-plate collectors during 1976 and 1977. Analysis of these results [5] showed that correction for the influence of the environment and test conditions to a set of reference conditions for incidence angle, diffuse fraction, wind, irradiance and ambient temperature resulted in only a minor reduction in data spread. It was concluded that systematic type measurement problems resulting from instrument calibration, sensor installation and procedural variations are probably more significant contributors to the data uncertainty.

1.2 Current Studies

In order to stimulate the establishment of an industry operated collector testing and certification program, DoE organized an Interim Collector Testing Program in 1978. The program had three major objectives as follows:

1. Provide state-of-the-art thermal performance data for designer, manufacturer and consumer use on a large number of collectors
2. Provide a technical base for the establishment of a collector certification and rating program
3. Evaluate and modify (if necessary) collector performance test methods

The thermal performance measurements portion of the program has been completed and the data are being compiled for publication. Only a limited number of tests were conducted for comparability purposes.

The primary factors that need to be determined are a measure of the repeatability and reproducibility of ASHRAE Standard 93-77. Repeatability is related to the variability in replicate results obtained on the same product within a single test facility. Reproducibility is related to the variability in results obtained on the same product between test sites.

As part of the overall DoE Solar Energy Program, a project was initiated in 1978 by NBS [6] to investigate accelerated and "real time" test methods for predicting collector durability and reliability. Representative commercially available flat-plate solar collectors and their materials are being exposed outdoors in four different U.S. climatic regions and with two types of solar simulators. As part of the characterization of the collectors, initial thermal performance measurements were made on multiple samples of each collector at each test site prior to commencing the exposure tests. These baseline data consisting of measurements made on eight collector types at each of four sites, with two to four collector replicates at each site, provide an appropriate data set which is used in this study to evaluate collector thermal performance measurement capabilities.

The NBS test program was primarily designed for durability/reliability considerations, and does not include some features desirable for identifying individual factors contributing to the measurement uncertainty, such as product variability, specific environmental conditions, and test apparatus. Additional investigations to evaluate and improve the ASHRAE test method are currently being conducted under the direction of an ASHRAE 93R (Revision) Committee.

1.3 Report Purpose

It is the intent of this study to show the following: (1) overall uncertainty in collector thermal performance data as reported by commercial test facilities on commercially available solar collectors (individual error sources will not be identified except for some cursory observations of possible causes), and (2) illustrations of how the uncertainty in individual collector test results affects the rating and selection of collectors for system design and for determining degradation with exposure or operating time.

2. THERMAL PERFORMANCE TEST METHOD

2.1 General

The thermal performance tests used to obtain the instantaneous efficiency were specified to be performed in general accordance with ASHRAE Standard 93-77. This consensus test method for both air and liquid heat transfer fluids includes guidelines for the test apparatus configuration, instrumentation accuracy, and precision tolerances. The measurements needed to determine the instantaneous efficiency are temperature, fluid mass flow, solar irradiance, and collector area, as expressed by the following equation:

$$\eta = \dot{m}\, c_p\, (t_{f,o} - t_{f,i})/I_t A_g \qquad (1)$$

where η = collector efficiency

$\dot{m}$ = fluid mass flow rate ($kg/s \cdot m^2$)

c_p = fluid specific heat ($J/kg \cdot °C$)

$t_{f,i}$ = transfer fluid inlet temperature (°C)

$t_{f,o}$ = transfer fluid exit temperature (°C)

A_g = collector gross area (m^2)

I_t = solar irradiance (W/m^2).

These measurements must be performed precisely with calibrated instruments capable of achieving the prescribed accuracy and also must be performed within a limited range of weather and test conditions. During testing, the solar irradiance, inlet temperature, and fluid flow rate must be maintained within close tolerances for time periods in excess of the collector time constant to insure that a quasi-steady state thermodynamic condition prevails in the collector with respect to the gain and loss of energy. Climatic factors such as ambient temperature and wind have relatively wide allowable ranges and they must be measured and reported as well as the solar diffuse fraction and relative humidity. Other test parameters which may influence the thermal performance but are not specifically restricted are tilt angle, sky temperature and solar spectral distribution.

The test procedure specifies that at least four inlet temperatures shall be used to obtain near normal incidence efficiency values over a range of operating conditions. At least four data points shall be taken at each inlet temperature. When measurements are made outdoors on a non-tracking mount, two data points should be taken before solar noon and two after solar noon to cancel out heat capacity effects. Measurements made using a solar simulator or an altazimuth mount are conducted with the sun normal to the collector during the test period. Each data point is obtained by integrating the measured parameters over a five-minute period (longer for collectors with time constants in excess of five minutes) and calculating the efficiency as indicated in equation 1.

2.2 Efficiency

ASHRAE Standard 93-77 is based upon the Hottel-Whillier-Bliss analytical model which assumes that the efficiency of a flat-plate solar collector operating under steady-state conditions and normal incidence can be described by:

$$\eta = F_R(\tau\alpha)_e - F_R U_L[(t_{f,i} - t_a)/I_t] \qquad (2)$$

where F_R = collector heat removal factor

$(\tau\alpha)_e$ = effective transmittance-absorptance product

U_L = heat transfer loss coefficient [$W/(m^2 \cdot °C)$]

The concept of the collector heat removal factor, F_R, was introduced in the testing of thermal collectors to preclude the necessity for determining the mean temperature of the absorber plate. The parameter F_R is defined as:

$$F_R = \frac{\text{actual useful energy collected by a flat-plate collector}}{\text{useful energy collected if the entire flat-plate collector surface were at the inlet fluid temperature}}$$

The quantity F_R may be expressed in exponential form as follows:

$$F_R = \frac{\dot{m}\, c_p}{U_L A_a} \left\{ 1 - e^{-(U_L F' A_a / \dot{m}\, c_p)} \right\} \qquad (3)$$

where A_a = collector aperture area (m^2).

The collector efficiency factor F' is made up of a series of heat path resistances dependent upon the absorber physical construction (materials and configuration) and the heat transfer coefficient from absorber surface-to-heat transfer fluid. Thus, the effects of collector physical design, mass flow rate, and fluid thermophysical properties are manifested in the collector's measured efficiency, assuming that the external boundary conditions of total incident radiation flux (I_t), ambient temperature (t_a), sky temperature, wind velocity, etc., are relatively constant.

A plot of the collector efficiency versus the $\Delta T/I_t$ parameter for the range of inlet temperatures can result in a linear relationship. The intercept on the "y" axis is equal to $A_a/A_g\ F_R(\tau\alpha)_e$* and the slope is equal to $Aa/Ag\ F_R U_L$*. Because of non-linearity in the loss coefficient with temperature, U_L is not always constant, and the test method provides for presenting the data by either a first-order or a second-order polynomial fit to the data points.

A typical plot of the efficiency curves for a collector with a double cover and a flat black absorber and for one with a single cover and a selective absorber are shown in Figure 1. Examples of variation in wind and diffuse fraction are shown for individual data points obtained on different measurement days. The influence of environmental conditions on individual data points is smoothed out by fitting a curve to all 16 of the measured data points.

2.3 Incident Angle Modifier

ASHRAE Standard 93-77 also provides for measurements of the influence of solar incidence angle on the collector efficiency. The incident angle modifier, $K_{\alpha\tau}$, is used in this method as a coefficient of the transmittance-absorptance product, $(\tau\alpha)_e = K_{\alpha\tau}\ (\tau\alpha)_{e,n}$, to describe non-tracking collector performance when irradiated off-normal. The coefficient is used in calculating collector all-day performance. The value of $K_{\alpha\tau}$ for many flat-plate collectors can be plotted as a function of

*The reported values are based upon calculations using collector gross area. Each term should be multiplied by the ratio of the gross area-to-aperture area (A_g/A_a) to conform to the definition of the heat removal factor expressed in equation 3, which is based upon aperture area.

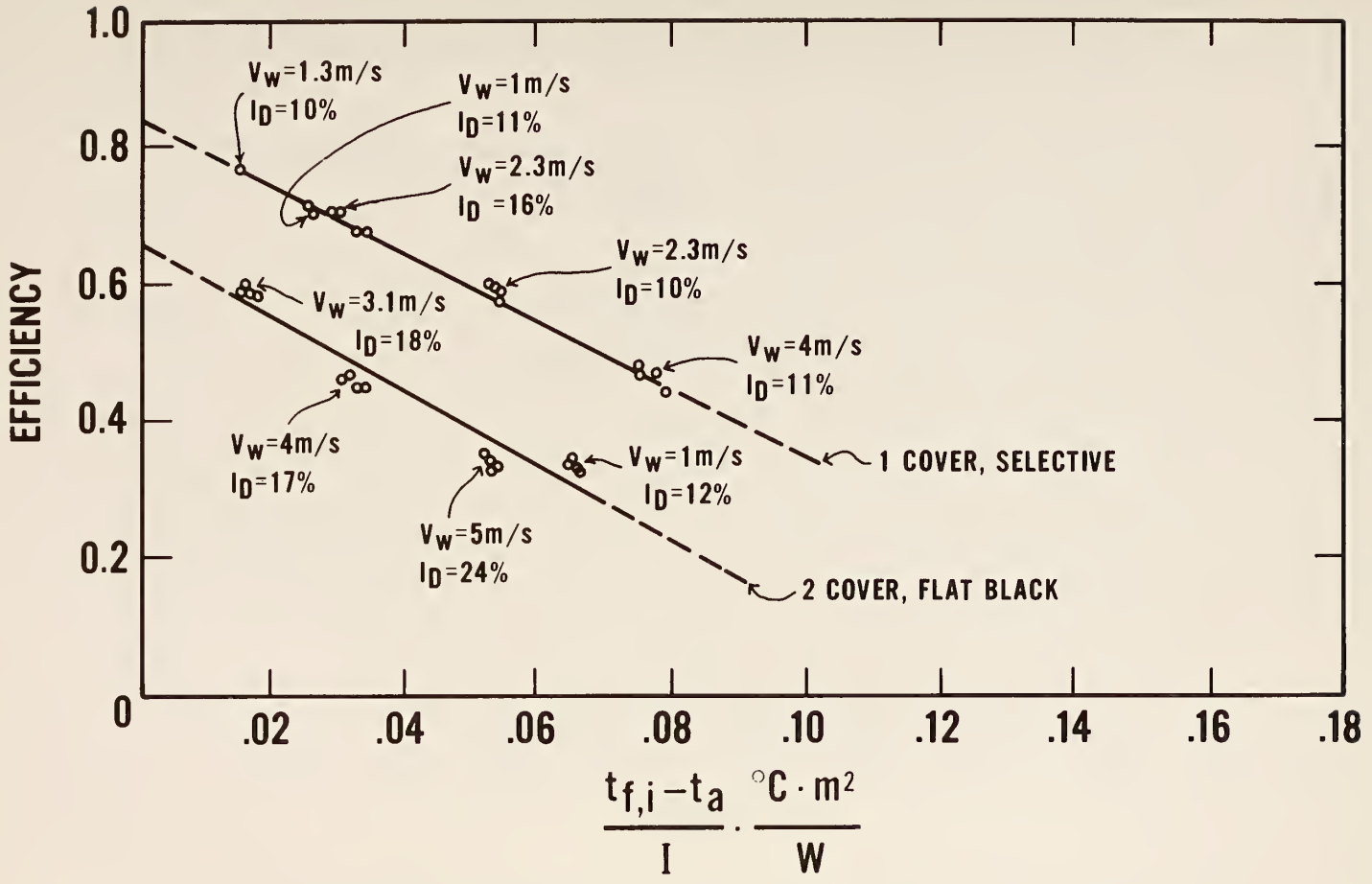

Figure 1. Typical solar collector thermal performance plot and data points

$(1/\cos \theta)-1$ as shown in Figure 2 and typically yields a straight line. The values of $K_{\alpha\tau}$ are determined by performing separate efficiency tests with the inlet temperature controlled to within $\pm 1°C$ ($\pm 2°F$) of the ambient temperature and at incident angles of 0, 30, 45 and 60°. This linear relationship shown in Figure 2 may not hold for collectors with special (non-flat) geometry, reflectors, etc.

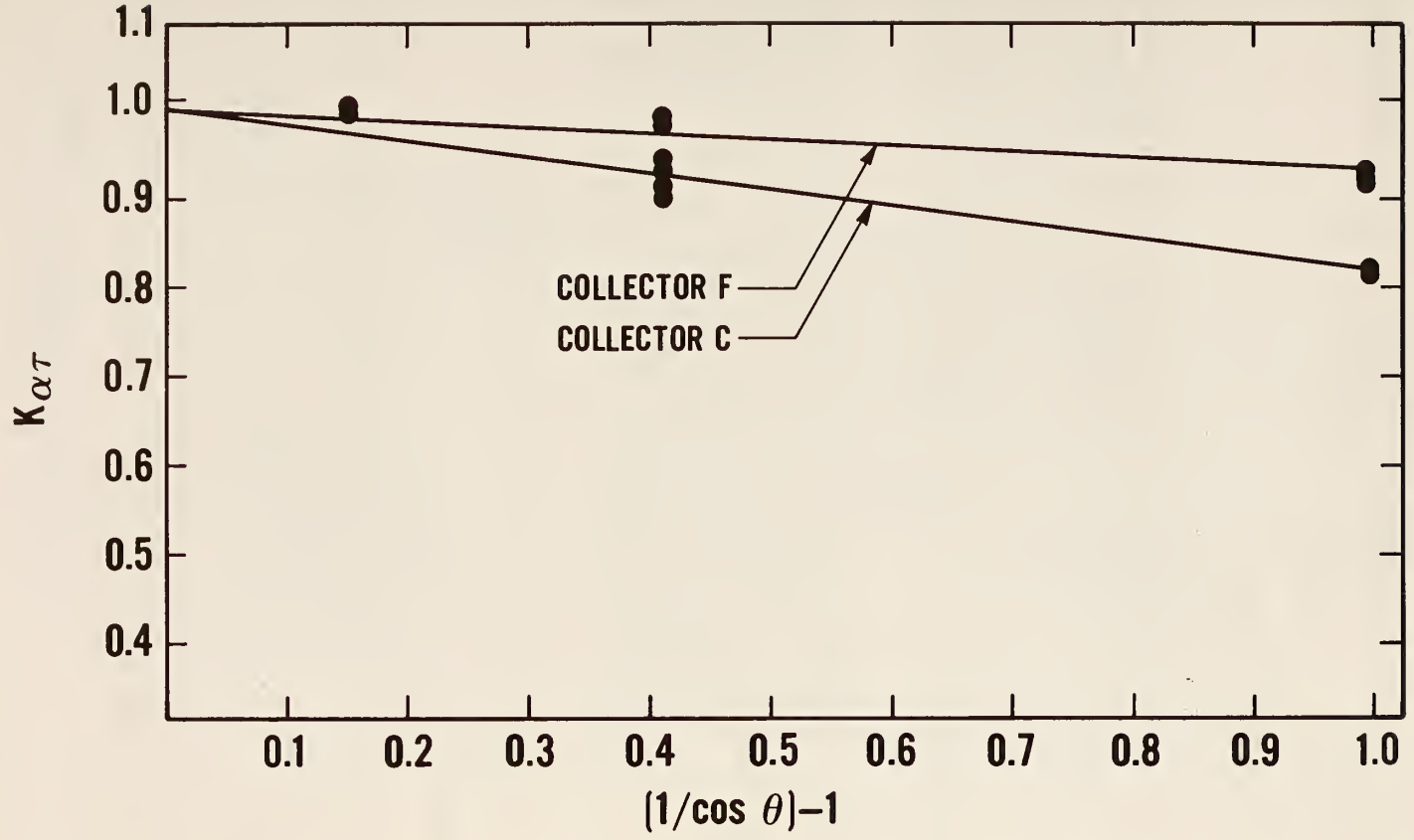

Figure 2. Typical solar collector incident angle modifier plot and data points

3. THERMAL PERFORMANCE DATA UNCERTAINTY

3.1 General

The evaluation of a test method involves an analysis of the total measurement process including:

- o measurement personnel expertise
- o test facility quality
- o local environmental factors
- o test specimen characteristics.

The identification of individual sources of uncertainties would require the use of well characterized reference samples for measurement under identical environmental conditions or the exchange of the same specimen for measurements by each test facility. The conduct of this durability program did not permit sample control to this extent. The evaluation was conducted in a manner similar to the procedures employed by industry in a certification program. Collectors are typically randomly selected from production lots, sent to a qualified laboratory and tested under the prevailing environmental conditions within the prescribed test limitations. Therefore, typical variations in collector production, pre-test collector handling, test apparatus calibration, test procedure, and data reduction are aggregated in the data.

Some factors which contribute to the uncertainty can be determined from analysis of the information obtained as part of the test procedure. For example, the collector gross area must be measured for use in calculating the efficiency as expressed by equation 1. Analysis of the reported area data for Test Site No. 1 indicates a coefficient of variation cv_r of 0.33 percent for "within" a test site. Similar analysis for the four test sites indicates a coefficient of variation cv_R of 0.94 percent for "between" test sites. Assuming that the "within" value reflects the average variation in manufacturing tolerances for these collectors and that the larger "between" value is more indicative of measurement uncertainties, then the area determination becomes a significant part of the coefficient of variation for intercepts calculated in Section 5.2.

The area, standard deviation, and coefficient of variation data are tabulated in Tables B-2 and B-3 of Appendix B.

3.2 Measurement Uncertainties

The influence of individual and cumulative instrumentation calibration and operational errors has been calculated [7] using propagated measurement uncertainty functions. Uncertainty functions were determined for the allowable accuracies specified in the test procedure (assuming 2-σ instrumentation errors) for individual measurements of solar irradiance, fluid flow rate, temperature and working fluid thermophysical properties plus a 1 percent uncertainty associated with the data acquisition. The magnitude of the calculated measurement uncertainty associated with parameters comprising the x and y axes is illustrated in Figure 3 by the rectangles superimposed on the solid lines. Uncertainties of about ± 4 percentage points are indicated for typical flat-plate collectors. The largest assumed individual contributing parameter is the uncertainty of ± 3 percent related to the measurement of solar irradiance.

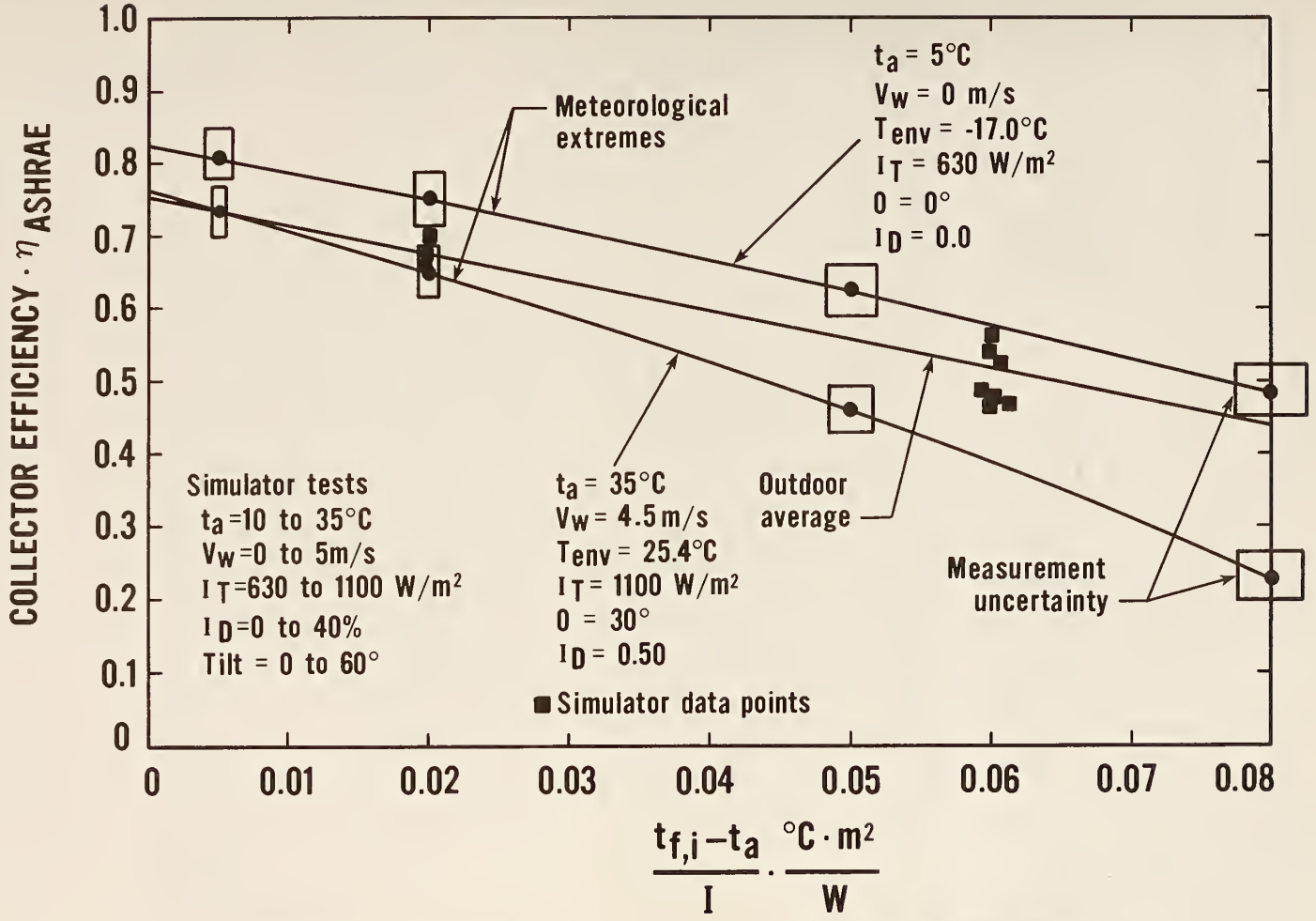

Figure 3. Uncertainty associated with the ASHRAE 93-77 efficiency measurements for a single-glazed selective absorber type collector

3.3 Meteorological Uncertainty

Additional variability in efficiency will result from the meteorological variations allowed in the test method. The range of allowable test conditions for solar irradiance, incidence angle, ambient temperature and wind speed specified in the test method are shown in Table 1.

Table 1. Environmental Test Conditions Allowed by ASHRAE Standard 93-77

Environmental Parameter	
Ambient air temperature	range < 30°C
Wind speed across collector	should be $\leq$ 4.5 m/s
Total solar irradiance within collector plane	> 630 W/m^2
Beam solar irradiance incident angle	< 30°
Reflected solar irradiation	< 0.20

The difference in calculated thermal performance for a single glass cover, selective absorber type collector exposed to these extreme conditions is represented by the solid curves shown in Figure 3. Calculations were made using an analytical model [5] based upon traditional heat transfer relationships for flat-plate collectors. It should be noted that the simultaneous occurrence of these extreme "high" or "low" meteorological conditions is extremely unlikely.

Experimental verification of the calculated meteorological extremes was performed in a solar simulator to the extent that the conditions could be achieved. The solid black squares represent data points taken using the extreme exposure conditions listed under "simulator tests" in Figure 3. The experimental data points are bracketed around the solid curve labeled "average outdoor," which represents the mean value reported for round-robin type tests [5] on a similar collector. The experimental data were obtained with a xenon type solar simulator [8].

4. BASELINE DATA

4.1 Collector Description

Liquid-heating flat-plate type collectors were selected for use in the test program. The designs chosen were representative of commonly used materials and types of construction. All collectors from each manufacturer were from the same production lot. The cover and absorber materials, their pertinent optical properties and average areas (gross and aperture) are shown for the respective collectors in Table 2. The absorber material optical property data are based upon measurements of at least ten samples taken from the actual absorber of each collector type. The solar transmittance of the glass materials was obtained using the full cover and a pyranometer (ASTM Standard E424 Method B [9]). The solar transmittance of non-glass cover materials and the solar absorptance values were obtained from spectral measurements with an integrating sphere (ASTM Standard E424 Method A [9]). Emittance was measured using a portable-type instrument employing a thermopile and infrared reflectance technique, in accordance with ASTM Standard E408, Method A [10].

Detailed descriptions of each collector's construction dimensions and pertinent material properties useful for thermal analytical modeling are listed in Table B-1, Appendix B.

4.2 Test Sites

One of the major objectives of the durability program is to determine the influence of environmental exposure conditions on collector degradation. The same type of information is required for evaluation of thermal performance testing.

Four exposure test sites were selected which represent both the median and extreme United States climatological conditions. These test sites can be briefly described as follows:

Climatological Extremes

Site 1. hot, dry
high solar radiation
(high UV radiation would accompany these conditions)

The hot, dry condition can be found in southwestern states (i.e. Arizona, Nevada and New Mexico). DSET Laboratories, Inc., located in Phoenix, Arizona was selected as this test site.

Site 2. hot, humid
high solar radiation
(low to moderate UV radiation would accompany these conditions)

The hot, humid condition can be found either in Florida or along the Gulf Coast in the states of Alabama, Mississippi, Louisiana or Texas. The Florida Solar Energy Center, located in Cape Canaveral, Florida was selected as this test site.

Median Climatological Conditions

Site 3. moderate temperature
dry
high solar radiation
moderate UV radiation

The moderate, dry condition can be found primarily in California. The Lockheed Research Laboratory, located in Palo Alto, California, was selected as this test site.

Table 2. Test Collector Specimen Description

Collector Code	Cover Material			Absorber Material			Average Area*	
	Outer	Inner	Solar Transmittance	Material	Solar Absorptance	Emittance	Gross (m^2)	Aperture (m^2)
A	Water White Glass	---	0.90	Black Nickel	0.87	0.13	2.150	1.831
B	Low Iron Glass	Low Iron Glass	0.88 (ea)	Black Velvet Paint	0.97	0.96	1.732	1.602
C	Plate Glass	Thin Film Heat Trap	0.86	Black Velvet Paint	0.98	0.92	2.589	1.924
D	Etched Glass	Etched Glass	0.96 (ea)	Black Chrome	0.97	0.07	1.655	1.402
E	FRP (Type I)	---	0.85	Lacquer Primer	0.95	0.87	1.892	1.720
F	Water White Glass	---	0.90	Copper Oxide	0.96	0.75	1.922	1.769
G	FRP (Type II)	FEP Film	0.84 0.96	Porcelain Enamel	0.93	0.86	2.563	2.188
H	Polyester Film	FEP Film	0.85 0.96	Siliconized Polyester Paint	0.95	0.89	2.916	2.641

*Average of values reported by four test sites.

Site 4. moderate temperature
humid
moderate solar radiation
moderate to low UV radiation

The moderate, humid condition can be found in the Pacific Northwest, Mid-Atlantic and Mid-South regions of the United States. The NBS test facility, located in Gaithersburg, Maryland will serve as this test site.

Each of the commercial sites was determined by an industry inspection team to be capable of conducting tests in accordance with ASHRAE Standard 93-77 [11]. In addition, on-site checks of the instrumentation used by these laboratories were made by the Solar Energy Research and Education Foundation (SEREF) with their Laboratory Intercorrelation Test Equipment (LITE) apparatus as part of the DoE Collector Testing Program. In general, they were found to meet the required ASHRAE measurement specifications. Since the main concern of this study was in establishing the precision of the test method, detailed study of the type and accuracy of the individual sensors and apparatus used at each test facility was not considered necessary.

4.3 Measured Data

Four test series, each having a sample of the eight collector types, were measured at Sites 1 and 2, and two test series at Sites 3 and 4. The thermal performance of all collectors in Series 1, 3 and 4 was measured prior to outdoor stagnation testing. Collectors in Series 2 were exposed for three days to a minimum daily solar radiation of 17,100 KJ/m^2 (1500 Btu/ft^2) prior to the initial thermal performance measurements. Series 2 is intended to determine the significance of the three-day preconditioning exposure specified in ASHRAE Standard 93-77. The complete set of baseline data is tabulated in Appendix C. All the measured data required to calculate and generate the efficiency curves are recorded for each data point. In addition, the time, wind, diffuse fraction, collector orientation and tilt are listed.

Baseline data for all collectors measured are listed in Table 3 by intercept [optical efficiency, $F_R(\tau\alpha)_e$] and slope (heat loss coefficient, F_RU_L). The curve fits and resultant values reported by the test sites were verified using the data points supplied by each test facility.

The baseline data for the incident angle modifier consists of measurements made on most of the collectors at Sites 1, 2 and 3. Measurements were made on Collectors C and G along each of two orthogonal axes, i.e. parallel and perpendicular to the fluid-flow axis of the collector, because of special cover configurations causing non-symmetrical incident angle effects. The other collectors were not measured in the parallel direction. The test procedure describes two methods for incident angle modifier measurement. Test facilities No. 1 and No. 2 used a tracking mount and maintained a constant incident angle for each data point. Test facility No. 3 held the collector at a fixed tilt and orientation, and measured the efficiency when the sun was at the desired incident angle. The incident angle modifier can be expressed as:

$$K_{\alpha\tau} = 1 + B_o \left(\frac{1}{\cos\theta} - 1\right) \qquad (4)$$

where B_o = slope of the curve connecting data points plotted for $K_{\alpha\tau}$ versus $\left(\frac{1}{\cos} - 1\right)$ and

θ = the incident angle.

Table 3. Baseline Collector Intercept and Slope Data for All Collectors

Collector		A		B		C		D		E		F		G		H	
Test Site	Series	$F_R(\tau\alpha)$	F_RU_L	$F_R(\tau\alpha)$	F_RU_L	$F_R(\tau\alpha)$	F_RU_L	$F_R(\tau\alpha)$	F_RU_L	$F_R(\tau\alpha)$	F_RU_L	$F_R(\tau\alpha)$	F_RU_L	$F_R(\tau\alpha)$	F_RU_L	$F_R(\tau\alpha)$	F_RU_L
1	1	0.602	4.559	0.654	5.462	0.545	4.378	0.648	3.469	0.613	7.438	0.665	6.507	0.572	5.905	0.636	5.780
	2	0.596	4.440	0.640	5.428	0.520	3.969	0.633	3.174	0.598	6.445	0.638	6.728	0.567	5.428	0.641	5.485
	3	0.622	4.548	0.652	5.479	0.538	3.906	0.626	2.833	0.599	6.802	0.632	5.689	0.553	5.479	0.633	5.769
	4	0.601	4.429	0.666	5.457	0.540	4.463	0.640	3.197	0.590	6.132	0.644	6.092	0.563	5.462	0.643	5.502
2	1	0.608	5.252	0.654	5.388	0.524	4.524	0.640	3.412	0.588	6.496	0.636	6.802	0.549	5.542	0.626	6.019
	2	0.606	4.542	0.630	5.701	0.511	4.276	0.658	3.009	0.619	6.586	0.661	6.257	0.533	5.195	0.629	5.706
	3	0.612	4.491	0.648	5.599	0.557	4.741	0.655	3.458	0.602	7.035	0.668	6.075	0.546	5.400	0.623	6.110
	4	0.581	4.429	0.648	5.735	0.541	4.804	0.636	3.384	0.602	6.047	0.653	6.149	0.529	5.371	0.607	5.928
3	1	0.627	3.912	0.652	5.491	0.549	4.230	0.647	2.555	0.621	6.308	0.680	5.349	0.586	5.332	0.638	5.638
	2	0.613	3.662	0.636	5.178	0.517	4.043	0.635	2.203	0.595	5.581	0.660	4.968	0.550	4.548	0.627	5.570
4	1	0.607	4.293	0.672	5.212	0.552	4.151	0.636	3.055	0.619	6.257	0.654	5.809	0.588	5.587	0.640	5.144
	2	0.650	5.377	0.680	6.200	0.549	4.060	0.670	3.384	0.594	6.132	0.621	5.547	0.589	5.820	0.653	5.320

Note: These values have been calculated using gross collector area. Therefore, they must be multiplied by a factor of Ag/Aa to represent the true values designated by equation 3.

For the flat-plate collectors evaluated in this program, the incident angle modifier was essentially a linear function when plotted versus $(\frac{1}{\cos\theta} - 1)$. The baseline values of B_o for all measured collectors are shown in Table 4. Because of the sparsity of suitable clear days, no incident angle measurements were made at test facility No. 4.

Table 4. Incident Angle Modifier Baseline Data

COLLECTOR (IAM) Slope, B_o

Test Site	Series	A	B	C	D	E	F	G	H
1	1	-0.017	-0.102	-0.299	-0.177	-0.228	-0.091	-0.289	-0.095
	2	- .044	- .106	- .204	- .127	- .138	-0.048	- .212	- .100
	4	- .060	- .111	- .242	- .208	- .139	- .096	- .107	- .186
2	1	- .110	--	- .18(II)* - .29(I) **	- .110	--	- .110	- .18(II) - .15(I)	--
	4	- .090	--	- .19(II)* - .25(I) **	- .16	--	- .07	- .21(II) - .11(I)	--
3	1	- .142	- .145	- .280	- .204	- .157	- .181	- .168	- .092

*(II) measurements parallel to passageway

**(P) measurements perpendicular to passageway

5. DATA ANALYSIS

5.1 General

The data analysis was performed using the concepts and terminology recommended by ASTM Standard Recommended Practice E177 [12], where appropriate. A brief description of frequency, distribution, normal distribution, and the role of standard deviation is given in Appendix A.

The test sites supplied linear and polynomial equations representing first and second order curve fits to the data points. The linear equations were used for the analysis used in this report to expedite the calculations and simplify the presentation of heat loss coefficient data. Technical justification for the use of linear coefficients is provided in Section A-2, Appendix A.

5.2 Thermal Efficiency

The intercept and slope values listed in Table 3 are subject to two sources of variability: the random variability between individual collectors of the same type measured at the same site and the additional variability resulting from different sites. Each source is characterized by a standard deviation. The former is called the "within" (sites) standard deviation (s_r). The standard deviation encompassing both "within" sites variability and variability among sites is referred to as "between" sites standard deviation (s_R). Detailed descriptions of the statistical analysis methods are given in References 13, 14, and 15.

It is also possible to calculate the uncertainty, determined as a standard deviation, of the grand average thermal performance for each type of collector. Such a standard deviation, pertaining to an average, is generally called a standard error. Tables 5 and 6 list the mean, standard error and the standard deviation "within" and "between" sites for intercepts and slopes, respectively. The standard deviations are listed both in their original form and as relative percentage values of the overall mean.

There appears to be no relation between the standard deviations for any particular type of collector and the corresponding mean values. The variability exhibited by the standard deviations in a particular column of Table 5 and 6 is within the expected sampling errors of standard deviations based on the number of samples involved.

As might be expected, the "between" standard deviations that include site-to-site variability are somewhat larger than those measured for within-site variability. For intercepts, the coefficient of variation (standard deviation expressed as relative percent of the mean value) is about 2.1 percent for "within", cv_r, and 2.4 percent for "between", cv_R. The corresponding values for the slope are approximately 5.9 percent and 8.4 percent.

Graphical depiction of the spread of individual data points from each test site and a comparison with the ± 4 percent to ± 5 percent random error band associated by Jenkins and Hill [7] with the instrumentation and represented by the dashed lines is shown in Figures 4a and 4b for Collectors D and B, respectively. It should be noted that no data were rejected on the basis of being an "outlier." The data points include variations in factors such as the measurement and calculation of collector area, flow rate, tilt angle, and orientation (tracking or fixed).

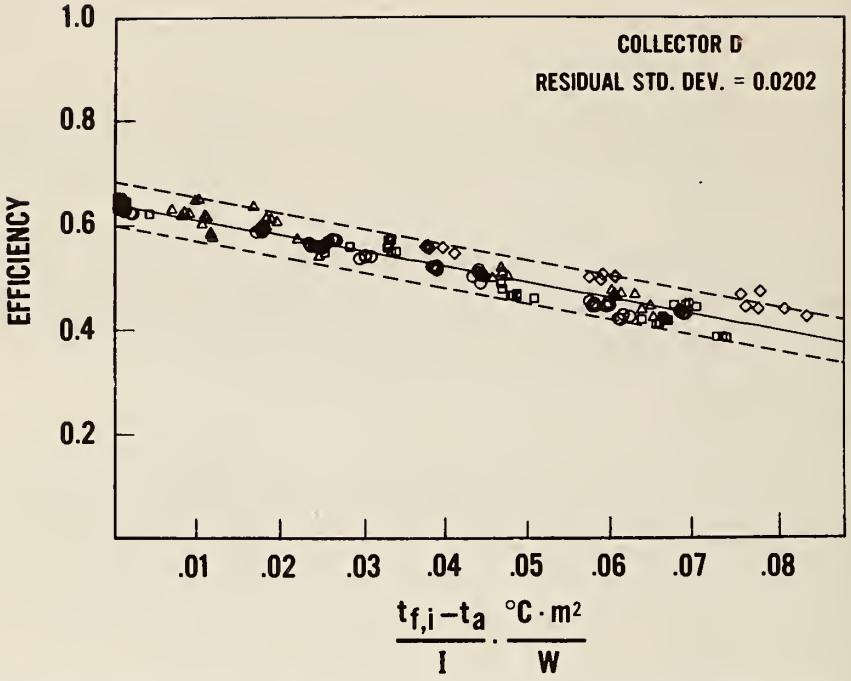

Figure 4a. Comparison of data point spread for double covered selective absorber type collector with uncertainty band

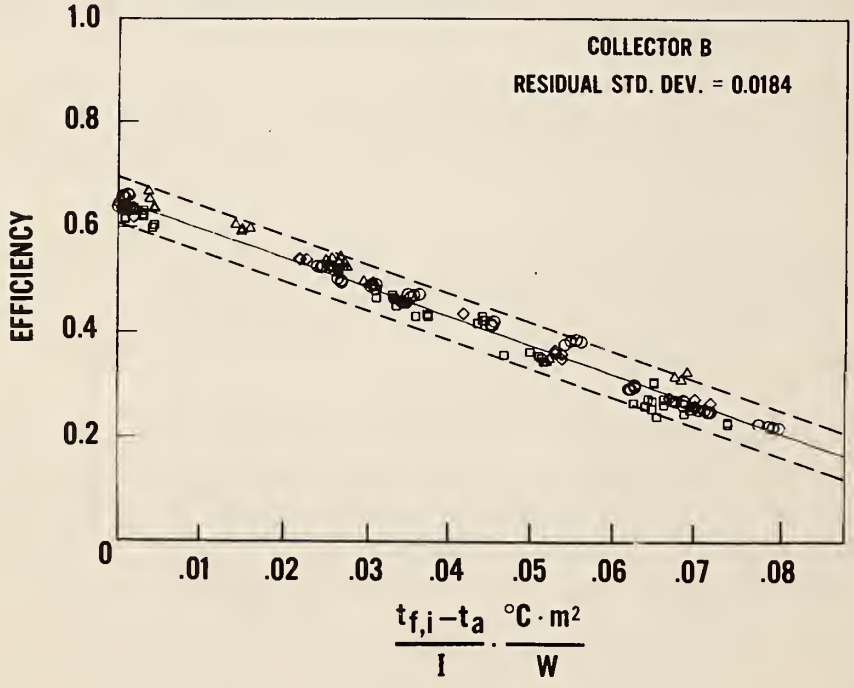

Figure 4b. Comparison of data point spread for double covered nonselective absorber type collector with uncertainty band

Table 5. Standard Deviation and Coefficient of Variation of Intercept Within and Between Test Sites

Collector	Intercept Mean	Standard Error of Mean		Standard Deviation and Coefficient of Variation			
				Within		Between	
		Value	Percent	s_r	$\%cv_r$	s_R	$\%c_R$
A	0.610	0.0061	0.99	0.0159	2.60	0.0176	2.88
B	0.652	.0073	1.11	.0105	1.60	0.0167	2.56
C	0.537	.0042	0.78	.0146	2.71	.0146	2.71
D	0.643	.0036	0.56	.0125	1.94	.0215	1.94
E	0.603	.0039	0.56	.0118	1.94	.0119	1.97
F	0.651	.0066	1.01	.0155	2.37	.0181	2.78
G	0.560	.0101	1.80	.0120	2.13	.0222	3.98
H	0.632	.0053	0.83	.0080	1.25	.0123	1.94

Average Coefficient of Variation Within ($\overline{\%cv_r}$) = 2.07%

Average Coefficient of Variation Between ($\overline{\%cv_R}$) = 2.39%

Table 6. Standard Deviation and Coefficient of Variation of Slope Within and Between Test Sites

Collector	Slope Mean ($W/°C \cdot m^2$)	Standard Error of Mean		Standard Deviation and Coefficient of Variation			
				Within		Between	
		Value	Percent	s_r	$\%cv_r$	s_r	$\%cv_R$
A	4.531	0.236	5.20	0.375	8.22	0.556	12.3
B	5.535	.078	1.41	.267	4.87	.267	4.87
C	4.287	.120	2.81	.233	5.48	.307	7.12
D	3.095	.216	6.98	.238	7.71	.471	15.26
E	6.439	.167	2.59	.466	7.22	.500	7.80
F	5.996	.254	4.51	.363	6.07	.613	10.20
G	5.405	.145	2.69	.278	5.16	.363	6.77
H	5.661	.145	2.56	.153	2.70	.312	5.54

Average Coefficient of Variation Within ($\overline{\%cv_r}$) = 5.93%

Average Coefficient of Variation Between ($\overline{\%cv_R}$) = 8.37%

5.3 Incident Angle Modifier (IAM)

Although the total sample size for incident angle modifier (IAM) measurements is only one-half that for thermal efficiency, these data are important because of the lack of comparative IAM data and the interest in values for calculating all-day performance. Analysis of the data listed in Table 4 was performed for two individual test sites and combined for three test sites as shown in Table 7. The mean values for Collectors A and G exhibited relatively large differences for "within" data. The corrugated outer cover on Collector G probably influences the angular transmittance, and this combined with the difference in diffuse solar fraction between test sites (about 10 percent at Site 1 and about 25 percent at Site 2) could contribute to the large differences found for this collector. There is no apparent reason for the large difference for Collector A. The "within" test site standard deviations do not exhibit a consistent trend with collector type.

Analysis of the IAM data to obtain "between" site standard deviation shows a large variation with collector type but the average coefficient of variation (expressed in percent) of 34 percent remains about the same with or without the extreme high or low values shown for collectors A, C, E, and F. Variations in IAM of this magnitude cannot be attributed to product variability for the flat-plate collectors used in this program.

Table 7. Incident Angle Modifier Standard Deviation Values Within and Between Test Sites

Data Source	Parameter	Collector Type								Average %cv
		A	B	C	D	E	F	G	H	
Test Site #1	Mean	0.040	0.106	0.248	0.170	0.168	0.078	0.203	0.127	
	Standard Error	.013	.003	.028	.024	.030	.015	.053	0.030	
	Standard Deviation	.022	.005	.048	.041	.052	.026	.091	0.051	
	$\%cv_r$	55	4.2	19	24	31	33	45	39	$\overline{\%cv_r} = 31$
Test Site #2	Mean	0.100	--	0.270	0.135	--	0.090	0.130	--	
	Standard Error	.010	--	.020	.025	--	.020	.020	--	
	Standard Deviation	.014	--	.028	.035	--	.028	.028	--	
	$\%cv_r$	14	--	10	26	--	31	22	--	$\overline{\%cv_r} = 20.6$
Test Sites 1, 2 & 3	Mean	0.094	0.125	0.261	0.165	0.165	0.113	0.173	0.118	
	Standard Error	.029	.019	.014	.017	.021	.032	.028	.023	
	Standard Deviation	.052	.027	.036	.040	.043	.057	.069	.045	
	$\%cv_R$	57	22	14	24	26	51	40	38	$\overline{\%cv_R} = 34$

6. IMPACT OF DATA UNCERTAINTY

6.1 General

The uncertainty associated with commercial collector performance data is seldom published by the manufacturer and is not required to be reported by the test method. Three applications for typical thermal performance data have been selected for illustration of the impact of the data uncertainty discussed above, as follows:

- o Evaluation of collector degradation
- o Collector rating
- o System performance prediction.

6.2 Collector Degradation

One method of quantitatively evaluating changes in the material properties or thermal characteristics of a collector is to perform thermal efficiency tests before and after non-operational exposure testing. Depending upon the data uncertainty, thermal performance measurements could reveal incremental changes in the cover solar transmittance, plate solar absorptance or emittance, and changes in insulation thermal conductivity. Analytical studies of probable error resulting from instrumentation only [16] indicated that an uncertainty band of about 4 percent in the thermal performance could be obtained. This uncertainty in knowing the actual thermal performance corresponds to changes in the solar transmittance, absorptance or emittance of about 0.10 and a change in back insulation thermal conductivity of about 50 percent for the collectors studied in this program. Consequently, changes in material properties of this magnitude would be required to clearly discern material property changes from the measurement uncertainty band for many flat-plate collectors.

The influence of changes in the solar transmittance (τ) of the cover material for Collector A is illustrated in Figure 5. The dark curves represent the calculated first order efficiency curve for τ values of 0.90 and 0.82. The light curves represent the instrumentation uncertainty associated with this collector and indicates that a change of 0.08 in τ would be required to positively conclude that a material property change had occurred. An uncertainty of 0.025 at a nominal intercept value of 0.60 represents a 4 percent change in relative efficiency which is approximately equal to the 2σ "within" site coefficient of variation (4.1 percent) determined for intercept measurements reported in this study. Therefore, thermal performance measurements may not be sensitive to material degradation changes incurred during short-term (30-day) durability tests.

6.3 Collector Rating

Rating a solar collector on the basis of thermal performance is useful for several purposes. Among the primary ones of interest to the consumer are:

- o To rank collectors on the basis of all-day output
- o To determine the relative difference (%) in energy output for a specific application.

One proposed rating method [17] for ranking collectors uses the ASHRAE Standard 93-77 curve (efficiency and incident angle modifier) to calculate the collector daily thermal output for days with specified inlet temperature, solar radiation and ambient temperature.

The influence of data uncertainty on all-day collector energy output was calculated for four flat-plate collectors with the properties and data uncertainties shown in Table 8. Calculations were made with a clear day solar radiation profile occurring at 40°N latitude, 0°C ambient temperature and a 60°C (140 F) collector inlet temperature. The data uncertainties used for the intercept, slope and incident angle modifier slope were determined from the baseline data analysis. Computations

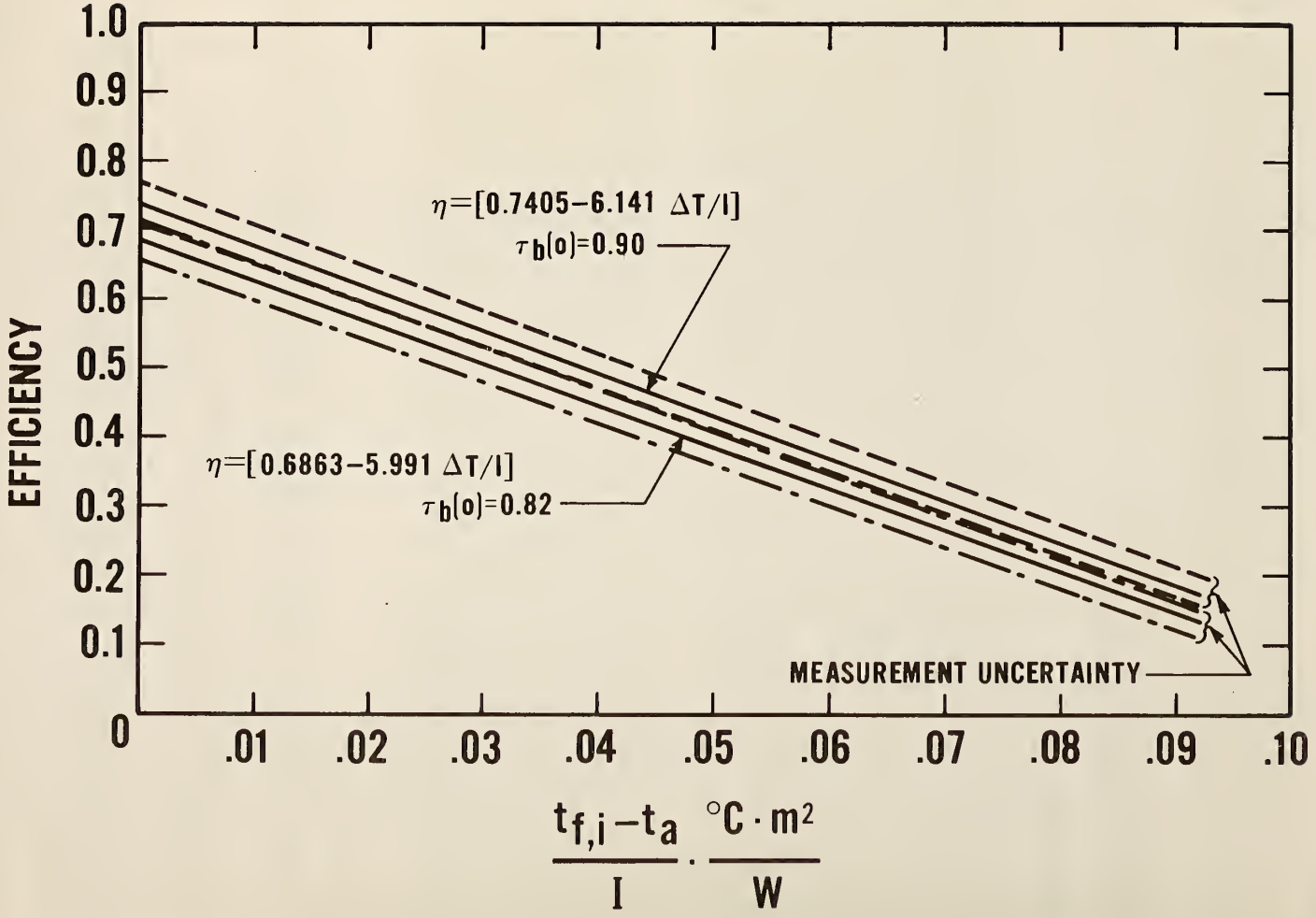

Figure 5. Sensitivity of a single glazed selective absorber type collector to changes in transmittance

Table 8. Thermal Performance Properties of Four Typical Flat Plate Collectors and Associated Data Uncertainties

Collector Type			$F_R(\tau\alpha)$	$F_R U_L$ ($W/°C \cdot m^2$)	IAM $-B_o$
No.	Cover	Absorber			
1	1 Glass	Black Paint	0.670	-6.132	-0.080
2	1 Glass	Selective	0.695	-5.337	-0.095
3	1 Fiber Reinforced Plastic	Black Paint	0.600	-6.019	-0.150
4	2 Glass	Selective	0.642	-3.174	-0.175

Measurement Uncertainties (Assumed):

$F_R(\tau\alpha)$ $\pm$ 4.1%

$F_R U_L$ $\pm$ 11%

B_o $\pm$ 20%

were made for the nominal intercept and slope value, and the combination of uncertainties that would yield the lowest energy output, the greatest energy output, and a mixture of high and low uncertainties to give an intermediate energy output as shown in Table 9. Rankings based upon the outputs for each calculation series are shown not to change for the collectors evaluated. However, when comparing the energy output of a collector with a high combination of uncertainties to the energy output of another collector with a low combination of uncertainties, a different ranking can be obtained.

6.4 System Performance

The prediction of a solar energy system's seasonal or annual performance with respect to meeting the heating or domestic hot water load can be calculated using system simulation programs. The f-chart method [18] is based upon a correlation technique derived from detailed modeling of a typical solar heating and hot water system in a number of U.S. cities with different combinations of component characteristics, sizes and loads. The collector performance, characterized by the first-order efficiency curve and the IAM slope, is used in conjunction with average local weather conditions and the site dependent load to determine the contribution to the load (fraction of the load) made by solar energy. F-chart calculations were made for a 152 m^2 residence occupied by a family of four and located in Madison, Wisconsin and in Washington, D.C. (see Appendix D for system description). The nominal collector area with a double cover selective absorber and a single cover flat black absorber, to provide 0.50 and 0.75 of the annual heating requirements for each location, were calculated as shown in Table 10. The solar fractions for the same areas were also calculated using the high and low values of collector uncertainty obtained from the baseline analysis shown in Table 7. Differences of about $\pm$0.03 in solar fraction are attributed to the efficiency uncertainty for Collector 4 and about $\pm$0.045 for Collector 1. The 0.50 system fraction is somewhat more sensitive to the uncertainty values than the 0.75 system fraction for Collector 1.

The influence of a $\pm$20 percent uncertainty in the IAM for either flat-plate collector is shown in Table 10 to have less than a $\pm$0.01 effect on the annual system solar fraction. A sensitivity study of the relationship between the value of B_o and the normalized solar fraction for the solar heating and domestic hot water system example is shown for Collectors 1 and 4 in Figure 6. The solid curves are for the month of December and the dashed curves are for the annual performance in Madison, Wisconsin. Changes in the incident angle modifier slope of $\pm$0.05 or about $\pm$28 percent for a nominal value of B_o = 0.175 would result in a relative percentage change in annual solar fraction of about $\pm$3.0 percent for Collector 4 and $\pm$2.5 percent for Collector 1.

Table 9. Measurement Uncertainty Influence on Rating
[Winter Rating T_{IN} = 60°C (140 F)]

Collector Type \ Daily Collected Energy	(Nominal Properties) (W/m^2)	Rank	Measurement Uncertainty					
			With High Uncertainty (W/m^2)	Rank	With Low Uncertainty (W/m^2)	Rank	With Mixed Uncertainty (W/m^2)	Rank
1 (SG, FB)	709	3	1058	3	407	3	821	3
2 (SG, SS)	1075	2	1435	2	750	2	1169	2
3 (SF, FB)	455	4	764	4	197	4	556	4
4 (DG, SS)	1647	1	1956	1	1357	1	1676	1

Table 10. Collector Measurement Uncertainty Influence on System Prediction
(f-Chart Predicted Solar Fractions for Solar Heating and
Domestic Hot Water System)

Collector	Uncertainty	Madison Solar f	Madison Solar f	D.C. Solar f	D.C. Solar f
		Area = 51 m^2	Area = 127 m^2	Area = 31 m^2	Area = 78 m^2
4	Nominal (2 GL + SS)	0.500	0.750	0.500	0.750
	High $F_R(\tau\alpha)$, Low F_RU_L	0.530	0.785	0.529	0.788
	Low $F_R(\tau\alpha)$, High F_RU_L	0.470	0.712	0.471	0.712
	High B_o	0.492	0.721	0.492	0.720
	Low B_o	0.508	0.759	0.508	0.760
		Area = 92 m^2	Area = 196 m^2	Area = 55 m^2	Area = 124 m^2
1	Nominal (1 GL + FB)	0.500	0.750	0.500	0.750
	High $F_R(\tau\alpha)$, Low F_RU_L	0.545	0.767	0.544	0.773
	Low $F_R(\tau\alpha)$, High F_RU_L	0.459	0.733	0.458	0.732
	High B_o	0.496	0.746	0.495	0.746
	Low B_o	0.505	0.753	0.504	0.754

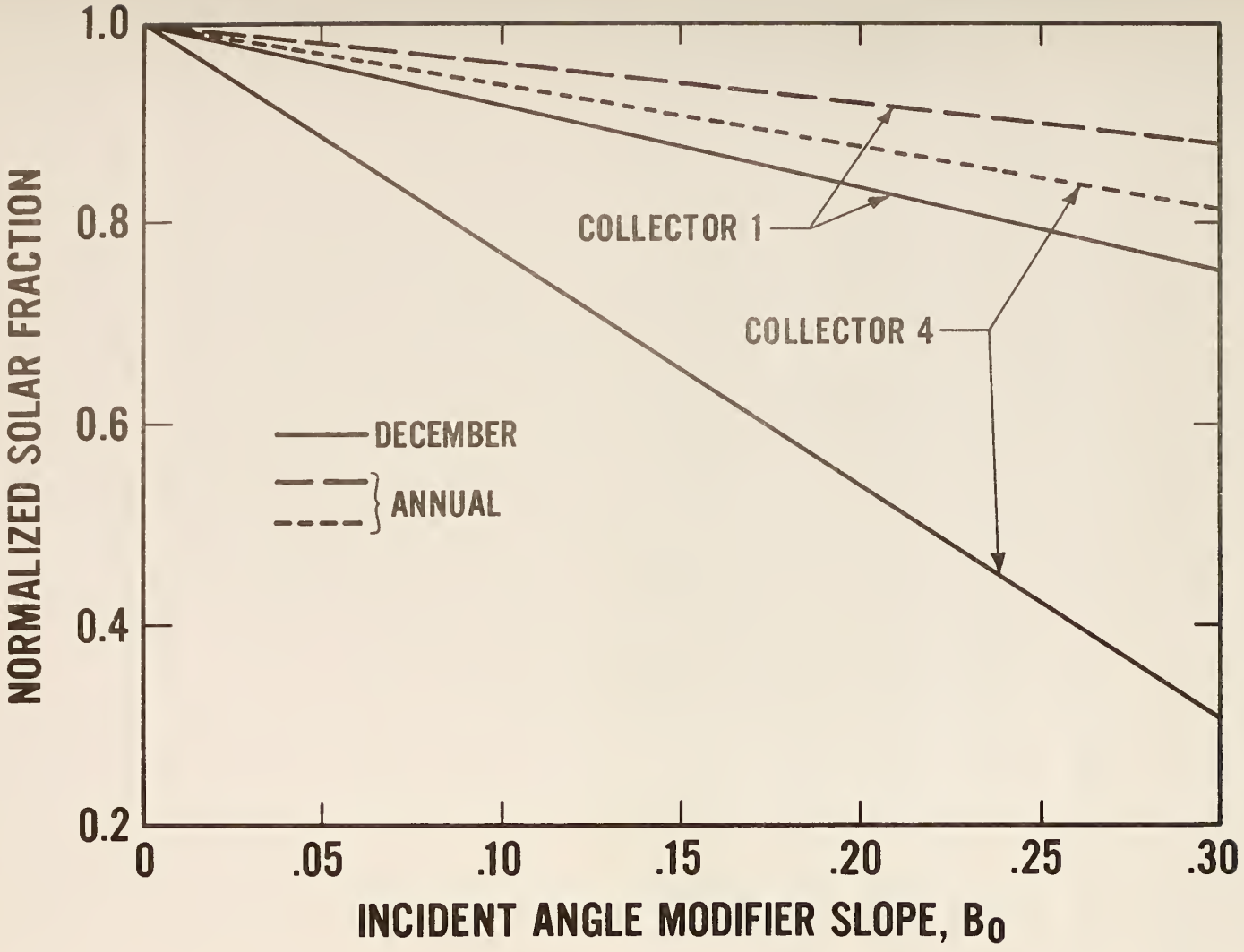

Figure 6. The relationship between solar fraction and incident angle modifier slope for December and annual performance

7. CONCLUSIONS

Statistical analysis of the thermal performance data sets obtained on eight liquid-heating, flat-plate solar collectors at four test sites broadly dispersed in the United States have confirmed that the total experimental uncertainty is about the same as the probable estimate of random error predicted for the use of ASHRAE Standard 93-77. Measurement error is believed to be the major contributor to the "within" test site variability (repeatability), and environmental effects a significant factor influencing the slope (loss coefficient) data obtained "between" test sites (reproducibility). No evidence of product variability was discerned for the various collector types.

On the basis of first-order curve fits of the data points, an average "within" test site coefficient of variation, $\%\overline{cv}_r$, of 2.1 percent and "between" test site coefficient of variation, $\%\overline{cv}_R$, of 2.4 percent was calculated for the intercept $[F_R\ (\tau\alpha)_e]$.

Similar data for the overall heat loss coefficient, $F_R U_L$, indicated "within" ($\%\overline{cv}_r$) coefficient of variation value of 5.93 percent and "between" ($\%\overline{cv}_R$) of 8.37 percent. The coefficient of variation ($\%\overline{cv}_R$) for incident angle modifier data of 34 percent was shown based upon measurements at three test sites. Application of these uncertainty values to three application areas where thermal performance data have significant impact were shown as follows:

- Material degradation equivalent to about a 0.10 change in cover transmittance or absorber solar absorptance and emittance
- Variations in collector all-day thermal output of from $\pm$17 to $\pm$68 percent for specific winter operating conditions resulting in significant ranking changes
- Variations in residential annual heating and domestic hot water solar fraction of $\pm$6 to 7 percent.

8. RECOMMENDATIONS

The establishment of data uncertainty and measurement precision for commercial products requires careful evaluation of test procedures and continued vigilance of experimental facilities. It is recommended that a systematic evaluation of the test procedure be conducted within at least three test sites with replicate measurements (using the same "standard" collector types at each site). Collectors with stable but different material configuration designs should be selected. Some of the factors that should be considered are:

- o Absorbers with serpentine flow, headers with parallel passage and fully wetted
- o Curved covers vs. flat
- o Selective vs. non-selective coatings
- o Relative high loss vs. low loss design (edge and back).

These measurements should be conducted with test apparatus that has been calibrated to the same field reference using a reference heat source or equivalent procedure. Measurements should be conducted under a range of local conditions as permitted by the test procedure (ambient temperature, wind, irradiance, diffuse fraction).

Initial testing should be conducted on all collectors at one site using the same instrumentation. Series testing of groups of about four collectors utilizing one collector as a reference in all tests would minimize instrumentation uncertainties associated with the flow and solar irradiance measurements. The collectors would be measured once per month at each site over a six-month period (to include summer and winter) with the largest meteorological variations. At the conclusion of the program, the collectors could be returned to the site of the initial testing to corroborate the results if the uncertainties were larger than suspected from statistical principles of the sampling number.

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APPENDIX A: DATA STATISTICAL ANALYSIS

A-1 General

The rectangles shown in Figure A-1a constitute a histogram in which the base (A,B) of the rectangle ABCD represents a small interval of possible results of the measuring process. The area of the rectangle ABCD represents the relative frequency of values lying in the interval AB. As larger and larger data samples become available, the total range of values can be divided into smaller intervals. The histogram then generally approaches a smooth curve called a frequency distribution such as illustrated in Figure A-1b.

A precise measuring process is represented by a narrow frequency distribution. The smaller the precision, the wider the frequency distribution will be (see Figures A-1c and A-1d). The width of a distribution is measured by its "standard deviation," σ, which is a quantity expressed in the same units as the measured value. Thus, the standard deviation is an inverse measure of the precision.

A type of frequency distribution that is of great theoretical and practical importance is the "normal" (or "Gaussian") distribution. In a normal distribution, an interval extending from a point located at one standard deviation below the mean to one located at one standard deviation above the mean, will correspond to a relative frequency (probability) of about 2/3 (68.27 percent). This is a ± 1 sigma interval. The probability corresponding to a ± 2 sigma interval is approximately 95 percent and that corresponding to a ± 3 sigma interval is about 99.7 percent, as illustrated in Figure A-1c. The probabilities are measured by the area bounded by the curve on top and by the lower and upper limits of the interval on both sides. These probabilities pertain to the normal curve and one not necessarily correct for other types of distributions.

A measuring process generally contains more than one source of variation (imprecision). Each source will have a frequency distribution with a definite sigma value. The joint effect of the various sources of error is a frequency distribution resulting from the superposition of the various individual curves. The standard deviation corresponding to this overall curve is the square root of the sum of the squares of the individual standard deviation. The square of the standard deviation is called the "variance."

The central value, or "mean," of a frequency distribution is not necessarily the "true value" of the quantity measured. The distance between the "true value" and the mean of the distribution is called the "bias" of the method. Often the true value is not known and must be replaced by a "nominal" or "reference" value. A method with a large bias is said to be inaccurate or of low accuracy (see Figure A-1e).

A-2 Residual Standard Deviation

When a curve (or straight line) is fitted to a set of data points, the vertical distance between the observed points and the fitted curve can also be measured in terms of a standard deviation. The smaller this "standard deviation of fit" (also called standard deviation of residuals or residual standard deviation), the better the fit.

A comparison of the standard deviation of the residuals for the curve fits for each data point for Collectors C and E are shown in Figures A-2a and A-2b. Collector C had the lowest residuals (least deviation from a linear fit) and Collector E had the greatest deviation. Relatively little difference is indicated between the first- and second-order curve fits; consequently, first order curves were used to represent the intercept and slope. Table A-1 lists the residual standard deviation for curve fits to each collector data set.

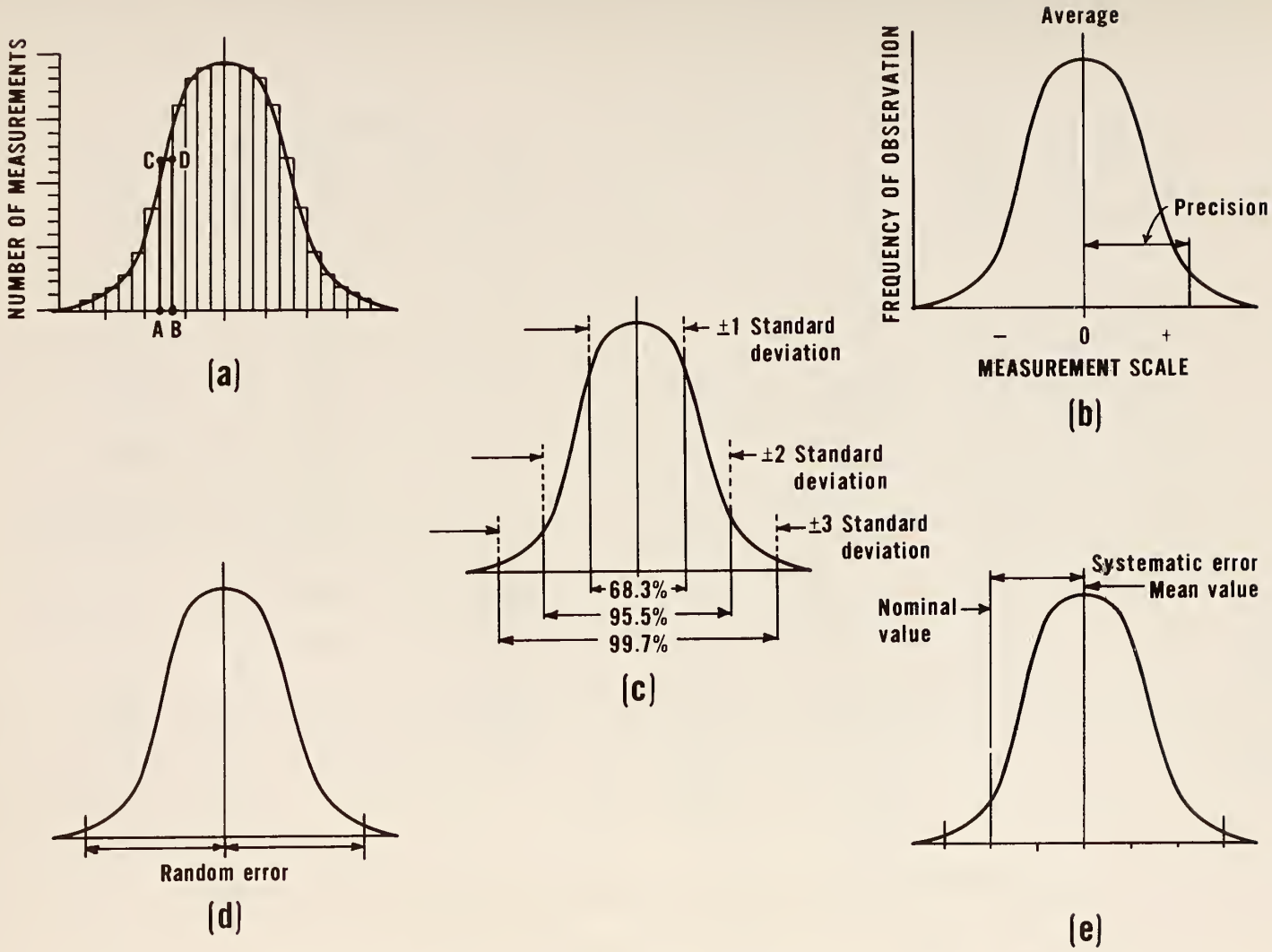

Figure A-1. Illustrations of the calculation and significance of standard deviation

Table A-1. Data Point Residual Standard Deviations for All Measurements

Test Site	Series	Collector Type							
		A Res Std Dev	B Res Std Dev	C Res Std Dev	D Res Std Dev	E Res Std Dev	F Res Std Dev	G Res Std Dev	H Res Std Dev
1	1	.01612	.01060	.01639	.01271	.01769	.01078	.01239	.01024
	2	.01563	.00652	.00537	.00355	.00810	.00774	.00430	.00363
	3	.00751	.01310	.01330	.00437	.00872	.00497	.00574	.01974
	4	.0727	.01394	.00483	.00506	.00553	.00603	.00384	.00815
2	1	.00992	.01202	.00312	.00660	.00711	.00444	.01082	.00926
	2	.00391	.01099	.00352	.00859	.01301	.00929	.01417	.01268
	3	.00907	.00471	.00453	.00857	.00572	.00907	.00740	.01767
	4	.00765	.00720	.00194	.00906	.01183	.00470	.00318	.00800
3	1	.01184	.00582	.02284	.00795	.00812	.01375	.02089	.00930
	2	.00365	.01362	.01625	.00632	.01421	.00473	.01367	.04880
4	1	.00753	.01003	.01095	.01510	.01439	.01203	.01167	.00811
	2	.01748	.01639	.00788	.01346	.01497	.00976	.00705	.00583

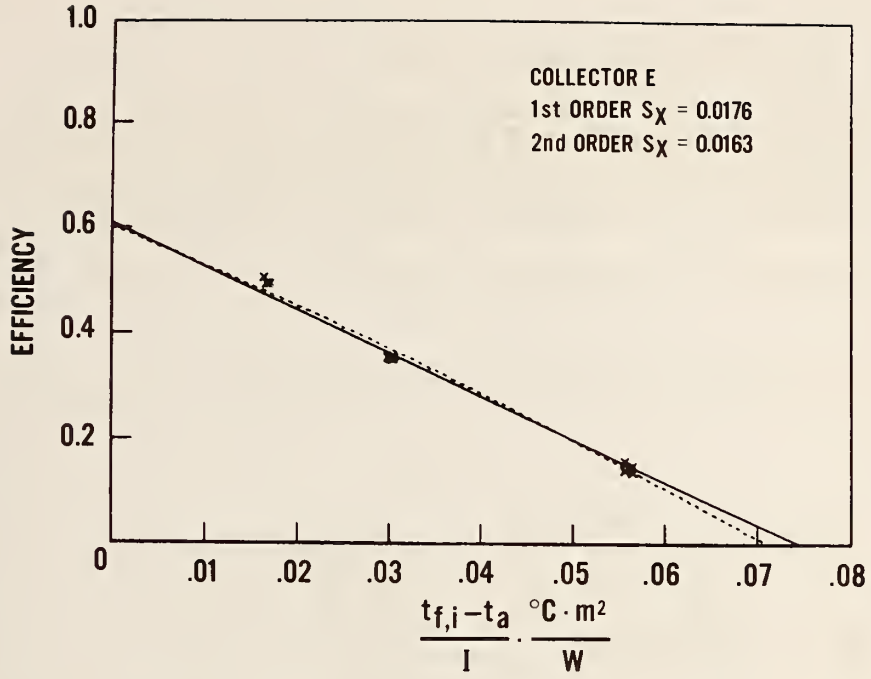

Figure A-2a. Comparison of first and second order curve fits for FRP covered nonselective absorber type collector

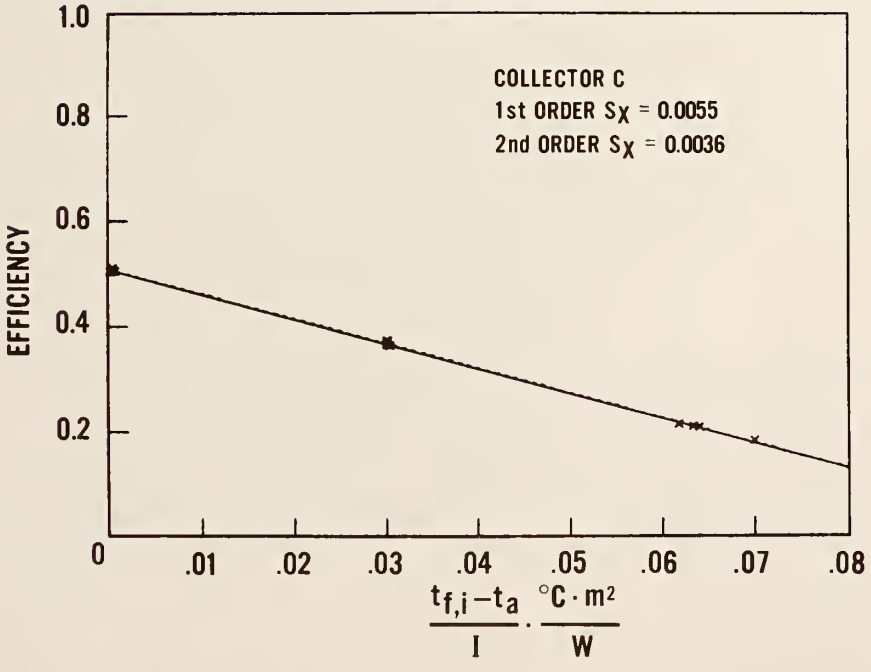

Figure A-2b. Comparison of first and second order curve fits for one cover, heat trap, nonselective absorber type collector

APPENDIX B: DETAILED COLLECTOR DESCRIPTION DATA

Table B-1 lists the important dimensions and material properties required for thermal analytical modeling. Most information was obtained from the manufacturers' literature. When the literature was not available, dimensions were taken from one collector. Handbook property values for thermal conductivity, refractive index and extinction coefficient were used when not specified by the manufacturer.

Table B-2 lists collector area measurements made for each collector at Test Site 1. Calculations of the standard deviation and "within" test site coefficient of variation are shown.

Table B-3 lists collector area measurements reported by each facility. Calculation of the standard deviation and "between" test site coefficient of variation is shown.

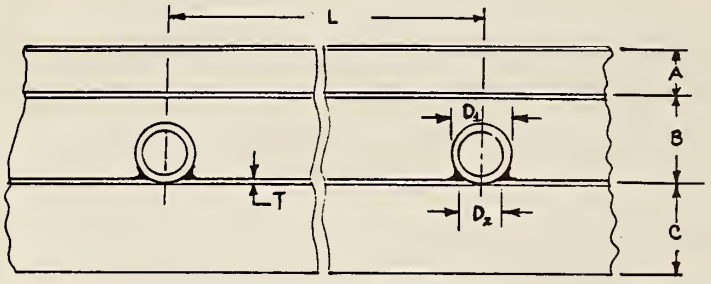

Table B-1. Collector Material Properties and Pertinent Dimensions

Component	Property or Dimension	Collector Designation							
		A	B	C	D	E	F	G	H
Outer Cover	Thickness (mm)	4.80	3.175	3.175	3.175	0.965	4.70	0.813	0.18
	Refractive Index	1.52	1.52	1.52	1.3	1.54	1.52	1.54	1.68
	Extinction Coefficient	0.003	0.0095	0.020	0.0095	0.0565	0.003	0.06	0.237
	Space A (mm)	---	6.35	10	25	---	---	33.3 (max)	12.7
Inner Cover	Thickness (mm)	---	3.175	0.04	3.175	---	---	0.0254	0.0254
	Refractive Index	---	1.52	Heat	1.3	---	---	1.33	1.33
	Extinction Coefficient	---	0.0095	Trap	0.0095	---	---	0.0658	0.0658
	Space B (mm)	3.175	25.4	102	37	60	19.1	25.4	25.4
Absorber Plate (Mild Steel)	Thickness (mm)	2.03	0.813	0.75	9.0	0.406	0.241	2.64	1.79
	Thermal Conductivity*	45	360	360	45	360	360	45	200
	Flow Length (m)	1.92	1.91	2.26	1.73	2.915	2.01	2.445	2.34
	Effective Width (m)	0.953	0.838	0.851	0.813	0.559	0.88	0.895	1.13
Fluid Passage	Tube-D_1 (mm)	22.2	10.39	NA[1]	6.35	16.06	11.1	NA[2]	15.9[3]
	Tube-D_2 (mm)	15.8	9.58	NA	4.93	12.7	7.94	NA	12.7
	Spacing-L (mm)	114	140	NA	76.2	114.3	152.4	NA	152.4
	Volume (liter)	3.96	1.01	1.8	1.08	2.48	1.29	0.76	2.34
Back Insulation	Thickness (mm)	76.2	76.2	101.6	88.9	25.4	38.1	25.4	25.4
	Thermal Conductivity (Effective W/m·°C)	0.035	0.04	0.027	0.04	0.02	0.024	0.02	0.02
Edge Insulation	Thickness (mm)	6.4	25.4	50.8	25.4	25.4	25.4	NA	25.4
Back Panel	Thickness (mm)	0.58 (steel)	0.64 (Al)	1.0 (Al)	0.76 (steel)	1.60 (Al)	0.81 (Al)	0.60 (steel)	0.025 (Al)

[1] Absorber plate is pressure bonded. [2] Absorber plate is stitch-welded. [3] Passageway has serpentine flow patte

*$W/m^2 \cdot C$

Table B-2. Individual Collector Area Measurements by Test Site No. 1

Collector \ Series	1 (ft^2)	2 (ft^2)	3 (ft^2)	4 (ft^2)	Mean (ft^2)	Std Dev s_r	Coeff. of Var. (%)
A	23.35	23.35	23.30	23.40	23.35	0.041	0.175
B	18.70	18.75	18.70	18.78	18.73	.039	.211
C	28.12	28.05	28.16	28.12	28.11	.046	.163
D	18.00	17.94	17.91	17.91	17.94	.042	.236
E	20.68	20.56	20.57	20.51	20.58	.072	.348
F	20.73	20.84	21.26	20.81	20.91	.238	1.14
G	27.80	27.88	27.88	27.81	27.84	.043	.156
H	31.50	31.61	31.50	31.60	31.55	.061	.193

Average Coefficient of Variation, $\overline{\%cv_r}$ = .328%
($\overline{\%cv_r}$ = 0.212% without 1.14 outlier value)

Table B-3. Collector Area Measurements for Each Test Site

Collector \ Test Site	1 (ft^2)	2 (ft^2)	3 (ft^2)	4 (ft^2)	Mean (ft^2)	Std Dev s_r	Coeff. of Var. (%)
A	23.35	23.19	22.81	23.16	23.13	0.228	0.99
B	18.73	18.72	18.37	18.71	18.64	0.175	0.94
C	28.11	27.88	27.56	27.87	27.86	0.226	0.81
D	17.94	17.88	17.53	17.88	17.81	0.187	1.05
E	20.58	20.35	20.17	20.32	20.36	0.169	0.83
F	20.91	20.71	20.38	20.70	20.68	0.219	1.06
G	27.84	27.64	27.25	27.60	27.58	0.245	0.89
H	31.55	31.51	30.94	31.51	31.38	0.292	0.93

Average Coefficient of Variation, $\overline{\%cv_R}$ = 0.94%

APPENDIX C: THERMAL PERFORMANCE DATA

The test data and measured efficiencies are tabulated in the ASHRAE Standard 93 prescribed format for all efficiency tests. The data are identified by collector type, series number, and laboratory number (test site). In view of the present accepted practice in this country for building technology, common U.S. units of measurement have been used for the data tables.

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : A
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 06/19/79
GROSS AREA : 23.350 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	170	9:30	9:35	338.9	7.9	13.1	0.0	85.0	82.5	98.0	15.5	33.7	81.8	0.0	59.7	-0.0070
02	170	9:35	9:40	339.0	7.8	13.1	0.0	84.4	82.7	98.2	15.5	32.7	80.9	0.0	59.6	-0.0050
03	170	9:40	9:45	339.8	7.8	13.2	0.0	84.8	82.9	98.2	15.4	31.6	79.9	0.0	59.4	-0.0050
04	170	9:45	9:50	339.9	7.6	13.3	0.0	84.0	83.0	98.4	15.4	30.6	78.9	0.0	59.9	-0.0030
05	170	9:50	9:55	340.3	7.4	13.2	0.0	84.9	83.2	98.5	15.3	29.6	77.8	0.0	59.4	-0.0050
06	174	12:42	12:47	334.8	8.5	12.9	0.0	99.1	190.6	200.4	9.9	14.3	- 46.4	0.0	38.2	0.2730
07	174	12:47	12:52	334.1	8.3	12.9	5.7	99.9	190.5	200.3	9.8	15.1	- 49.7	0.0	38.1	0.2710
08	174	12:58	13:03	337.8	8.6	12.9	6.3	100.0	190.0	199.6	9.6	16.9	- 56.1	0.0	36.9	0.2660
09	174	13:03	13:08	334.9	8.5	12.9	0.0	99.3	190.2	199.8	9.6	17.8	- 58.6	0.0	37.0	0.2710
10	174	14:05	14:10	331.9	9.4	13.0	0.0	101.5	212.8	221.1	8.3	29.8	- 78.1	0.0	32.8	0.3350
11	174	14:10	14:15	333.0	9.7	13.0	5.7	101.0	212.4	221.0	8.6	30.8	- 79.1	0.0	33.8	0.3340
12	174	14:15	14:20	333.3	9.9	13.0	2.8	101.7	212.4	220.7	8.3	31.8	- 80.1	0.0	32.5	0.3320
13	174	14:20	14:25	332.4	10.0	13.0	4.0	101.8	212.2	220.6	8.4	32.9	- 81.1	0.0	32.7	0.3320
14	174	15:10	15:15	325.8	10.7	12.9	0.0	100.3	147.8	160.6	12.8	43.2	- 89.2	0.0	50.7	0.1460
15	174	15:15	15:20	324.9	10.8	12.9	0.0	99.7	147.7	160.6	12.9	44.2	- 89.9	0.0	51.3	0.1480
16	174	15:20	15:25	324.0	10.8	12.9	0.0	100.5	147.6	160.4	12.9	45.3	- 90.6	0.0	51.2	0.1450
17	174	15:25	15:30	323.7	10.9	12.9	4.8	100.1	147.6	160.3	12.7	46.3	- 91.3	0.0	50.6	0.1470

COLLECTOR I.D : A
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 07/02/79
GROSS AREA : 23.350 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	183	10:30	10:35	325.4	10.9	13.0	5.7	94.0	209.1	217.1	8.0	21.9	66.2	0.0	32.3	0.3540
02	183	10:35	10:40	327.2	10.4	12.9	8.5	94.2	209.8	217.1	7.3	20.9	64.4	0.0	28.8	0.3530
03	183	10:40	10:45	327.0	10.6	13.0	5.7	93.8	209.0	217.3	8.3	20.0	62.4	0.0	33.2	0.3520
04	183	10:45	10:50	325.2	10.8	12.9	0.6	93.5	208.4	216.5	8.2	19.1	60.3	0.0	32.5	0.3530
05	183	11:55	12:00	320.0	12.6	13.1	4.0	96.2	140.9	153.5	12.6	10.8	2.5	0.0	51.8	0.1400
06	183	12:00	12:05	324.6	12.3	13.0	6.8	95.6	141.1	153.0	11.9	10.8	- 1.4	0.0	47.9	0.1400
07	183	12:05	12:10	324.2	12.1	13.1	4.5	94.5	141.4	153.4	12.0	10.9	- 1.4	0.0	48.4	0.1450
08	183	12:10	12:15	323.4	12.1	13.1	2.3	95.4	141.2	153.5	12.2	11.2	- 2.4	0.0	49.3	0.1420
09	186	10:25	10:30	333.2	7.8	13.0	4.5	94.9	93.7	109.0	15.2	23.0	67.3	0.0	59.2	-0.0040
10	186	10:30	10:35	333.1	7.7	13.0	7.4	94.4	93.8	109.1	15.3	22.0	65.6	0.0	59.6	-0.0020
11	186	10:35	10:40	333.6	7.6	13.0	1.1	94.7	93.8	109.2	15.4	21.1	63.8	0.0	59.8	-0.0030
12	186	10:40	10:45	334.1	7.6	12.9	6.8	95.1	94.0	109.3	15.3	20.2	61.8	0.0	58.9	-0.0030

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : A
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 04/14/79
GROSS AREA : 23.330 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	104	10:25	10:30	344.9	7.8	13.1	5.2	80.3	200.7	209.6	8.8	32.6	45.8	0.0	33.9	0.3490
02	104	10:30	10:35	345.1	7.8	13.0	5.6	80.8	200.4	209.5	9.1	31.9	43.9	0.0	34.5	0.3470
03	104	10:35	10:40	345.1	7.8	13.1	0.0	81.1	200.6	209.3	8.7	31.1	42.0	0.0	33.1	0.3460
04	104	10:40	10:45	346.0	7.8	13.1	4.1	80.6	200.3	209.4	9.1	30.5	40.0	0.0	34.8	0.3460
05	104	11:35	11:40	346.3	7.8	12.8	4.8	83.1	144.4	157.8	13.3	25.3	12.8	0.0	49.4	0.1770
06	104	11:40	11:45	346.4	7.9	12.8	0.0	83.9	144.5	157.6	13.1	25.1	9.9	0.0	48.4	0.1750
07	104	11:50	11:55	347.4	7.9	12.8	1.1	82.5	144.4	157.5	13.2	24.8	4.1	0.0	48.4	0.1780
08	104	12:10	12:15	344.9	8.0	12.7	1.1	83.3	143.8	157.1	13.3	25.0	- 7.6	0.0	48.9	0.1760
09	104	13:30	13:35	344.7	8.5	12.9	1.1	85.8	86.9	103.4	16.5	32.7	- 46.1	0.0	61.5	0.0030
10	104	13:35	13:40	345.1	8.9	12.9	2.3	84.4	87.2	103.5	16.3	33.5	- 47.9	0.0	61.0	0.0080
11	104	13:40	13:45	344.3	8.9	12.9	4.0	85.1	87.3	103.7	16.4	34.3	- 49.6	0.0	61.2	0.0070
12	104	13:45	13:50	342.5	9.0	12.9	0.0	85.2	87.4	103.8	16.5	35.1	- 51.3	0.0	61.9	0.0060

COLLECTOR I.D : A
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 06/23/79
GROSS AREA : 23.400 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	174	9:02	9:07	322.6	8.3	12.9	3.4	90.2	210.4	218.4	8.0	39.5	86.5	0.0	31.9	0.3720
02	174	9:07	9:12	323.3	8.1	12.9	3.4	90.4	211.3	218.7	7.4	38.4	85.7	0.0	29.6	0.3740
03	174	9:12	9:17	321.2	7.1	12.9	1.1	92.8	211.2	219.3	8.0	37.4	84.9	0.0	32.2	0.3690
04	174	9:17	9:22	325.3	8.0	12.8	0.6	93.2	211.6	219.6	8.1	36.4	84.1	0.0	31.7	0.3640
05	174	10:45	10:50	331.0	7.1	12.9	0.6	96.7	170.3	181.3	11.0	18.9	61.3	0.0	42.8	0.2230
06	174	10:50	10:55	330.9	7.3	12.9	2.3	97.0	170.5	181.4	10.9	18.0	59.0	0.0	42.4	0.2220
07	174	11:00	11:05	330.8	7.3	12.7	4.5	97.2	170.2	181.2	11.0	16.2	53.9	0.0	42.2	0.2210
08	174	11:05	11:10	332.0	7.4	12.9	6.8	96.0	169.9	180.9	11.1	15.4	51.0	0.0	43.0	0.2230
09	174	12:05	12:10	334.9	7.7	13.0	4.5	98.0	139.7	152.6	12.9	10.5	- 10.1	0.0	49.9	0.1240
10	174	12:10	12:15	334.7	7.4	13.1	1.1	98.4	140.0	152.8	12.8	10.8	- 16.2	0.0	50.1	0.1240
11	174	12:15	12:20	334.0	7.5	12.9	5.7	98.4	140.5	153.2	12.7	11.1	- 21.9	0.0	49.0	0.1260
12	174	12:20	12:25	331.1	7.5	13.0	0.6	99.5	140.2	153.3	13.1	11.6	- 27.3	0.0	51.6	0.1230
13	174	13:20	13:25	332.1	7.3	12.9	2.3	99.4	100.9	116.4	15.5	20.9	- 65.6	0.0	60.0	0.0040
14	174	13:25	13:30	332.3	7.5	12.8	1.1	101.3	101.0	116.6	15.6	21.9	- 67.4	0.0	59.9	-0.0000
15	174	13:30	13:35	331.2	8.0	12.9	5.7	100.0	101.0	116.5	15.5	22.8	- 69.0	0.0	60.0	0.0030
16	174	13:35	13:40	330.4	7.9	13.0	3.4	99.4	101.0	116.3	15.3	23.8	- 70.5	0.0	60.2	0.0050

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : B
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 10/04/78
GROSS AREA : 18.700 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	277	9:48	9:53	320.6	14.3	13.4	0.0	92.6	217.3	223.7	6.3	50.0	43.9	0.0	26.4	0.3890
02	277	9:53	9:58	321.5	14.3	13.4	2.3	91.8	216.7	223.3	6.5	49.3	42.5	0.0	27.3	0.3890
03	277	9:58	10:03	322.7	14.3	13.3	1.7	90.7	216.5	223.1	6.6	48.6	41.2	0.0	27.2	0.3900
04	277	10:03	10:08	323.7	13.8	13.3	0.0	92.1	216.5	223.1	6.6	47.9	39.8	0.0	27.2	0.3840
05	277	10:40	10:45	330.1	13.6	13.4	6.8	92.1	177.5	187.9	10.4	43.6	28.4	0.0	42.2	0.2590
06	277	10:45	10:50	330.6	13.3	13.3	6.0	92.3	177.4	187.7	10.3	43.1	26.7	0.0	41.6	0.2570
07	277	10:50	10:55	330.8	13.4	13.2	4.5	92.0	177.3	187.7	10.4	42.7	25.0	0.0	41.5	0.2580
08	277	10:55	11:00	330.9	13.6	13.1	2.3	91.9	176.9	187.4	10.5	42.3	23.3	0.0	41.7	0.2570
09	277	12:05	12:10	330.0	13.8	13.3	5.7	94.6	141.0	154.1	13.1	39.7	- 3.1	0.0	52.5	0.1400
10	277	12:10	12:15	330.9	13.5	13.3	2.8	94.3	140.9	154.0	13.1	39.7	- 5.1	0.0	52.6	0.1410
11	277	12:15	12:20	330.9	13.7	13.3	4.5	94.8	141.0	154.0	13.1	39.9	- 7.0	0.0	52.4	0.1400
12	277	12:20	12:25	331.1	13.8	13.3	3.4	95.5	140.8	154.0	13.1	40.0	- 8.9	0.0	52.7	0.1370
13	277	13:15	13:20	327.8	13.6	13.3	1.1	95.6	95.1	111.1	16.1	43.7	- 28.7	0.0	65.1	-0.0020
14	277	13:20	13:25	328.7	13.6	13.0	3.4	95.8	95.1	111.4	16.3	44.2	- 30.4	0.0	64.0	-0.0020
15	277	13:25	13:30	326.7	14.1	13.3	4.5	96.3	95.3	111.3	16.0	44.8	- 32.0	0.0	64.8	-0.0030
16	277	13:30	13:35	323.6	14.2	13.3	5.1	95.7	95.4	111.2	15.8	45.3	- 33.5	0.0	65.1	-0.0010

COLLECTOR I.D : B
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 06/23/79
GROSS AREA : 18.750 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	174	11:32	11:37	337.3	9.0	13.5	2.3	99.4	218.3	225.7	7.4	11.7	29.4	0.0	29.6	0.3520
02	174	11:37	11:42	336.6	9.1	13.4	5.7	99.6	218.3	225.8	7.4	11.3	24.1	0.0	29.6	0.3530
03	174	11:42	11:47	335.0	9.3	13.4	4.5	98.7	217.9	225.4	7.6	10.9	18.5	0.0	30.2	0.3560
04	174	11:47	11:52	335.0	9.2	13.4	6.8	98.4	217.6	225.1	7.5	10.6	12.5	0.0	29.9	0.3560
05	174	12:50	12:55	339.7	9.0	13.5	9.7	101.7	153.1	165.8	12.7	15.6	- 51.6	0.0	50.2	0.1510
06	174	12:55	13:00	344.1	9.1	13.4	8.0	100.2	153.1	165.8	12.7	16.4	- 54.5	0.0	49.6	0.1540
07	174	13:00	13:05	340.0	9.5	13.4	0.0	101.8	153.0	165.7	12.7	17.3	- 57.1	0.0	50.2	0.1510
08	174	13:05	13:10	339.2	9.4	13.4	8.0	100.6	152.9	165.6	12.6	18.1	- 59.5	0.0	49.9	0.1540
09	174	14:10	14:15	337.1	10.7	13.3	9.1	103.3	102.7	118.7	16.0	30.8	- 79.1	0.0	63.2	-0.0020
10	174	14:15	14:20	337.5	10.8	13.3	5.7	103.2	103.0	119.1	16.1	31.8	- 80.1	0.0	63.2	-0.0010
11	174	14:20	14:25	336.7	11.0	13.3	8.5	101.7	103.1	119.2	16.1	32.9	- 81.1	0.0	63.5	0.0040
12	174	14:25	14:30	336.1	11.1	13.3	6.8	101.3	103.2	119.3	16.1	33.9	- 82.0	0.0	63.8	0.0060

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : B
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 10/02/78
GROSS AREA : 18.700 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	275	10:15	10:20	321.5	13.7	13.4	1.1	90.1	220.5	226.6	6.0	45.7	36.8	0.0	25.1	0.4060
02	275	10:20	10:25	322.3	13.8	13.3	1.7	89.0	220.4	226.5	6.1	45.1	35.3	0.0	25.2	0.4080
03	275	10:25	10:30	323.4	13.9	13.3	2.3	89.4	220.2	226.4	6.2	44.5	33.7	0.0	25.5	0.4040
04	275	10:30	10:35	323.8	13.9	13.3	4.0	90.5	220.0	226.2	6.2	43.9	32.1	0.0	25.5	0.4000
05	275	11:15	11:20	328.4	17.8	13.4	5.1	90.9	159.2	170.8	11.5	40.1	16.4	0.0	47.3	0.2080
06	275	11:20	11:25	328.5	13.3	13.4	0.0	92.1	159.0	170.5	11.5	39.8	14.5	0.0	47.1	0.2040
07	275	11:25	11:30	328.4	13.1	13.4	5.7	92.7	159.0	170.5	11.5	39.6	12.6	0.0	46.9	0.2020
08	275	11:30	11:35	328.4	13.3	13.4	5.7	93.0	158.7	170.3	11.6	39.4	10.6	0.0	47.4	0.2000
09	275	12:25	12:30	327.0	13.9	13.4	8.0	94.1	94.8	110.7	15.9	39.4	- 11.0	0.0	64.7	0.0020
10	275	12:30	12:35	326.3	14.1	13.4	4.5	95.7	95.1	110.8	15.7	39.6	- 13.0	0.0	64.4	-0.0020
11	275	12:35	12:40	325.9	14.4	13.4	7.4	96.1	95.1	110.9	15.8	39.9	- 14.9	0.0	64.6	-0.0030
12	275	12:40	12:45	325.7	14.5	13.3	3.4	95.1	95.3	111.0	15.7	40.1	- 16.8	0.0	64.0	0.0000

COLLECTOR I.D : B
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 10/17/78
GROSS AREA : 18.780 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	290	8:35	8:40	294.2	13.5	13.4	0.0	79.5	213.5	218.4	4.8	65.4	56.5	0.0	22.1	0.4550
02	290	8:40	8:45	297.0	13.4	13.3	0.0	80.0	214.0	218.9	4.9	64.6	55.5	0.0	22.2	0.4510
03	290	8:45	8:50	299.9	13.4	13.1	0.0	80.0	214.4	219.5	5.1	63.7	54.5	0.0	22.4	0.4480
04	290	8:50	8:55	302.9	13.4	13.1	0.0	81.2	214.8	220.1	5.3	62.9	53.5	0.0	22.9	0.4410
05	290	9:35	9:40	316.1	12.9	13.3	3.4	84.9	185.7	194.8	9.1	55.9	43.6	0.0	38.5	0.3190
06	290	9:40	9.45	317.9	12.8	13.4	0.0	85.3	185.6	194.8	9.2	55.2	42.4	0.0	38.9	0.3160
07	290	9:45	9:50	319.5	12.9	13.4	3.4	85.8	185.5	194.7	9.2	54.5	41.1	0.0	38.6	0.3120
08	290	9:50	9:55	321.2	12.9	13.3	0.0	86.6	185.7	194.8	9.1	53.8	39.9	0.0	38.0	0.3080
09	290	10:40	10:45	331.1	13.1	13.1	4.5	87.9	146.3	158.5	12.2	48.1	25.8	0.0	48.2	0.1770
10	290	10:45	10:50	330.9	13.0	13.2	2.3	88.0	146.8	159.2	12.4	47.7	24.2	0.0	49.2	0.1780
11	290	10:50	10:55	332.8	13.0	13.2	2.8	89.1	147.1	159.5	12.4	47.3	22.7	0.0	49.1	0.1750
12	290	10:55	11:00	333.6	13.2	13.1	5.1	89.5	147.6	160.1	12.4	46.9	21.1	0.0	48.9	0.1740
13	299	9:05	9:10	317.7	9.5	13.5	0.0	66.4	68.5	84.2	15.6	62.8	48.1	0.0	66.3	0.0070
14	299	9:10	9:15	320.1	9.4	13.4	0.0	66.0	68.5	84.3	15.8	62.0	47.1	0.0	66.1	0.0080
15	299	9:15	9:20	322.3	9.2	13.4	0.0	66.9	68.6	84.5	15.8	61.3	46.0	0.0	65.8	0.0050
16	299	9:20	9:25	324.0	9.2	13.5	0.0	67.7	68.8	84.7	15.9	60.5	44.9	0.0	65.9	0.0040

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : C
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 10/06/78
GROSS AREA : 28.120 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	279	13:50	13:55	320.0	15.2	10.3	2.3	93.6	92.4	109.2	16.8	48.5	- 38.9	0.0	54.2	-0.0040
02	279	13:55	14:00	321.3	15.1	10.3	7.4	94.0	92.3	109.1	16.8	49.1	- 40.3	0.0	53.7	-0.0050
03	279	14:00	14:05	318.3	15.4	10.3	8.5	94.5	92.4	109.0	16.6	49.8	- 41.7	0.0	53.7	-0.0070
04	279	14:05	14:10	313.6	15.5	10.3	5.7	94.7	92.4	109.0	16.6	50.5	- 43.0	0.0	54.1	-0.0080
05	283	12:25	12:30	332.3	9.9	10.5	6.8	95.8	218.4	226.1	7.7	42.5	- 10.3	0.0	24.3	0.3690
06	283	12:30	12:35	332.4	9.9	10.5	5.7	94.1	217.6	225.5	7.9	42.7	- 12.1	0.0	25.0	0.3710
07	283	12:35	12:40	332.5	9.8	10.6	3.4	96.0	217.5	225.3	7.8	42.9	- 13.9	0.0	24.9	0.3650
08	283	12:40	12:45	333.2	10.2	10.4	8.0	96.9	218.1	225.9	7.8	43.2	- 15.7	0.0	24.2	0.3640
09	283	13:25	13:30	326.4	10.9	10.6	2.3	97.1	181.2	192.9	11.7	46.8	- 30.6	0.0	38.0	0.2580
10	283	13:30	13:35	327.3	10.8	10.6	8.0	97.5	181.1	192.3	11.2	47.4	- 32.1	0.0	36.4	0.2550
11	283	13:35	13:40	327.1	11.1	10.6	6.8	95.5	179.7	190.9	11.2	47.9	- 33.6	0.0	36.3	0.2580
12	283	13:40	13:45	326.1	11.0	10.5	8.5	95.8	179.0	189.8	10.9	48.5	- 35.0	0.0	35.1	0.2550
13	283	14:50	14:55	307.3	12.4	10.5	3.4	94.8	140.8	153.8	13.0	58.6	- 52.6	0.0	44.4	0.1500
14	283	14:55	15:00	304.4	12.6	10.5	8.0	94.2	140.8	153.5	12.7	59.5	- 53.7	0.0	43.8	0.1530
15	283	15:00	15:05	302.1	12.4	10.4	3.4	93.8	141.0	153.6	12.5	60.3	- 54.7	0.0	43.2	0.1560
16	283	15:05	15:10	301.3	12.1	10.5	2.3	94.6	141.3	153.9	12.6	61.2	- 55.8	0.0	43.7	0.1550

COLLECTOR I.D : C
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 06/20/79
GROSS AREA : 28.050 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	171	14:10	14:15	331.5	10.1	10.5	7.4	95.6	202.2	211.5	9.3	30.8	- 79.1	0.0	29.6	0.3220
02	171	14:15	14:20	331.8	10.3	10.4	1.1	94.9	201.8	210.9	9.2	31.8	- 80.1	0.0	28.9	0.3220
03	171	14:20	14:25	330.5	10.4	10.4	4.4	95.5	201.9	211.0	9.1	32.9	- 81.1	0.0	28.8	0.3220
04	171	14:25	14:30	331.0	10.5	10.7	3.3	95.3	201.4	210.6	9.2	33.9	- 82.0	0.0	29.8	0.3210
05	174	11:25	11:30	335.6	8.3	10.8	0.0	98.4	94.8	111.2	16.4	12.5	36.0	0.0	52.4	-0.0110
06	174	11:30	11:35	335.8	8.5	10.7	0.0	97.7	95.2	111.5	16.3	12.0	31.4	0.0	52.0	-0.0070
07	174	11:35	11:40	334.6	8.6	10.7	0.0	97.8	95.4	111.8	16.4	11.5	26.3	0.0	52.4	-0.0070
08	174	11:40	11:45	333.7	8.9	10.6	0.0	97.3	95.6	112.1	16.5	11.0	20.8	0.0	52.3	-0.0050
09	174	12:45	12:50	334.0	8.4	10.6	0.0	99.6	150.8	164.0	13.2	14.8	- 48.4	0.0	41.9	0.1530
10	174	12:50	12:55	337.1	8.1	10.6	5.7	100.5	150.5	164.0	13.4	15.6	- 51.6	0.0	42.5	0.1480
11	174	12:55	13:00	340.2	8.3	10.6	6.3	100.2	150.4	163.8	13.5	16.4	- 54.5	0.0	41.8	0.1480
12	174	13:00	13:05	335.4	8.6	10.5	0.0	99.2	150.3	163.8	13.4	17.3	- 57.1	0.0	42.1	0.1520

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : C
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 04/14/79
GROSS AREA : 28.160 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	104	10:25	10:30	344.9	7.8	10.7	5.2	80.3	200.1	209.4	9.3	32.6	45.8	0.0	28.9	0.3470
02	104	10:30	10:35	345.1	7.8	10.6	5.6	80.8	199.6	209.1	9.5	31.9	43.9	0.0	29.3	0.3440
03	104	10:35	10:40	345.1	7.8	10.7	0.0	81.1	199.8	209.1	9.3	31.1	42.0	0.0	28.9	0.3440
04	104	10:40	10:45	346.0	7.8	10.6	4.1	80.6	199.5	209.0	9.5	30.5	40.0	0.0	29.4	0.3440
05	104	11:30	11:35	346.7	7.8	10.6	1.7	82.4	144.8	159.1	14.3	25.6	15.6	0.0	43.6	0.1890
06	104	11:35	11:40	346.3	7.8	10.6	4.8	83.1	144.7	158.8	14.1	25.3	12.8	0.0	43.3	0.1780
07	104	11:40	11:45	346.4	7.9	10.6	0.0	83.9	144.6	158.7	14.1	25.1	9.9	0.0	43.0	0.1750
08	104	11:50	11:55	347.4	7.9	10.5	1.1	82.5	144.7	158.8	14.1	24.8	4.1	0.0	42.8	0.1790
09	104	13:30	13:35	344.7	8.5	10.6	1.1	85.8	85.8	103.1	17.3	32.7	- 46.1	0.0	53.1	0.0000
10	104	13:35	13:40	345.1	8.9	10.6	2.3	84.4	86.0	103.3	17.2	33.5	- 47.9	0.0	52.7	0.0050
11	104	13:40	13:45	344.3	8.9	10.5	4.0	85.1	86.2	103.4	17.2	34.3	- 49.6	0.0	52.7	0.0030
12	104	13:45	13:50	342.5	9.0	10.5	0.0	85.2	86.2	103.4	17.2	35.1	- 51.3	0.0	52.6	0.0030

COLLECTOR I.D : C
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 06/25/79
GROSS AREA : 28.120 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	176	14:45	14:50	314.9	9.6	10.4	7.6	107.4	203.3	212.4	9.1	38.0	- 85.4	0.0	30.4	0.3040
02	176	14:50	14:55	316.2	9.5	10.4	6.3	107.2	203.3	212.5	9.2	39.1	- 86.2	0.0	30.5	0.3040
03	176	14:55	15:00	314.2	9.9	10.3	7.7	106.4	203.1	212.1	9.1	40.1	- 86.9	0.0	29.9	0.3080
04	176	15:00	15:05	314.7	10.0	10.4	5.9	105.8	202.5	211.6	9.1	41.1	- 87.7	0.0	30.3	0.3070
05	177	9:30	9:35	316.9	8.7	10.4	0.0	103.5	97.6	114.5	17.0	33.7	81.7	0.0	55.4	-0.0190
06	177	9:35	9:40	317.6	8.7	10.4	0.0	103.7	97.9	114.9	17.0	32.7	80.3	0.0	55.4	-0.0180
07	177	9:40	9:45	318.9	8.6	10.4	4.5	104.4	98.2	115.3	17.1	31.7	79.8	0.0	55.8	-0.0190
08	177	9:45	9:50	319.5	8.8	10.4	4.7	104.4	98.5	115.5	17.1	30.6	78.8	0.0	55.3	-0.0190
09	177	10:40	10:45	320.7	8.0	10.4	0.0	104.9	166.1	177.8	11.7	19.8	63.2	0.0	38.1	0.1910
10	177	10:45	10:50	322.5	7.9	10.4	1.1	105.9	166.1	178.1	11.9	18.9	61.1	0.0	38.4	0.1870
11	177	10:50	10:55	322.9	8.3	10.4	5.6	106.1	166.2	178.3	12.1	18.0	58.9	0.0	39.0	0.1860
12	177	11:00	11:05	321.3	8.2	10.4	5.8	105.8	165.8	177.7	12.0	16.3	53.7	0.0	38.7	0.1870
13	177	12:00	12:05	317.0	9.4	10.4	0.0	107.6	138.3	152.6	14.3	10.5	- 3.8	0.0	47.1	0.0970
14	177	12:05	12:10	317.9	9.6	10.5	0.0	108.6	138.7	152.9	14.2	10.6	- 10.0	0.0	46.7	0.0950
15	177	12:10	12:15	320.9	9.7	10.4	4.0	108.6	138.7	153.1	14.4	10.8	- 16.1	0.0	46.8	0.0940
16	177	12:15	12:20	321.4	9.6	10.4	7.4	108.4	138.8	153.1	14.3	11.2	- 21.8	0.0	46.6	0.0950

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : D
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 10/06/78
GROSS AREA : 18.000 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	279	13:51	13:56	320.0	15.1	12.4	2.3	93.7	91.8	108.6	16.7	48.6	- 39.2	0.0	64.5	-0.0060
02	279	13:56	14:01	321.1	15.2	12.4	7.4	93.9	91.8	108.6	16.7	49.3	- 40.6	0.0	64.2	-0.0060
03	279	14:01	14:06	317.5	15.4	12.4	8.5	94.7	92.0	108.5	16.5	49.9	- 42.0	0.0	64.3	-0.0090
04	279	14:06	14:11	313.3	15.5	12.3	5.7	94.8	92.0	108.4	16.4	50.6	- 43.3	0.0	64.3	-0.0090
05	285	11:20	11:25	331.8	9.7	12.2	1.1	99.1	213.8	225.3	11.4	42.8	13.5	0.0	42.0	0.3460
06	285	11:25	11:30	332.2	9.8	12.3	2.3	97.7	213.7	225.2	11.5	42.6	11.7	0.0	42.8	0.3490
07	285	11:30	11:35	332.5	9.9	12.3	4.5	95.6	213.2	224.7	11.4	42.4	9.9	0.0	42.4	0.3540
08	285	11:35	11:40	333.3	9.8	12.2	2.3	97.6	213.4	224.8	11.4	42.3	8.1	0.0	41.9	0.3470
09	285	13:25	13:30	326.4	10.9	12.2	2.3	97.1	178.6	192.1	13.5	46.8	- 30.6	0.0	50.9	0.2500
10	285	13:30	13:35	327.3	10.8	12.2	8.0	97.5	177.9	191.4	13.4	47.4	- 32.1	0.0	50.1	0.2460
11	285	13:35	13:40	327.1	11.1	12.2	6.8	95.5	177.8	191.3	13.5	47.9	- 33.6	0.0	50.5	0.2520
12	285	13:40	13:45	326.1	11.0	11.8	8.5	95.8	177.6	191.0	13.5	48.5	- 35.0	0.0	48.9	0.2510
13	285	13:56	14:01	324.2	11.3	12.1	8.0	96.5	177.6	191.3	13.7	50.5	- 39.5	0.0	51.3	0.2500
14	285	14:50	14:55	307.3	12.4	12.1	3.4	94.8	139.8	154.2	14.4	58.6	- 52.6	0.0	56.7	0.1460
15	285	14:55	15:00	304.4	12.6	12.2	8.0	94.2	139.5	153.8	14.3	59.5	- 53.7	0.0	57.2	0.1490
16	285	15:00	15:05	302.1	12.4	12.3	3.4	93.8	139.8	153.8	14.0	60.3	- 54.7	0.0	57.1	0.1520
17	285	15:05	15:10	301.3	12.1	12.2	2.3	94.6	139.8	153.9	14.1	61.2	- 55.8	0.0	57.0	0.1500

COLLECTOR I.D : D
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 06/23/79
GROSS AREA : 17.940 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	174	11:27	11:32	338.0	8.7	12.0	4.5	99.1	210.5	223.0	12.5	12.3	34.2	0.0	44.4	0.3300
02	174	11:32	11:37	337.3	9.0	12.0	2.3	99.4	209.9	222.4	12.5	11.7	29.4	0.0	44.5	0.3280
03	174	11:37	11:42	336.6	9.1	11.9	5.7	99.6	209.4	222.2	12.8	11.3	24.1	0.0	45.4	0.3260
04	174	11:42	11:47	335.0	9.3	12.0	4.5	98.7	209.0	221.5	12.6	10.9	18.5	0.0	44.9	0.3290
05	174	12:57	13:02	343.0	9.3	12.0	8.0	101.3	147.4	163.4	16.0	16.7	- 55.5	0.0	55.9	0.1350
06	174	13:02	13:07	338.9	9.5	12.1	0.0	101.2	147.7	163.3	15.6	17.6	- 58.1	0.0	55.9	0.1370
07	174	13:09	13:14	341.7	9.1	12.0	8.0	99.5	147.9	163.6	15.8	18.9	- 61.3	0.0	55.5	0.1420
08	174	13:14	13:19	342.0	9.6	11.9	5.7	102.1	147.6	163.7	16.2	19.8	- 63.3	0.0	56.5	0.1330
09	174	14:10	14:15	337.2	10.7	12.0	9.1	103.3	105.6	123.3	17.8	30.8	- 79.1	0.0	62.9	0.0070
10	174	14:15	14:20	337.5	10.8	12.0	5.7	103.2	105.4	123.1	17.7	31.8	- 80.1	0.0	62.7	0.0070
11	174	14:20	14:25	336.7	11.0	11.9	8.5	101.7	105.5	123.1	17.6	32.9	- 81.1	0.0	62.4	0.0110
12	174	14:25	14:30	336.1	11.1	12.0	6.8	101.3	105.5	123.0	17.5	33.9	- 82.0	0.0	62.3	0.0120

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : D
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 05/29/79
GROSS AREA : 17.910 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	149	13:41	13:46	327.8	12.7	12.2	2.3	87.6	143.9	158.4	14.5	26.0	- 68.6	0.0	54.2	0.1720
02	149	13:46	13:51	329.0	12.9	12.1	6.3	88.5	143.8	158.3	14.5	26.9	- 70.1	0.0	53.5	0.1680
03	149	13:51	13:56	328.7	12.8	12.1	6.8	87.1	143.8	158.4	14.6	27.9	- 71.4	0.0	53.9	0.1720
04	149	13:56	14:01	326.7	13.1	12.2	8.5	86.1	143.7	158.2	14.5	28.9	- 72.7	0.0	53.9	0.1760
05	149	14:42	14:47	324.8	13.5	12.3	3.4	89.0	86.5	103.3	16.8	38.2	- 82.2	0.0	63.4	-0.0080
06	149	14:47	14:52	322.1	13.1	12.2	1.1	88.6	86.7	103.5	16.8	39.3	- 83.1	0.0	63.4	-0.0060
07	149	14:52	14:57	321.9	13.2	12.2	2.3	88.7	86.9	103.6	16.7	40.3	- 83.9	0.0	63.2	-0.0050
08	149	14:57	15:02	323.7	13.4	12.2	7.4	91.2	87.1	103.7	16.6	41.3	- 84.8	0.0	62.4	-0.0130
09	150	8:40	8:45	326.1	10.8	12.3	0.0	78.1	206.0	217.3	11.3	44.8	87.6	0.0	43.0	0.3920
10	150	8:45	8:50	326.9	10.6	12.3	1.1	78.3	206.0	217.3	11.4	43.7	86.8	0.0	43.0	0.3900
11	150	8:50	8:55	327.2	10.4	12.2	0.0	79.0	206.0	217.5	11.5	42.7	86.1	0.0	43.3	0.3880
12	150	8:55	9:00	328.0	10.4	12.3	0.0	78.8	206.1	217.7	11.6	41.7	85.3	0.0	43.5	0.3880

COLLECTOR I.D : D
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 06/24/79
GROSS AREA : 17.910 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	175	11:25	11:30	331.4	6.5	12.2	4.5	99.4	211.7	224.0	12.3	12.5	36.0	0.0	45.1	0.3390
02	175	11:30	11:35	331.7	6.5	12.1	0.6	98.9	211.6	223.8	12.2	12.0	31.3	0.0	44.6	0.3400
03	175	11:35	11:40	330.3	6.3	12.2	0.6	100.5	211.6	223.7	12.1	11.5	26.3	0.0	44.5	0.3370
04	175	11:40	11:45	331.7	6.5	12.2	1.1	99.8	212.0	224.1	12.1	11.1	20.8	0.0	44.5	0.3380
05	175	12:45	12:50	330.7	7.2	12.2	4.0	101.8	173.9	187.9	14.0	14.8	- 48.4	0.0	51.9	0.2180
06	175	12:50	12:55	329.6	7.4	12.1	0.6	101.5	174.4	188.3	13.9	15.6	- 51.5	0.0	51.4	0.2210
07	175	12:55	13:00	330.0	7.6	12.1	6.8	102.0	174.5	188.5	14.1	16.4	- 54.4	0.0	51.7	0.2200
08	175	13:00	13:05	329.4	7.6	12.1	1.1	101.4	174.1	188.3	14.2	17.3	- 57.0	0.0	52.1	0.2210
09	175	14:25	14:30	321.7	8.9	12.1	5.7	104.3	135.6	151.3	15.6	33.9	- 82.0	0.0	58.7	0.0970
10	175	14:30	14:35	321.7	9.1	12.1	6.8	103.0	135.6	151.3	15.6	34.9	- 82.9	0.0	58.7	0.1010
11	175	14:35	14:40	320.0	9.0	12.2	0.6	102.8	135.4	150.9	15.6	36.0	- 83.7	0.0	59.3	0.1020
12	175	14:40	14:45	321.9	8.8	12.2	2.3	102.9	135.3	150.9	15.6	37.0	- 84.6	0.0	59.0	0.1010
13	175	16:00	16:05	301.0	10.0	12.2	1.1	102.7	99.7	115.6	15.9	53.6	- 95.8	0.0	64.3	-0.0100
14	175	16:05	16:10	299.1	10.2	12.1	6.8	103.9	99.7	115.5	15.8	54.6	- 96.4	0.0	64.0	-0.0140
15	175	16:10	16:15	296.2	10.2	12.2	1.1	103.5	99.7	115.4	15.7	55.6	- 97.0	0.0	64.6	-0.0130
16	175	16:15	16:20	294.1	10.0	12.2	0.6	103.7	99.8	115.3	15.6	56.7	- 97.6	0.0	64.3	-0.0130

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : E
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 06/15/79
GROSS AREA : 20.680 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	166	10:25	10:30	325.4	6.6	13.2	0.6	98.5	213.3	217.0	3.7	22.7	68.4	0.0	15.1	0.3530
02	166	10:30	10:35	325.7	6.5	13.1	8.0	98.5	213.5	217.0	3.5	21.7	66.8	0.0	13.9	0.3530
03	166	10:35	10:40	326.7	6.5	13.2	6.8	99.7	213.4	216.9	3.5	20.8	65.0	0.0	14.3	0.3480
04	166	10:40	10:45	324.7	6.7	13.1	5.7	100.3	213.3	217.3	4.0	19.9	63.0	0.0	16.1	0.3480
05	166	12:20	12:25	324.0	7.8	13.0	8.0	102.7	165.0	173.8	8.9	11.7	- 27.1	0.0	35.7	0.1920
06	166	12:25	12:30	324.4	7.9	13.1	6.8	102.6	164.0	172.6	8.7	12.2	- 32.1	0.0	35.3	0.1890
07	166	12:30	12:35	321.4	8.1	13.1	3.4	102.7	163.9	172.5	8.6	12.8	- 36.6	0.0	35.1	0.1900
08	166	12:35	12:40	322.5	8.1	13.1	1.1	103.1	163.7	172.4	8.8	13.4	- 40.8	0.0	35.5	0.1830
09	170	11:10	11:15	334.1	4.7	13.3	5.1	86.4	85.5	100.8	15.3	14.6	47.7	0.0	60.8	-0.0030
10	170	11:15	11:20	334.1	4.5	13.3	6.3	87.1	85.7	100.9	15.2	13.9	44.2	0.0	60.3	-0.0040
11	170	11:20	11:25	334.7	4.7	13.2	5.7	86.5	85.9	101.2	15.3	13.2	40.3	0.0	60.0	-0.0020
12	170	11:25	11:30	335.3	4.7	13.2	1.1	87.3	86.1	101.4	15.3	12.5	36.0	0.0	59.9	-0.0040
13	170	13:20	13:25	333.4	5.5	13.2	0.6	89.3	124.0	136.9	12.8	20.9	- 65.6	0.0	50.8	0.1040
14	170	13:25	13:30	333.8	5.5	13.1	6.8	89.5	124.8	137.5	12.6	21.9	- 67.4	0.0	49.6	0.1060
15	170	13:30	13:35	335.0	5.8	13.2	8.0	88.6	124.9	137.5	12.6	22.8	- 69.0	0.0	49.6	0.1080
16	170	13:35	13:40	335.4	6.0	13.2	8.0	88.6	124.8	137.4	12.7	23.8	- 70.5	0.0	49.6	0.1080

COLLECTOR I.D : E
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 06/25/79
GROSS AREA : 20.560 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	176	13:50	13:55	326.3	11.3	12.9	5.2	106.9	103.1	118.4	15.3	26.8	- 74.5	0.0	60.2	-0.0120
02	176	13:55	14:00	323.3	11.4	13.1	7.2	108.4	103.2	118.4	15.2	27.8	- 75.7	0.0	61.5	-0.0160
03	176	14:00	14:05	324.0	11.4	13.0	6.4	107.0	103.5	118.7	15.3	28.8	- 76.9	0.0	61.2	-0.0110
04	176	14:05	14:10	323.6	11.5	13.1	6.0	106.8	103.6	118.8	15.2	29.8	- 78.0	0.0	61.1	-0.0100
05	177	12:07	12:12	324.2	11.1	13.3	3.4	108.4	161.6	171.9	10.4	10.7	- 12.5	0.0	42.5	0.1640
06	177	12:12	12:17	326.4	11.1	13.3	4.4	108.7	161.0	171.0	10.0	11.0	- 18.4	0.0	41.0	0.1600
07	177	12:17	12:22	326.9	11.0	13.3	8.9	108.0	161.2	171.1	9.9	11.3	- 24.0	0.0	40.3	0.1630
08	177	12:22	12:27	326.2	10.8	13.3	7.0	106.2	161.1	171.4	10.3	11.8	- 29.2	0.0	42.1	0.1680
09	177	13:40	13:45	325.1	11.4	13.4	4.9	110.2	209.6	215.5	6.0	24.8	- 71.8	0.0	24.7	0.3060
10	177	13:45	13:50	324.7	11.4	13.3	9.2	109.2	209.3	215.4	6.1	25.8	- 73.2	0.0	25.0	0.3080
11	177	13:50	13:55	325.1	11.4	13.3	9.8	109.3	209.4	215.4	6.0	26.8	- 74.5	0.0	24.8	0.3080
12	177	13:55	14:00	326.3	11.5	13.2	8.5	108.9	209.1	215.0	6.0	27.8	- 75.7	0.0	24.3	0.3070

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : E
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 05/30/79
GROSS AREA : 20.570 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	150	11:30	11:35	337.6	8.9	13.2	3.4	86.9	209.0	213.5	4.5	13.5	28.0	0.0	17.6	0.3620
02	150	11:35	11:40	338.4	8.9	13.1	0.0	86.7	208.7	212.9	4.2	13.0	23.3	0.0	16.4	0.3600
03	150	11:40	11:45	338.6	9.1	13.1	6.8	86.5	208.3	212.6	4.3	12.7	18.3	0.0	16.6	0.3600
04	150	11:45	11:50	338.2	9.1	13.3	0.0	86.5	208.0	211.9	3.8	12.4	13.1	0.0	15.1	0.3590
05	150	12:50	12:55	338.0	9.8	13.1	7.4	88.7	137.7	148.8	11.1	16.8	- 47.4	0.0	43.0	0.1450
06	150	12:55	13:00	337.1	16.0	13.1	8.5	89.3	137.8	148.8	11.0	17.6	- 50.3	0.0	42.9	0.1440
07	150	13:00	13:05	337.0	9.9	13.1	5.7	87.7	138.0	149.2	11.2	18.4	- 53.0	0.0	43.4	0.1490
08	150	13:05	13:10	335.9	10.2	13.1	6.8	90.2	137.7	148.8	11.1	19.2	- 55.5	0.0	43.3	0.1410
09	150	13:48	13:53	332.5	11.1	13.1	0.0	88.6	89.4	104.4	15.0	27.2	- 70.9	0.0	58.9	0.0020
10	150	13:53	13:58	333.6	11.0	13.2	7.4	87.3	89.6	104.5	14.9	28.2	- 72.2	0.0	58.8	0.0070
11	150	14:15	14:20	329.8	11.7	13.1	8.0	89.0	90.2	105.0	14.9	32.6	- 77.3	0.0	59.0	0.0040
12	150	14:20	14:25	330.0	11.5	13.1	4.0	89.2	90.2	105.1	15.0	33.7	- 78.4	0.0	59.2	0.0030

COLLECTOR I.D : E
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 06/24/79
GROSS AREA : 20.510 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	175	13:00	13:05	336.3	9.4	13.6	4.0	101.5	98.6	113.7	15.1	17.3	- 57.0	0.0	60.9	-0.0090
02	175	13:05	13:10	337.7	9.3	13.5	4.5	101.7	98.6	113.6	15.1	18.2	- 59.4	0.0	59.9	-0.0090
03	175	13:10	13:15	336.9	9.6	13.1	5.1	102.4	98.7	114.0	15.3	19.1	- 61.7	0.0	59.2	-0.0110
04	175	13:15	13:20	335.6	9.6	13.1	3.4	101.2	98.9	114.2	15.3	20.0	- 63.7	0.0	59.9	-0.0070
05	175	14:55	15:00	327.1	10.9	13.3	1.7	105.7	206.0	212.2	6.2	40.1	- 87.0	0.0	25.4	0.3070
06	175	15:00	15:05	324.5	11.1	13.3	6.5	105.9	206.1	212.4	6.3	41.1	- 87.7	0.0	25.9	0.3090
07	175	15:05	15:10	324.3	10.9	13.2	0.0	104.5	206.6	212.8	6.2	42.2	- 88.4	0.0	25.1	0.3150
08	175	15:10	15:15	321.5	11.3	13.1	4.0	105.3	206.6	212.7	6.2	43.2	- 89.2	0.0	25.3	0.3150
09	176	10:45	10:50	331.2	9.2	13.0	8.0	102.1	172.0	181.3	9.3	18.9	61.2	0.0	36.5	0.2110
10	176	10:55	11:00	331.3	9.3	13.0	3.4	102.2	171.9	181.1	9.1	17.1	56.5	0.0	36.0	0.2110
11	176	11:00	11:05	332.3	9.3	13.0	4.5	102.2	171.6	180.7	9.1	16.3	53.8	0.0	35.7	0.2090
12	176	11:05	11:10	333.2	9.0	12.9	5.1	102.2	171.3	180.6	9.3	15.4	50.9	0.0	36.2	0.2070
13	176	12:10	12:15	332.7	9.8	13.2	5.7	104.0	137.4	149.6	12.2	10.8	- 16.1	0.0	48.5	0.1010
14	176	12:15	12:20	333.5	9.8	13.1	9.1	106.4	137.4	149.8	12.3	11.2	- 21.9	0.0	48.3	0.0980
15	176	12:20	12:25	331.5	10.2	13.0	8.0	104.5	137.4	149.8	12.4	11.6	- 27.3	0.0	48.6	0.0990
16	176	12:25	12:30	330.2	10.4	13.1	3.4	104.1	137.5	149.9	12.3	12.1	- 32.3	0.0	48.8	0.1010

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : F
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 06/19/79
GROSS AREA : 20.730 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	170	9:10	9:15	337.4	8.4	13.5	1.1	81.1	81.6	98.1	16.4	37.8	85.2	0.0	65.5	0.0020
02	170	9:15	9:20	337.7	8.4	13.5	1.1	82.5	81.9	98.3	16.4	36.8	84.4	0.0	65.7	-0.0020
03	170	9:20	9:25	339.0	8.3	13.6	4.0	83.7	82.1	98.6	16.5	35.7	83.6	0.0	65.9	-0.0050
04	170	9:25	9:30	339.2	8.0	13.6	2.4	83.9	82.3	98.8	16.5	34.7	82.7	0.0	66.0	-0.0050
05	170	12:45	12:50	343.1	6.9	13.4	0.0	87.0	204.5	211.3	6.8	14.8	- 48.4	0.0	26.5	0.3430
06	170	12:50	12:55	342.9	7.0	13.4	4.5	87.8	204.4	211.4	7.0	15.6	- 51.6	0.0	27.4	0.3400
07	170	12:55	13:00	342.7	7.2	13.4	0.0	88.5	203.7	210.6	6.9	16.4	- 54.4	0.0	27.0	0.3360
08	170	13:00	13:05	343.1	7.3	13.4	5.5	90.0	204.0	210.8	6.9	17.3	- 57.1	0.0	27.0	0.3320
09	170	13:40	13:45	341.9	7.9	13.6	7.6	89.8	161.7	172.4	10.7	24.8	- 72.0	0.0	42.6	0.2100
10	170	13:45	13:50	341.7	7.9	13.6	5.2	89.3	161.8	172.5	10.7	25.8	- 73.3	0.0	42.5	0.2120
11	170	13:55	14:00	340.3	8.2	13.6	0.0	88.8	161.7	172.4	10.7	27.8	- 75.8	0.0	42.9	0.2140
12	170	14:00	14:05	340.2	8.4	13.5	0.0	90.2	161.9	172.6	10.7	28.8	- 77.0	0.0	42.6	0.2110
13	170	15:15	15:20	327.9	10.2	12.9	0.0	90.3	131.2	144.7	13.5	44.2	- 89.9	0.0	53.3	0.1250
14	170	15:20	15:25	327.0	10.5	13.0	5.5	89.9	131.0	144.6	13.6	45.3	- 90.6	0.0	53.7	0.1260
15	170	15:25	15:30	325.9	10.5	12.9	0.0	90.1	131.0	144.4	13.5	46.3	- 91.3	0.0	53.4	0.1250
16	170	15:30	15:35	324.9	10.7	12.9	3.3	90.6	130.9	144.4	13.5	47.4	- 91.9	0.0	53.7	0.1240

COLLECTOR I.D : F
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 06/28/79
GROSS AREA : 20.840 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	179	11:15	11:20	324.2	17.1	13.2	2.8	107.5	104.7	120.5	15.8	14.0	43.8	0.0	64.1	-0.0090
02	179	11:20	11:25	326.1	17.7	13.2	7.0	107.2	104.8	120.7	15.9	13.3	39.9	0.0	64.1	-0.0070
03	179	11:25	11:30	324.5	17.8	13.3	4.9	107.8	104.9	120.7	15.8	12.7	35.7	0.0	64.3	-0.0090
04	179	11:30	11:35	326.3	17.5	13.2	9.4	106.9	104.9	120.8	15.9	12.1	31.0	0.0	64.2	-0.0060
05	183	11:55	12:00	320.0	12.6	13.3	4.0	96.2	144.6	155.9	11.3	10.8	2.5	0.0	46.7	0.1510
06	183	12:00	12:05	324.6	12.3	13.4	6.8	95.6	144.9	156.2	11.3	10.8	- 3.7	0.0	46.4	0.1520
07	183	12:05	12:10	324.2	12.1	13.3	4.5	94.5	144.5	155.8	11.3	10.9	- 9.8	0.0	46.4	0.1540
08	183	12:10	12:15	323.4	12.1	13.4	2.3	95.4	144.6	156.0	11.4	11.2	- 15.6	0.0	47.0	0.1520
09	186	10:25	10:30	333.2	7.8	13.5	4.5	94.9	221.7	226.3	4.6	23.0	67.3	0.0	18.4	0.3810
10	186	10:30	10:35	333.1	7.7	13.3	7.4	94.4	222.3	226.6	4.4	22.0	65.6	0.0	17.3	0.3840
11	186	10:35	10:40	333.6	7.6	13.4	1.1	94.7	222.7	227.3	4.7	21.1	63.8	0.0	18.7	0.3840
12	186	10:40	10:45	334.1	7.6	13.2	6.8	95.1	222.4	226.9	4.6	20.2	61.8	0.0	18.1	0.3810

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : F
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 05/29/79
GROSS AREA : 21.260 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	149	13:41	13:46	327.8	12.7	12.9	2.3	87.6	143.3	155.0	11.7	26.0	- 68.6	0.0	46.0	0.1700
02	149	13:46	13:51	329.0	12.9	12.9	6.3	88.5	142.7	154.5	11.8	26.9	- 70.1	0.0	46.4	0.1650
03	149	13:51	13:56	328.7	12.8	13.0	6.8	87.1	142.8	154.4	11.6	27.9	- 71.4	0.0	46.0	0.1690
04	149	13:56	14:01	326.7	13.1	12.9	8.5	86.1	142.9	154.6	11.7	28.9	- 72.7	0.0	46.3	0.1740
05	149	14:43	14:48	324.2	13.4	13.0	3.4	88.6	88.0	103.9	15.9	38.4	- 82.4	0.0	63.6	-0.0020
06	149	14:48	14:53	322.0	13.1	13.0	1.1	89.0	88.2	104.0	15.8	39.5	- 83.3	0.0	63.7	-0.0030
07	149	14:53	14:58	321.9	13.2	13.0	2.3	88.7	88.4	104.2	15.8	40.5	- 84.1	0.0	63.8	-0.0010
08	149	14:58	15:03	323.8	13.4	12.9	7.4	91.5	88.6	104.5	15.9	41.5	- 84.9	0.0	63.0	-0.0090
09	150	8:40	8:45	326.1	10.8	13.0	0.0	78.1	212.7	218.0	5.3	44.8	87.6	0.0	21.2	0.4130
10	150	8:45	8:50	326.9	10.6	13.0	1.1	78.3	212.4	217.8	5.5	43.7	86.8	0.0	22.0	0.4100
11	150	8:50	8:55	327.2	10.4	13.1	0.0	79.0	212.5	218.1	5.7	42.7	86.1	0.0	22.6	0.4080
12	150	8:55	9:00	328.0	10.4	13.0	0.0	78.8	212.0	217.8	5.7	41.7	85.3	0.0	22.7	0.4060

COLLECTOR I.D : F
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 06/24/79
GROSS AREA : 20.810 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	175	12:50	12:55	336.7	9.2	13.3	1.1	102.5	96.7	113.3	16.6	15.6	- 51.5	0.0	65.4	-0.0170
02	175	12:55	13:00	337.0	9.4	13.4	4.5	101.3	96.8	113.4	16.6	16.4	- 54.4	0.0	65.8	-0.0130
03	175	13:00	13:05	336.3	9.4	13.4	4.0	101.5	96.9	113.5	16.6	17.3	- 57.0	0.0	65.9	-0.0140
04	175	13:05	13:10	337.7	9.3	13.3	4.5	101.7	96.9	113.6	16.7	18.2	- 59.4	0.0	65.5	-0.0140
05	175	14:40	14:45	329.3	10.9	13.4	5.7	103.1	210.1	217.2	7.1	37.0	- 84.6	0.0	28.9	0.3250
06	175	14:45	14:50	329.2	10.7	13.2	0.0	103.3	210.0	217.3	7.3	38.0	- 85.4	0.0	29.2	0.3240
07	175	14:50	14:55	329.0	10.8	13.4	4.5	102.8	209.8	216.9	7.1	39.1	- 86.2	0.0	29.2	0.3250
08	175	14:55	15:00	327.1	10.9	13.1	1.7	105.7	209.7	217.0	7.4	40.1	- 87.0	0.0	29.6	0.3180
09	176	10:40	10:45	332.6	9.2	13.6	0.0	101.2	173.3	183.5	10.2	19.8	63.3	0.0	42.0	0.2170
10	176	10:45	10:50	331.2	9.2	13.5	8.0	102.1	173.3	183.6	10.4	18.9	61.2	0.0	42.4	0.2150
11	176	10:50	10:55	332.5	9.1	13.6	0.0	101.6	173.5	183.5	10.1	18.0	58.9	0.0	41.3	0.2160
12	176	10:55	11:00	331.3	9.3	13.6	3.4	102.2	173.6	183.8	10.2	17.1	56.5	0.0	42.0	0.2160
13	176	12:10	12:15	332.7	9.8	13.5	5.7	104.0	143.3	156.1	12.9	10.8	- 16.1	0.0	52.0	0.1180
14	176	12:15	12:20	333.5	9.8	13.4	9.1	106.4	143.2	156.2	13.0	11.2	- 21.9	0.0	52.4	0.1100
15	176	12:20	12:25	331.5	10.2	13.4	8.0	104.5	143.2	156.0	12.9	11.6	- 27.3	0.0	52.0	0.1170
16	176	12:25	12:30	330.2	10.4	13.4	3.4	104.1	143.2	156.0	12.9	12.1	- 32.3	0.0	52.4	0.1180

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : G
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 06/15/79
GROSS AREA : 27.300 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	166	10:20	10:25	326.6	6.6	13.6	5.7	98.4	221.2	225.3	4.2	23.7	70.0	0.0	17.4	0.3760
02	166	10:25	10:30	325.4	6.6	13.7	0.6	98.5	221.0	225.2	4.2	22.7	68.4	0.0	17.8	0.3760
03	166	10:30	10:35	325.7	6.5	13.6	8.0	98.5	221.2	225.3	4.1	21.7	66.8	0.0	17.1	0.3770
04	166	10:35	10:40	326.7	6.5	13.7	6.8	99.7	221.0	225.1	4.2	20.8	65.0	0.0	17.5	0.3710
05	166	12:15	12:20	324.3	7.4	13.5	3.4	103.4	171.8	180.3	8.5	11.2	- 21.7	0.0	35.5	0.2110
06	166	12:25	12:30	324.4	7.9	13.7	6.8	102.6	169.9	178.5	8.6	12.2	- 32.1	0.0	36.5	0.2080
07	166	12:30	12:35	321.4	8.1	13.7	3.4	102.7	170.0	178.4	8.4	12.8	- 36.6	0.0	35.6	0.2090
08	166	12:35	12:40	322.5	8.1	13.6	1.1	103.1	169.6	178.1	8.5	13.4	- 40.8	0.0	36.0	0.2060
09	170	11:10	11:15	334.1	4.7	13.9	5.1	86.4	85.3	98.9	13.6	14.6	47.7	0.0	56.3	-0.0030
10	170	11:15	11:20	334.1	4.5	13.9	6.3	87.1	85.5	99.1	13.6	13.9	44.2	0.0	56.5	-0.0050
11	170	11:20	11:25	334.7	4.7	13.9	5.7	86.5	85.6	99.2	13.5	13.2	40.3	0.0	56.2	-0.0020
12	170	11:25	11:30	335.3	4.7	13.9	1.1	87.3	85.9	99.4	13.5	12.5	36.0	0.0	55.8	-0.0040
13	170	13:20	13:25	333.4	5.5	14.0	0.6	89.3	123.8	135.3	11.6	20.9	- 65.6	0.0	48.4	0.1030
14	170	13:25	13:30	333.8	5.5	13.9	6.8	89.5	124.2	135.6	11.4	21.9	- 67.4	0.0	47.5	0.1040
15	170	13:30	13:35	335.0	5.8	13.9	8.0	88.6	124.2	135.8	11.5	22.8	- 69.0	0.0	47.9	0.1060
16	170	13:35	13:40	335.4	6.0	14.0	8.0	88.6	124.0	135.4	11.5	23.8	- 70.5	0.0	47.8	0.1050

COLLECTOR I.D : G
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 06/26/79
GROSS AREA : 27.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	177	9:50	9:55	320.0	8.7	13.2	2.8	103.7	199.8	206.7	6.9	29.6	77.7	0.0	28.4	0.3000
02	177	9:55	10:00	320.1	8.6	13.3	7.6	104.4	200.3	206.9	6.6	28.6	76.6	0.0	27.7	0.3000
03	177	10:00	10:05	321.3	8.8	13.2	4.7	104.3	199.6	206.5	6.9	27.6	75.5	0.0	28.6	0.2970
04	177	10:05	10:10	321.4	8.7	13.2	5.7	104.7	199.6	206.3	6.7	26.6	74.2	0.0	27.6	0.2950
05	177	10:45	10:50	322.5	7.9	13.2	1.1	105.9	104.6	118.5	13.9	18.9	61.1	0.0	56.9	-0.0040
06	177	10:50	10:55	322.9	8.3	13.3	5.6	106.1	104.7	118.6	13.9	18.0	58.9	0.0	56.9	-0.0040
07	177	10:55	11:00	320.5	8.3	13.2	4.9	105.3	104.8	118.6	13.8	17.1	56.4	0.0	56.8	-0.0020
08	177	11:00	11:05	321.3	8.2	13.2	5.8	105.8	104.9	118.7	13.8	16.3	53.7	0.0	56.7	-0.0030
09	177	11:50	11:55	323.8	8.8	13.4	0.0	106.3	156.3	166.5	10.3	10.6	8.8	0.0	42.3	0.1540
10	177	11:55	12:00	322.5	9.4	13.4	3.4	107.7	156.2	166.6	10.4	10.5	2.5	0.0	42.9	0.1510
11	177	12:00	12:05	317.0	9.4	13.3	0.0	107.6	156.6	166.6	10.0	10.5	- 3.8	0.0	41.9	0.1540
12	177	12:05	12:10	317.9	9.6	13.3	0.0	108.6	157.1	167.2	10.1	10.6	- 10.0	0.0	42.4	0.1520

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : G
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 05/30/79
GROSS AREA : 27.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	150	11:35	11:40	338.4	8.9	13.4	0.0	86.7	216.4	220.9	4.5	13.0	23.3	0.0	18.1	0.3630
02	150	11:40	11:45	338.6	9.1	13.4	6.8	86.5	216.1	220.7	4.6	12.7	18.3	0.0	18.3	0.3630
03	150	11:45	11:50	338.2	9.1	13.4	0.0	86.5	215.7	220.1	4.4	12.4	13.1	0.0	17.7	0.3620
04	150	11:50	11:55	338.8	8.9	13.3	8.5	86.3	215.7	220.3	4.7	12.2	7.7	0.0	18.2	0.3620
05	150	12:50	12:55	338.0	9.8	13.4	7.4	88.7	141.7	151.9	10.3	16.8	- 47.4	0.0	40.7	0.1570
06	150	12:55	13:00	337.1	10.0	13.5	8.5	89.3	141.6	151.8	10.2	17.6	- 50.3	0.0	40.8	0.1550
07	150	13:00	13:05	337.0	9.9	13.5	5.7	87.7	141.6	151.8	10.3	18.4	- 53.0	0.0	41.0	0.1600
08	150	13:05	13:10	335.9	10.2	13.5	6.8	90.2	141.6	151.7	10.2	19.2	- 55.5	0.0	40.8	0.1530
09	150	13:48	13:53	332.5	11.1	13.5	0.0	88.6	87.4	101.0	13.6	27.2	- 70.9	0.0	55.2	-0.0040
10	150	13:53	13:58	333.6	11.0	13.5	7.4	87.3	87.5	101.1	13.6	28.2	- 72.2	0.0	54.8	0.0010
11	150	14:15	14:20	329.8	11.7	13.5	8.0	89.0	88.1	101.6	13.5	32.6	- 77.3	0.0	55.1	-0.0030
12	150	14:20	14:25	330.0	11.5	13.5	4.0	89.2	88.1	101.7	13.6	33.7	- 78.4	0.0	55.2	-0.0030

COLLECTOR I.D : G
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 06/24/79
GROSS AREA : 27.810 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	175	11:35	11:40	335.8	7.8	14.0	0.0	100.5	200.0	206.6	6.6	11.5	26.3	0.0	27.5	0.2970
02	175	11:40	11:45	337.0	8.0	14.0	4.9	99.8	199.5	206.2	6.6	11.1	20.8	0.0	27.6	0.2960
03	175	11:45	11:50	338.2	8.1	14.0	4.9	99.9	199.0	205.7	6.7	10.7	14.9	0.0	27.9	0.2930
04	175	11:55	12:00	336.6	8.0	14.1	5.9	101.5	199.8	206.5	6.8	10.4	2.5	0.0	28.5	0.2920
05	175	12:50	12:55	334.4	8.8	13.8	3.4	101.5	169.3	178.1	8.9	15.6	- 51.5	0.0	36.7	0.2030
06	175	12:55	13:00	334.8	8.9	13.8	5.8	102.0	169.0	178.0	9.0	16.4	- 54.4	0.0	37.3	0.2000
07	175	13:00	13:05	334.2	8.9	13.8	4.7	101.4	168.9	177.8	8.9	17.3	- 57.0	0.0	36.7	0.2020
08	175	13:05	13:10	335.3	8.8	13.7	4.5	102.0	169.2	178.1	8.9	18.2	- 59.4	0.0	36.6	0.2000
09	175	13:50	13:55	331.9	9.6	13.7	5.9	103.3	137.5	148.8	11.3	26.8	- 74.6	0.0	46.7	0.1030
10	175	13:55	14:00	330.1	10.0	13.8	4.8	102.5	137.4	148.6	11.2	27.8	- 75.8	0.0	46.6	0.1060
11	175	14:00	14:05	331.4	9.8	13.8	4.1	102.4	137.4	148.6	11.2	28.8	- 76.9	0.0	46.6	0.1060
12	175	14:05	14:10	331.7	9.6	13.8	5.1	102.1	137.4	148.6	11.3	29.8	- 78.0	0.0	46.8	0.1060
13	175	14:35	14:40	325.3	10.5	13.7	2.3	102.8	98.4	112.1	13.7	36.0	- 83.7	0.0	57.7	-0.0140
14	175	14:40	14:45	327.2	10.3	13.6	2.3	102.9	98.3	112.1	13.8	37.0	- 84.6	0.0	57.2	-0.0140
15	175	14:45	14:50	326.6	10.2	13.7	3.9	103.4	98.4	112.2	13.8	38.0	- 85.4	0.0	57.6	-0.0160
16	175	14:50	14:55	326.6	10.3	13.7	1.9	103.0	98.4	112.1	13.7	39.1	- 86.2	0.0	57.2	-0.0140

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : H
SERIES NO : 1
LABORATORY NO : 1

TEST DATE : 10/04/78
GROSS AREA : 31.500 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	277	9:50	9:55	320.7	14.3	13.0	0.0	92.2	221.2	226.7	5.5	49.7	43.3	0.0	22.5	0.4020
02	277	9:55	10:00	322.1	14.3	13.0	2.3	91.6	221.1	226.6	5.5	49.0	42.0	0.0	22.0	0.4020
03	277	10:00	10:05	323.1	14.1	12.9	1.7	91.0	221.3	226.7	5.4	48.3	40.6	0.0	21.8	0.4030
04	277	10:05	10:10	324.3	13.7	12.9	0.0	92.4	222.3	227.7	5.4	47.7	39.2	0.0	21.4	0.4010
05	277	10:40	10:45	330.1	13.6	12.9	6.8	92.1	179.0	188.1	9.2	43.6	28.4	0.0	36.0	0.2630
06	277	10:45	10:50	330.6	13.3	12.9	6.0	92.3	178.8	188.4	9.6	43.1	26.7	0.0	37.4	0.2620
07	277	10:50	10:55	330.8	13.4	13.0	4.5	92.0	178.6	188.3	9.7	42.7	25.0	0.0	38.3	0.2620
08	277	10:55	11:00	330.9	13.6	13.0	2.3	91.9	178.2	187.9	9.8	42.3	23.3	0.0	38.4	0.2610
09	277	12:05	12:10	330.0	13.8	13.0	5.7	94.6	142.6	155.3	12.7	39.7	- 3.1	0.0	50.0	0.1450
10	277	12:10	12:15	330.9	13.5	12.9	2.8	94.3	142.6	155.3	12.8	39.7	- 5.1	0.0	49.9	0.1460
11	277	12:15	12:20	330.9	13.7	13.1	4.5	94.8	142.9	155.5	12.6	39.9	- 7.0	0.0	49.6	0.1460
12	277	12:20	12:25	331.1	13.8	12.9	3.4	95.5	142.6	155.3	12.7	40.0	- 8.9	0.0	49.8	0.1420
13	277	13:15	13:20	327.8	13.6	12.9	1.1	95.6	95.7	111.7	15.9	43,7	- 28.7	0.0	62.7	0.0000
14	277	13:20	13:25	328.7	13.6	13.0	3.4	95.8	95.7	111.6	15.8	44.2	- 30.4	0.0	62.6	-0.0000
15	277	13:25	13:30	326.7	14.1	13.0	4.5	96.3	96.0	111.7	15.8	44.8	- 32.0	0.0	62.7	-0.0010
16	277	13:30	13:35	323.6	14.2	13.0	5.1	95.7	96.0	111.6	15.7	45.3	- 33.5	0.0	63.0	0.0000

COLLECTOR I.D : H
SERIES NO : 2
LABORATORY NO : 1

TEST DATE : 06/20/79
GROSS AREA : 31.610 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	171	10:10	10:15	329.7	6.5	13.4	3.4	91.3	205.1	212.7	7.6	25.6	73.1	0.0	31.1	0.3450
02	171	10:15	10:20	328.8	6.2	13.3	0.6	92.5	204.8	212.4	7.6	24.6	71.7	0.0	30.9	0.3420
03	171	10:20	10:25	328.6	6.0	13.2	3.4	92.8	205.1	213.0	7.8	23.6	70.3	0.0	31.5	0.3420
04	171	10:25	10:30	328.9	6.0	13.1	2.3	90.8	205.0	212.5	7.5	22.6	68.7	0.0	30.1	0.3470
05	171	12:05	12:10	331.2	6.0	13.2	7.4	94.2	146.4	158.6	12.2	10.5	- 10.1	0.0	48.7	0.1570
06	171	12:10	12:15	332.8	6.0	13.2	8.0	93.6	146.6	158.7	12.2	10.8	- 16.2	0.0	48.2	0.1590
07	171	12:15	12:20	334.0	6.1	13.3	7.4	93.6	146.8	159.0	12.3	11.1	- 21.9	0.0	48.8	0.1590
08	171	12:20	12:25	334.2	6.1	13.4	6.3	94.1	146.8	159.1	12.3	11.5	- 27.3	0.0	49.1	0.1580
09	171	15:10	15:15	318.4	10.0	13.2	2.3	95.8	92.3	108.1	15.7	43.2	- 89.2	0.0	65.2	-0.0110
10	171	15:15	15:20	314.9	10.3	13.2	1.1	96.2	92.4	108.0	15.6	44.2	- 89.9	0.0	65.6	-0.0120
11	171	15:20	15:25	312.2	10.5	13.3	0.6	96.5	92.5	107.9	15.4	45.3	- 90.6	0.0	65.5	-0.0130
12	171	15:25	15:30	311.2	10.4	13.2	0.6	96.7	92.6	108.0	15.4	46.3	- 91.3	0.0	64.9	-0.0130

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : H
SERIES NO : 3
LABORATORY NO : 1

TEST DATE : 10/02/78
GROSS AREA : 31.500 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	275	10:15	10:20	321.5	13.7	13.3	1.1	90.1	225.7	230.4	4.6	45.7	36.8	0.0	19.2	0.4220
02	275	10:20	10:25	322.3	13.8	13.3	1.7	89.0	225.6	230.6	5.0	45.1	35.3	0.0	20.6	0.4240
03	275	10:25	10:30	323.4	13.9	13.3	2.3	89.4	225.5	230.0	4.5	44.5	33.7	0.0	18.6	0.4210
04	275	10:30	10:35	323.8	13.9	13.2	4.0	90.5	225.6	230.2	4.6	43.9	32.1	0.0	18.9	0.4170
05	275	11:15	11:20	328.4	17.8	13.3	5.1	90.9	160.1	171.2	11.2	40.1	16.4	0.0	45.1	0.2110
06	275	11:20	11:25	328.5	13.3	13.1	0.0	92.1	159.9	171.0	11.1	39.8	14.5	0.0	44.4	0.2060
07	275	11:25	11:30	328.4	13.1	13.1	5.7	92.7	159.8	171.0	11.2	39.6	12.6	0.0	44.5	0.2040
08	275	11:30	11:35	328.4	13.3	13.3	5.7	93.0	159.5	170.6	11.1	39.4	10.6	0.0	44.9	0.2020
09	275	12:25	12:30	327.0	13.9	13.3	8.0	94.1	94.7	110.1	15.4	39.4	- 11.0	0.0	62.4	0.0020
10	275	12:30	12:35	326.3	14.1	13.2	4.5	95.7	95.0	110.4	15.4	39.6	- 13.0	0.0	62.1	-0.0020
11	275	12:35	12:40	325.9	14.4	13.1	7.4	96.1	95.0	110.5	15.5	39.9	- 14.9	0.0	62.1	-0.0030
12	275	12:40	12:45	325.7	14.5	13.2	3.4	95.1	95.2	110.5	15.3	40.1	- 16.8	0.0	61.9	0.0000

COLLECTOR I.D : H
SERIES NO : 4
LABORATORY NO : 1

TEST DATE : 10/17/78
GROSS AREA : 31.630 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	290	8:40	8:45	297.0	13.4	12.8	0.0	80.0	221.4	225.5	4.1	64.6	55.5	0.0	17.6	0.4760
02	290	8:45	8:50	299.9	13.4	12.7	0.0	80.0	221.7	225.9	4.1	63.7	54.5	0.0	17.6	0.4730
03	290	8:50	8:55	302.9	13.4	12.7	0.0	81.2	222.2	226.6	4.4	62.9	53.5	0.0	18.3	0.4660
04	290	8:55	9:00	305.0	13.4	12.7	0.0	81.4	222.5	227.1	4.5	62.0	52.5	0.0	19.0	0.4630
05	290	9:35	9:40	316.1	12.9	12.6	3.4	84.9	188.8	196.9	8.1	55.9	43.6	0.0	32.4	0.3290
06	290	9:40	9:45	317.9	12.8	12.7	0.0	85.3	189.1	197.8	8.6	55.2	42.4	0.0	34.7	0.3270
07	290	9:45	9:50	319.5	12.9	12.5	3.4	85.8	189.6	198.1	8.6	54.5	41.1	0.0	33.7	0.3250
08	290	9:50	9:55	321.2	12.9	12.4	0.0	86.6	189.7	198.4	8.8	53.8	39.9	0.0	34.0	0.3210
09	290	10:40	10:45	331.1	13.1	13.1	4.5	87.9	148.2	160.2	12.0	48.1	25.8	0.0	47.4	0.1820
10	290	10:45	10:50	330.9	13.0	13.1	2.3	88.0	148.7	160.4	11.7	47.7	24.2	0.0	46.2	0.1830
11	290	10:50	10:55	332.8	13.0	13.1	2.8	89.1	149.1	160.9	11.9	47.3	22.7	0.0	46.7	0.1800
12	290	10:55	11:00	333.6	13.2	13.2	5.1	89.5	149.3	161.2	12.0	46.9	21.1	0.0	47.4	0.1790
13	299	9:05	9:10	317.7	9.5	13.1	0.0	66.4	68.0	83.4	15.4	62.8	48.1	0.0	63.5	0.0050
14	299	9:10	9:15	320.1	9.4	13.2	0.0	66.0	68.1	83.5	15.4	62.0	47.1	0.0	63.2	0.0070
15	299	9:15	9:20	322.3	9.2	13.2	0.0	66.9	68.3	83.8	15.6	61.3	46.0	0.0	63.5	0.0040
16	299	9:20	9:25	324.0	9.2	13.2	0.0	67.7	68.5	84.2	15.7	60.5	44.9	0.0	63.7	0.0020

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : A
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 23.190 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
05	92	11:40	11:45	327.1	18.1	12.7	7.2	80.1	81.3	96.6	15.3	24.3	10.2	0.0	59.3	0.0030
06	92	11:45	11:50	326.9	18.4	12.7	6.1	80.0	81.2	96.4	15.2	24.2	7.2	0.0	59.1	0.0040
07	92	12:43	12:48	329.4	20.5	12.7	7.5	81.1	126.0	138.7	12.7	26.4	- 26.7	0.0	49.1	0.1360
11	92	13:03	13:08	334.6	22.2	12.8	9.4	80.3	125.8	138.7	12.8	28.7	- 36.3	0.0	49.1	0.1360
12	92	13:08	13:13	333.8	21.8	12.8	8.8	80.2	126.0	139.0	12.9	29.4	- 38.5	0.0	49.6	0.1370
15	92	13:23	13:28	326.2	23.3	12.8	7.4	80.4	126.2	138.6	12.4	31.6	- 44.5	0.0	48.6	0.1400
18	93	12:11	12:16	336.5	39.9	12.7	7.4	81.8	163.6	173.9	10.3	23.8	- 8.4	0.0	39.0	0.2430
21	93	13:05	13:10	325.0	35.0	12.6	7.8	81.5	163.7	173.4	9.8	28.5	- 37.3	0.0	38.0	0.2530
22	96	9:44	9:49	330.8	11.6	12.9	4.5	74.3	75.2	90.6	15.4	38.7	61.0	0.0	59.8	0.0030
25	96	9:59	10:04	332.8	11.3	12.9	5.2	74.2	75.1	90.7	15.6	35.9	56.9	0.0	60.3	0.0030
34	96	11:56	12:01	339.3	9.6	12.7	7.7	75.5	160.6	170.7	10.2	22.4	1.0	0.0	38.2	0.2510
36	96	12:06	12:11	339.2	9.5	12.7	8.1	75.5	160.5	170.8	10.3	22.5	- 5.6	0.0	38.7	0.2510
38	96	12:42	12:47	336.3	10.6	12.4	9.1	75.0	210.9	216.8	5.9	24.8	- 27.3	0.0	22.0	0.4040
39	96	12:47	12:52	337.2	10.6	12.5	8.2	74.9	210.7	216.7	6.0	25.3	- 30.0	0.0	22.5	0.4030
40	96	13:18	13:23	335.3	11.6	12.6	8.1	74.6	197.8	204.8	7.0	29.4	- 44.2	0.0	26.5	0.3670
41	96	13:23	13:28	335.2	11.7	12.6	7.6	74.8	197.8	204.9	7.1	30.2	- 46.1	0.0	26.7	0.3670

COLLECTOR I.D : A
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 23.190 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	110	9:50	9:55	325.4	15.0	12.9	6.3	76.8	78.3	93.6	15.2	34.4	66.5	0.0	60.3	0.0050
02	110	9:55	10:00	325.8	15.3	12.9	5.7	77.2	78.4	93.7	15.2	33.4	65.2	0.0	60.3	0.0040
05	110	10:10	10:15	327.2	15.2	12.8	5.3	77.4	78.3	93.6	15.3	30.4	61.0	0.0	59.9	0.0030
06	110	10:15	10:20	326.8	15.4	12.8	5.8	78.0	78.5	93.8	15.4	29.5	59.5	0.0	60.2	0.0020
09	110	12:10	12:15	332.1	15.7	12.8	7.0	79.4	141.9	153.4	11.4	17.4	- 10.3	0.0	44.1	0.1880
10	110	12:15	12:20	331.9	15.9	12.8	6.4	78.6	141.7	153.3	11.5	17.7	- 14.3	0.0	44.4	0.1900
11	110	12:20	12:25	331.7	16.1	12.8	5.5	79.1	141.8	153.2	11.4	18.0	- 18.2	0.0	44.0	0.1890
18	111	9:37	9:42	332.4	33.1	12.4	7.5	74.8	209.8	216.6	6.8	36.8	70.0	0.0	25.4	0.4060
22	112	10:02	10:07	316.5	25.2	12.6	8.9	78.5	200.8	207.3	6.5	31.5	64.3	0.0	25.9	0.3860
23	112	10:07	10:12	317.9	24.5	12.6	7.8	78.5	201.3	207.9	6.6	30.5	62.9	0.0	26.5	0.3860
24	112	10:12	10:17	319.4	22.7	12.6	10.1	78.3	201.7	208.3	6.7	29.5	61.4	0.0	26.5	0.3860

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : A
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/05/79
GROSS AREA : 23.190 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
10	150	8:24	8:29	291.0	15.3	12.8	5.3	84.7	141.5	152.1	10.6	48.4	94.8	0.0	46.8	0.1950
11	150	8:29	8:34	294.1	15.1	12.7	5.1	85.3	141.6	152.5	10.9	47.3	94.2	0.0	47.0	0.1920
12	150	8:34	8:39	297.2	15.8	12.6	5.5	85.7	141.6	152.8	11.3	46.2	93.7	0.0	47.7	0.1880
17	150	10:05	10:10	304.1	14.3	12.5	5.5	84.1	201.7	209.0	7.3	26.2	81.7	0.0	30.2	0.3870
18	150	10:19	10:24	308.8	12.7	12.5	6.4	83.7	201.5	208.9	7.4	23.2	78.9	0.0	30.1	0.3810
24	150	10:49	10:54	310.3	11.0	12.5	5.9	85.4	202.0	209.7	7.7	16.8	70.5	0.0	31.1	0.3760
28	151	14:33	14:38	307.7	12.8	12.7	5.7	85.1	200.3	207.7	7.5	35.6	- 88.5	0.0	31.1	0.3740
33	151	10:31	10:36	309.4	10.8	12.7	7.0	85.8	87.4	102.0	14.6	20.6	76.4	0.0	60.0	0.0050
34	151	10:36	10:41	309.7	10.4	12.7	5.8	85.8	87.3	102.1	14.8	19.5	75.1	0.0	60.5	0.0050
35	151	10:41	10:46	310.5	10.0	12.7	6.5	85.8	87.3	102.1	14.8	18.5	73.7	0.0	60.3	0.0050
36	151	10:46	10:51	310.9	10.0	12.6	7.1	85.7	87.3	102.2	14.8	17.4	72.1	0.0	60.2	0.0050
43	151	11:57	12:02	312.1	9.5	12.7	6.4	86.4	148.8	160.2	11.4	6.5	1.2	0.0	46.6	0.2000

COLLECTOR I.D : A
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 05/16/79
GROSS AREA : 23.190 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
03	132	10:15	10:20	316.1	16.0	12.9	3.8	84.2	86.1	99.9	13.9	25.6	71.7	0.0	56.6	0.0060
04	132	10:25	10:30	330.1	19.3	12.9	3.2	84.8	86.1	100.7	14.6	23.6	68.9	0.0	56.9	0.0040
05	132	11:05	11:10	313.9	15.4	12.8	5.6	83.5	86.1	100.5	14.4	15.9	52.0	0.0	58.8	0.0080
06	132	11:10	11:15	312.7	14.8	12.8	5.1	83.7	86.1	100.2	14.1	15.0	48.9	0.0	57.9	0.0070
09	132	11:49	11:54	317.1	16.2	12.8	6.3	83.8	130.8	142.1	11.2	10.5	10.9	0.0	45.5	0.1480
10	132	11:54	11:59	318.1	16.2	12.8	6.0	83.8	130.6	142.3	11.7	10.4	4.5	0.0	47.2	0.1470
11	132	11:59	12:04	319.5	16.5	12.7	6.4	83.9	130.6	142.3	11.8	10.4	- 2.2	0.0	46.9	0.1460
12	132	12:04	12:09	319.7	17.4	12.7	6.2	83.9	130.6	142.5	11.9	10.5	- 8.7	0.0	47.3	0.1460
14	132	12:38	12:43	323.6	20.0	12.5	7.1	84.7	167.1	176.9	9.8	13.9	- 44.1	0.0	38.2	0.2550
16	132	12:48	12:53	322.6	20.8	12.5	6.3	83.9	167.5	177.2	9.7	15.6	- 51.0	0.0	37.7	0.2590
17	132	12:53	12:58	322.8	20.3	12.5	7.4	84.1	167.1	177.3	10.1	16.4	- 53.9	0.0	39.3	0.2570
18	132	12:58	13:03	325.8	20.7	12.5	6.4	84.1	167.2	177.1	9.9	17.3	- 56.5	0.0	38.0	0.2550
19	132	13:37	13:42	335.2	24.6	12.4	6.2	84.8	201.9	210.0	8.1	25.1	- 71.0	0.0	30.2	0.3500
20	132	13:42	13:47	337.5	25.1	12.5	7.2	84.2	201.9	210.1	8.3	26.1	- 72.3	0.0	30.7	0.3490
21	132	13:58	14:03	336.0	26.1	12.5	5.7	84.4	201.7	210.0	8.3	29.5	- 76.0	0.0	31.1	0.3490

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : B
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 18.720 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	97	10:25	10:30	326.8	12.1	13.4	4.9	78.4	79.9	95.5	15.6	31.0	49.0	0.0	64.0	0.0050
02	97	10:30	10:35	327.3	12.1	13.4	3.6	78.7	79.7	95.4	15.7	30.2	47.2	0.0	64.4	0.0030
04	97	10:40	10:45	328.4	11.7	13.4	3.9	79.1	80.1	95.8	15.7	28.6	43.2	0.0	64.1	0.0030
05	97	10:45	10:50	328.9	11.3	13.4	4.9	78.9	80.4	96.1	15.8	27.9	41.1	0.0	64.0	0.0040
09	97	11:24	11:29	332.3	10.1	13.2	5.1	79.3	127.3	140.6	13.2	23.4	21.1	0.0	52.6	0.1450
10	97	11:48	11:53	329.6	10.6	13.1	6.5	78.6	128.6	141.7	13.1	22.1	6.0	0.0	51.9	0.1520
11	97	11:53	11:58	334.1	10.2	13.1	6.1	78.2	128.6	141.9	13.3	22.1	2.7	0.0	52.2	0.1510
12	97	11:58	12:03	333.4	10.0	13.1	5.2	79.3	128.8	142.1	13.3	22.0	- 0.7	0.0	52.2	0.1460
15	97	12:39	12:44	334.9	9.6	13.1	7.8	80.2	163.1	173.8	10.7	24.2	- 26.2	0.0	42.0	0.2480
16	97	13:25	13:30	332.0	10.3	13.2	5.4	79.8	163.1	173.8	10.7	30.3	- 47.5	0.0	42.5	0.2510
17	97	13:30	13:35	331.6	10.2	13.2	7.1	79.9	163.3	174.1	10.8	31.1	- 49.3	0.0	43.1	0.2510
18	97	13:35	13:40	329.3	10.8	13.2	5.7	80.0	163.2	173.8	10.6	32.0	- 51.1	0.0	42.4	0.2530
20	97	14:06	14:11	329.5	11.4	12.8	5.2	79.8	209.6	216.1	6.5	37.6	- 60.3	0.0	25.5	0.3940
21	97	14:11	14:16	327.3	12.1	12.8	5.5	79.9	209.4	216.1	6.7	38.6	- 61.6	0.0	26.3	0.3960
22	97	14:32	14:37	321.2	12.9	12.8	6.0	79.9	198.4	206.0	7.6	42.7	- 66.4	0.0	30.6	0.3690
23	97	14:37	14:42	322.3	12.6	12.8	5.6	79.5	198.4	206.1	7.7	43.7	- 67.5	0.0	30.8	0.3690

COLLECTOR I.D : B
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 18.720 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	105	9:25	9:30	320.1	26.5	13.4	6.3	79.6	87.5	102.0	14.5	40.3	69.5	0.0	60.5	0.0250
04	105	9:49	9:54	319.0	24.9	13.2	5.9	79.7	87.4	101.9	14.5	35.5	64.0	0.0	60.0	0.0240
08	105	11:04	11:09	329.3	19.5	13.0	8.3	80.0	167.6	176.7	9.1	22.7	35.7	0.0	36.0	0.2660
14	105	12:21	12:26	328.8	22.8	12.9	5.2	83.2	205.2	211.4	6.2	19.8	- 17.9	0.0	24.3	0.3710
17	105	13:47	13:52	316.4	30.0	13.2	4.9	82.8	143.6	154.4	10.8	32.1	- 59.2	0.0	45.1	0.1920
26	106	11:35	11:40	341.6	14.6	13.2	8.1	77.1	78.8	94.7	15.9	19.4	16.9	0.0	61.7	0.0050
29	106	11:50	11:55	346.2	12.2	13.2	7.8	77.1	78.7	94.9	16.2	18.7	5.7	0.0	61.6	0.0050
32	106	12:48	12:53	345.0	11.8	12.9	7.6	77.1	147.8	159.4	11.5	22.1	- 35.0	0.0	43.1	0.2050
40	107	15:31	15:36	309.1	18.5	13.1	5.8	79.2	145.0	155.2	10.3	53.2	- 81.1	0.0	43.5	0.2130
41	107	15:36	15:41	307.4	18.8	13.1	4.5	79.2	145.0	155.1	10.1	54.3	- 81.8	0.0	43.2	0.2140
50	108	9:53	9:58	329.2	21.2	12.8	5.1	78.1	199.2	205.8	6.6	34.1	64.6	0.0	25.7	0.3680
54	108	10:13	10:18	331.3	21.1	12.8	6.0	79.4	199.6	206.4	6.8	30.2	58.9	0.0	26.2	0.3630
58	108	10:33	10:38	336.2	22.0	12.9	6.2	79.7	199.1	206.0	6.9	26.6	51.9	0.0	26.8	0.3550

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : B
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/05/79
GROSS AREA : 18.720 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	153	12:41	12:46	314.0	18.4	13.4	6.3	85.5	88.8	103.7	14.9	11.8	- 60.5	0.0	63.2	0.0110
02	153	12:46	12:51	314.8	18.6	13.3	6.3	85.7	89.1	104.1	15.0	12.7	- 63.4	0.0	63.1	0.0110
03	153	12:51	12:56	312.0	18.6	13.2	6.2	86.0	88.9	104.0	15.1	13.7	- 66.0	0.0	63.9	0.0090
04	153	12:56	13:01	313.4	17.1	13.3	6.8	85.4	88.8	103.9	15.1	14.8	- 68.3	0.0	63.8	0.0110
07	153	13:47	13:52	312.6	14.8	13.1	6.3	85.4	146.2	157.2	11.0	25.6	- 82.2	0.0	46.0	0.1950
09	153	14:08	14:13	312.3	13.7	13.2	5.2	85.1	146.3	157.2	10.9	30.2	- 85.6	0.0	46.0	0.1960
11	153	14:22	14:27	312.2	13.5	13.1	6.3	84.3	146.3	157.1	10.8	33.3	- 87.6	0.0	45.6	0.1980
12	153	14:27	14:32	311.4	13.3	13.1	7.2	84.3	146.2	157.1	10.9	34.4	- 88.2	0.0	46.0	0.1990
14	153	15:16	15:21	303.8	13.7	12.9	5.7	84.1	198.3	204.7	6.4	45.1	- 93.8	0.0	27.5	0.3760
16	153	15:31	15:36	301.1	14.2	12.9	5.5	84.3	199.3	205.6	6.3	48.4	- 95.4	0.0	27.1	0.3820
17	154	7:52	7:57	272.4	22.1	13.0	5.1	83.0	197.4	202.2	4.8	55.1	98.5	0.0	22.9	0.4200
18	154	7:57	8:02	273.0	22.6	13.0	4.8	83.2	198.0	202.8	4.9	54.0	98.1	0.0	23.2	0.4200

COLLECTOR I.D : B
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 05/24/79
GROSS AREA : 18.720 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	140	14:18	14:23	305.7	27.3	13.3	5.1	82.7	87.9	102.3	14.4	33.0	- 83.0	0.0	62.4	0.0170
04	140	14:58	15:03	299.8	25.5	13.3	6.0	82.4	87.8	101.8	14.0	41.8	- 88.6	0.0	62.1	0.0180
05	140	15:03	15:08	299.0	28.2	13.3	5.5	82.5	87.8	101.8	14.1	42.9	- 89.3	0.0	62.4	0.0180
06	140	15:08	15:13	296.1	26.0	13.3	5.4	82.4	87.7	101.8	14.1	44.0	- 89.9	0.0	63.1	0.0180
08	140	15:36	15:41	280.7	26.7	13.1	5.2	82.3	132.3	142.3	10.0	50.2	- 93.1	0.0	46.7	0.1780
10	140	15:53	15:58	266.4	28.4	13.1	5.5	82.1	132.4	142.0	9.6	53.9	- 94.9	0.0	47.1	0.1890
11	140	15:58	16:03	266.1	28.6	13.0	5.3	81.7	132.3	141.8	9.5	55.0	- 95.4	0.0	46.6	0.1900
12	140	16:03	16:08	262.4	29.0	13.0	4.9	81.6	132.5	141.9	9.3	56.1	- 95.9	0.0	46.3	0.1940
13	141	8:46	8:51	282.9	35.3	13.2	5.0	78.6	161.4	168.8	7.4	44.1	90.3	0.0	34.6	0.2930
14	141	8:51	8:56	283.0	36.3	13.2	5.1	78.7	161.4	168.9	7.6	43.0	89.7	0.0	35.4	0.2920
15	141	8:56	9:01	283.5	39.4	13.2	4.5	79.1	161.4	169.1	7.7	41.9	89.0	0.0	35.8	0.2900
16	141	9:01	9:06	289.8	39.2	13.3	5.3	79.0	161.3	169.2	7.9	40.8	88.4	0.0	36.4	0.2840
21	141	12:23	12:28	309.2	37.6	12.8	3.8	87.1	200.1	206.7	6.6	10.1	- 36.3	0.0	27.5	0.3650
22	141	12:28	12:33	305.7	38.6	12.8	4.1	87.2	199.8	206.2	6.4	10.8	- 41.7	0.0	27.1	0.3680
23	141	12:36	12:41	292.3	39.6	12.9	2.6	86.6	200.6	206.2	5.6	12.1	- 48.8	0.0	24.8	0.3900
24	141	12:41	12:46	301.5	37.7	12.9	2.4	87.5	200.7	206.8	6.1	12.9	- 52.5	0.0	26.4	0.3760

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : C
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 27.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
03	92	11:30	11:35	333.2	18.5	7.8	5.6	80.4	81.4	103.7	22.2	24.8	16.0	0.0	51.9	0.0030
05	92	11:40	11:45	331.3	19.1	7.8	7.2	80.1	81.4	103.6	22.2	24.3	10.2	0.0	52.1	0.0040
07	92	12:43	12:48	333.8	21.5	7.8	7.5	81.1	126.1	144.0	17.9	26.4	- 26.7	0.0	41.9	0.1350
08	92	12:48	12:53	334.2	21.2	7.8	7.9	80.5	126.1	144.0	17.9	26.9	- 29.3	0.0	41.8	0.1360
09	92	12:53	12:58	335.0	21.5	7.8	7.2	80.3	125.9	144.0	18.1	27.5	- 31.7	0.0	42.0	0.1360
15	92	13:23	13:28	330.6	24.3	7.9	7.4	80.4	126.4	144.0	17.5	31.6	- 44.5	0.0	41.9	0.1390
18	93	12:11	12:16	340.7	40.6	7.8	7.4	81.8	164.1	178.3	14.3	23.8	- 8.4	0.0	32.8	0.2420
19	93	12:55	13:00	329.3	35.5	7.7	9.6	81.4	163.8	177.4	13.6	27.3	- 32.7	0.0	32.0	0.2500
20	93	13:00	13:05	327.4	36.3	7.7	8.5	81.2	163.9	177.4	13.5	27.9	- 35.1	0.0	31.8	0.2520
21	93	13:05	13:10	329.2	35.8	7.7	7.8	81.5	164.0	177.7	13.8	28.5	- 37.3	0.0	32.3	0.2500
22	96	9:44	9:49	334.2	12.5	7.9	4.5	74.3	75.3	97.4	22.1	38.7	61.0	0.0	52.1	0.0030
25	96	9:59	10:04	336.2	12.2	7.9	5.2	74.2	75.2	97.4	22.2	35.9	56.9	0.0	52.1	0.0030
38	96	12:42	12:47	342.1	12.1	7.2	9.1	75.0	209.7	219.6	9.9	24.8	- 27.3	0.0	21.0	0.3940
41	96	13:23	13:28	340.6	13.1	7.5	7.6	74.8	198.0	208.7	10.7	30.2	- 46.1	0.0	23.5	0.3620
42	96	13:28	13:33	340.3	13.3	7.5	8.2	74.8	198.0	208.7	10.7	31.0	- 48.0	0.0	23.7	0.3620
45	96	13:43	13:48	338.4	13.7	7.4	8.8	74.1	198.1	208.6	10.5	33.6	- 53.1	0.0	23.3	0.3660

COLLECTOR I.D : C
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 27.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	110	9:50	9:55	323.4	14.5	7.8	6.3	76.8	78.4	99.4	21.0	34.4	66.5	0.0	50.6	0.0050
03	110	10:00	10:05	324.2	14.5	7.7	5.8	77.3	78.5	99.7	21.2	32.4	63.9	0.0	50.7	0.0030
04	110	10:05	10:10	324.2	14.6	7.8	6.9	76.9	78.2	99.6	21.4	31.4	62.5	0.0	51.1	0.0040
06	110	10:15	10:20	324.6	14.8	7.7	5.8	78.0	78.6	99.9	21.3	29.5	59.5	0.0	50.6	0.0020
07	110	11:52	11:57	328.8	15.6	7.7	5.6	78.6	141.3	156.8	15.4	17.2	4.5	0.0	36.4	0.1910
08	110	12:05	12:10	329.3	14.9	7.7	6.1	79.3	141.6	157.3	15.7	17.3	- 6.3	0.0	36.7	0.1890
10	110	12:15	12:20	329.4	15.3	7.7	6.4	78.6	141.2	157.2	15.9	17.7	- 14.3	0.0	37.3	0.1900
11	110	12:20	12:25	328.9	15.4	7.7	5.5	79.1	141.4	157.3	15.9	18.0	- 18.2	0.0	37.3	0.1890
16	111	9:27	9:32	308.3	29.3	7.6	8.4	74.6	209.4	216.9	7.5	38.9	72.1	0.0	18.5	0.4370
19	112	9:10	9:15	304.1	24.2	7.6	8.0	77.4	199.2	207.5	8.4	42.2	75.7	0.0	21.0	0.4000
20	112	9:43	9:48	308.9	28.5	7.6	8.7	77.7	199.9	208.4	8.5	35.3	69.1	0.0	21.1	0.3960
24	112	10:12	10:17	316.7	22.0	7.7	10.1	78.3	200.7	209.5	8.8	29.5	61.4	0.0	21.5	0.3860

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : C
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/08/79
GROSS AREA : 27.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	153	12:41	12:46	310.9	17.6	7.9	6.3	85.5	88.9	110.3	21.4	11.8	- 60.5	0.0	54.3	0.0110
02	153	12:46	12:51	311.4	17.7	7.9	6.3	85.7	89.1	110.8	21.7	12.7	- 63.4	0.0	54.9	0.0110
03	153	12:51	12:56	308.7	17.7	7.9	6.2	86.0	88.9	110.6	21.7	13.7	- 66.0	0.0	55.3	0.0090
04	153	12:56	13:01	310.2	16.2	7.9	6.8	85.4	88.8	110.5	21.7	14.8	- 68.3	0.0	55.0	0.0110
07	153	13:47	13:52	309.3	13.9	7.7	6.3	85.4	146.7	162.0	15.3	25.6	- 82.2	0.0	38.4	0.1980
09	153	14:08	14:13	308.7	12.7	7.8	5.2	85.1	146.7	162.0	15.3	30.2	- 85.6	0.0	38.7	0.1990
10	153	14:17	14:22	308.2	12.5	7.9	7.6	84.7	146.7	162.2	15.5	32.2	- 86.9	0.0	39.6	0.2010
11	153	14:22	14:27	308.9	12.6	7.9	6.3	84.3	146.7	162.0	15.3	33.3	- 87.6	0.0	39.0	0.2020
12	153	14:27	14:32	308.5	12.5	7.8	7.2	84.3	146.7	162.1	15.4	34.4	- 88.2	0.0	38.9	0.2020
13	153	15:11	15:16	301.4	12.8	7.6	6.8	83.9	199.4	208.7	9.3	44.1	- 93.3	0.0	23.6	0.3830
14	153	15:16	15:21	300.3	12.7	7.6	5.7	84.1	199.3	208.7	9.5	45.1	- 93.8	0.0	24.2	0.3840
15	153	15:24	15:29	299.8	12.9	7.6	5.9	84.2	199.9	209.0	9.1	46.9	- 94.7	0.0	23.2	0.3860

COLLECTOR I.D : C
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 06/07/79
GROSS AREA : 27.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
07	151	10:26	10:31	312.9	11.5	7.8	6.0	85.6	87.3	108.8	21.6	21.7	77.7	0.0	54.0	0.0050
08	151	10:31	10:36	312.7	11.7	7.8	7.0	85.8	87.4	108.8	21.5	20.6	76.4	0.0	53.5	0.0050
09	151	10:36	10:41	313.2	11.4	7.8	5.8	85.8	87.3	108.9	21.6	19.5	75.1	0.0	53.5	0.0050
10	151	10:41	10:46	313.9	11.0	7.8	6.5	85.8	87.3	109.0	21.7	18.5	73.7	0.0	53.8	0.0050
11	151	10:46	10:51	314.3	10.9	7.8	7.1	85.7	87.3	109.0	21.7	17.4	72.1	0.0	53.6	0.0050
12	151	10:51	10:56	314.2	10.9	7.8	5.8	85.4	87.3	109.0	21.7	16.4	70.3	0.0	53.6	0.0060
18	151	11:57	12:02	315.3	10.5	7.7	6.4	86.4	148.7	163.9	15.2	6.5	1.2	0.0	37.2	0.1970
19	151	12:15	12:20	314.9	10.7	7.8	6.9	85.8	148.4	163.4	15.0	7.6	- 32.3	0.0	37.1	0.1990
27	151	13:32	13:37	314.0	10.8	7.7	5.8	86.4	169.5	182.4	12.9	22.3	- 78.4	0.0	31.9	0.2650
28	151	13:37	13:42	313.9	11.2	7.7	5.7	86.1	169.4	182.2	12.8	23.4	- 79.5	0.0	31.6	0.2650
29	151	13:42	13:47	313.2	11.3	7.7	6.6	85.7	169.5	182.3	12.8	24.5	- 80.5	0.0	31.7	0.2680
30	151	13:47	13:52	313.2	11.6	7.7	5.9	85.5	169.6	182.2	12.6	25.6	- 81.5	0.0	31.1	0.2690
31	151	14:23	14:28	310.9	12.4	7.6	6.5	85.0	200.1	209.3	9.2	33.4	- 87.1	0.0	22.6	0.3700
32	151	14:28	14:33	307.9	12.9	7.6	6.2	85.0	200.1	209.1	9.0	34.5	- 87.8	0.0	22.5	0.3740
33	151	14:33	14:38	309.8	13.4	7.6	5.7	85.1	200.2	209.4	9.2	35.6	- 88.5	0.0	22.7	0.3720
34	151	14:38	14:43	308.8	13.9	7.6	6.1	85.0	200.2	209.4	9.2	36.7	- 89.1	0.0	22.7	0.3730

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : D
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 17.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
03	98	11:43	11:48	331.4	11.2	12.6	7.4	78.4	80.7	97.5	16.8	21.9	9.2	0.0	63.4	0.0070
04	98	11:48	11:53	331.0	11.3	12.5	7.7	78.9	80.6	97.3	16.7	21.8	5.9	0.0	63.3	0.0050
06	98	11:58	12:03	330.9	11.4	12.6	6.4	79.1	80.6	97.3	16.7	21.7	- 0.9	0.0	63.3	0.0040
07	98	14:23	14:28	322.4	14.7	12.4	8.0	78.2	159.1	172.2	13.1	40.7	- 65.0	0.0	50.2	0.2510
08	98	14:28	14:33	321.9	14.8	12.4	9.3	77.7	159.1	172.0	13.0	41.7	- 66.1	0.0	49.9	0.2530
10	98	14:57	15:02	313.9	16.1	12.2	8.7	77.8	207.3	217.2	9.9	47.7	- 71.9	0.0	38.5	0.4130
20	102	10:59	11:04	318.7	29.0	12.4	7.0	81.4	127.3	141.3	14.0	24.3	36.8	0.0	54.7	0.1440
21	102	11:56	12:01	323.7	23.2	12.5	6.9	81.6	127.0	141.6	14.6	20.1	0.5	0.0	56.1	0.1400
22	102	12:01	12:06	331.2	21.5	12.7	8.0	81.7	127.2	141.8	14.6	20.1	- 3.2	0.0	55.8	0.1370
24	102	12:21	12:26	324.2	20.4	12.7	7.4	81.7	127.2	141.4	14.2	20.9	- 17.1	0.0	55.6	0.1400
26	102	15:06	15:11	297.2	28.1	12.2	7.2	80.2	159.1	171.0	11.9	48.8	- 75.2	0.0	48.9	0.2650
31	105	9:49	9:54	310.3	22.8	12.6	5.9	79.7	87.3	102.6	15.3	35.5	64.0	0.0	62.2	0.0240
34	105	10:59	11:04	322.8	17.3	12.3	8.8	80.2	165.9	178.5	12.6	23.3	38.3	0.0	47.8	0.2660
40	105	12:16	12:21	330.5	18.3	12.1	6.4	83.0	202.8	214.1	11.3	19.5	- 14.4	0.0	41.8	0.3620
41	105	12:21	12:26	319.9	20.7	12.1	5.2	83.2	202.9	213.7	10.8	19.8	- 17.9	0.0	41.2	0.3740
43	105	12:31	12:36	322.6	21.0	12.1	6.7	83.1	203.0	213.8	10.8	20.6	- 24.6	0.0	40.9	0.3720

COLLECTOR I.D : D
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 17.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	110	9:50	9:55	322.4	14.2	12.4	6.3	76.8	78.4	95.3	16.9	34.4	66.5	0.0	65.1	0.0050
02	110	9:55	10:00	322.4	14.4	12.5	5.7	77.2	78.5	95.4	16.9	33.4	65.2	0.0	65.5	0.0040
05	110	10:10	10:15	323.8	14.3	12.3	5.3	77.4	78.4	95.4	17.0	30.4	61.0	0.0	64.7	0.0030
06	110	10:15	10:20	323.6	14.5	12.4	5.8	78.0	78.6	95.7	17.1	29.5	59.5	0.0	65.3	0.0020
08	110	12:05	12:10	328.4	14.6	12.5	6.1	79.3	141.1	155.8	14.7	17.3	- 6.3	0.0	56.1	0.1880
09	110	12:10	12:15	329.0	14.9	12.5	7.0	79.4	141.2	156.2	14.9	17.4	- 10.3	0.0	57.0	0.1880
10	110	12:15	12:20	328.9	15.1	12.6	6.4	78.6	141.0	156.0	15.0	17.7	- 14.3	0.0	57.2	0.1900
11	110	12:20	12:25	328.2	15.2	12.6	5.5	79.1	141.1	156.0	14.9	18.0	- 18.2	0.0	57.0	0.1890
16	112	9:10	9:15	304.3	24.3	12.4	8.0	77.4	198.7	209.5	10.8	42.2	75.7	0.0	44.2	0.3990
17	112	9:43	9:48	309.4	28.6	12.5	8.7	77.7	199.5	210.6	11.1	35.3	69.1	0.0	45.0	0.3940
18	112	9:54	9:59	306.9	27.4	12.5	9.4	78.1	198.4	209.3	10.9	33.1	66.4	0.0	44.6	0.3920
21	112	10:12	10:17	316.6	22.0	12.5	10.1	78.3	200.0	211.2	11.2	29.5	61.4	0.0	44.6	0.3840

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : D
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/05/79
GROSS AREA : 17.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
10	147	12:25	12:30	320.3	13.1	12.5	4.7	78.7	140.4	154.4	14.0	9.6	- 43.2	0.0	54.8	0.1930
13	147	12:40	12:45	321.4	13.1	12.4	5.0	79.4	140.6	154.8	14.2	12.1	- 56.2	0.0	54.8	0.1900
14	147	12:45	12:50	321.8	12.8	12.4	5.6	79.6	140.6	154.9	14.2	13.0	- 59.4	0.0	54.8	0.1900
20	149	11:05	11:10	314.4	18.3	12.6	5.7	85.1	87.5	103.6	16.1	13.6	62.9	0.0	64.5	0.0080
22	149	11:15	11:20	317.4	20.1	12.6	6.2	85.0	87.5	103.7	16.3	11.7	56.8	0.0	64.5	0.0080
29	150	8:44	8:49	302.2	16.5	12.2	4.7	85.2	141.8	155.5	13.8	44.0	92.6	0.0	55.5	0.1870
31	150	10:00	10:05	313.2	14.7	12.3	6.8	84.0	201.9	212.6	10.8	27.3	82.6	0.0	42.4	0.3760
33	150	10:19	10:24	311.1	13.3	11.3	6.4	83.7	201.7	213.2	11.4	23.2	78.9	0.0	41.7	0.3790
34	150	10:24	10:29	311.5	13.0	11.2	5.3	84.2	201.9	213.4	11.5	22.1	77.7	0.0	41.7	0.3780
35	150	10:29	10:34	311.9	12.7	11.2	6.1	84.2	201.8	213.4	11.6	21.0	76.5	0.0	42.0	0.3770
46	151	10:31	10:36	312.6	11.7	12.7	7.0	85.8	87.5	103.5	16.0	20.6	76.4	0.0	64.7	0.0060
47	151	10:36	10:41	313.0	11.4	12.6	5.8	85.8	87.5	103.5	16.0	19.5	75.1	0.0	64.4	0.0050

COLLECTOR I.D : D
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 05/23/79
GROSS AREA : 17.880 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	138	9:42	9:47	317.8	27.6	12.6	6.6	78.7	79.5	95.5	16.0	32.1	81.4	0.0	63.2	0.0020
03	138	10:37	10:42	326.5	23.0	12.6	8.3	78.9	79.7	96.0	16.3	20.4	68.5	0.0	62.9	0.0030
04	138	10:42	10:47	326.0	22.4	12.6	7.8	79.0	79.7	96.1	16.3	19.4	66.7	0.0	63.2	0.0020
05	138	10:47	10:52	324.1	22.5	12.6	7.8	78.9	79.9	96.1	16.2	18.4	64.8	0.0	62.9	0.0030
11	138	15:00	15:05	346.7	31.8	12.8	7.6	78.3	125.8	140.9	15.1	42.4	- 68.3	0.0	55.9	0.1370
12	138	15:17	15:22	327.3	30.6	12.9	9.0	77.7	125.9	140.3	14.4	46.2	- 90.4	0.0	56.7	0.1470
13	139	8:24	8:29	315.5	24.2	12.4	3.9	75.2	125.9	140.1	14.2	49.1	92.2	0.0	55.7	0.1610
15	139	12:04	12:09	330.8	13.7	12.3	5.5	79.4	169.8	182.2	12.4	8.8	- 10.2	0.0	46.4	0.2730
17	139	12:31	12:36	329.5	13.5	12.4	3.8	79.8	169.4	181.6	12.3	11.6	- 43.2	0.0	46.4	0.2720
20	139	12:50	12:55	326.1	13.7	12.4	3.5	79.3	169.4	181.5	12.1	14.8	- 56.9	0.0	46.2	0.2760
21	139	12:55	13:00	326.7	14.8	12.3	4.7	79.1	169.4	181.8	12.4	15.7	- 59.6	0.0	46.8	0.2760
22	139	13:32	13:37	322.4	15.0	12.3	2.1	79.7	172.6	184.6	12.0	23.2	- 73.2	0.0	45.8	0.2680
25	139	14:03	14:08	323.3	14.3	12.1	4.7	79.2	214.1	224.3	10.2	29.9	- 80.1	0.0	38.5	0.4170
26	139	14:08	14:13	320.6	14.9	12.0	3.2	79.1	213.8	224.0	10.2	31.0	- 81.0	0.0	38.4	0.4200
28	139	14:33	14:38	321.6	14.7	12.0	4.8	78.5	200.3	211.4	11.1	36.4	- 85.0	0.0	41.7	0.3790
29	139	14:38	14:43	320.1	15.0	12.0	4.5	78.6	200.3	211.3	11.0	37.5	- 85.7	0.0	41.6	0.3800

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : E
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 20.350 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	97	10:25	10:30	327.3	12.2	9.6	4.9	78.4	79.8	99.6	19.7	31.0	49.0	0.0	58.1	0.0040
02	97	10:30	10:35	327.5	12.1	9.7	3.6	78.7	79.7	99.6	19.9	30.2	47.2	0.0	58.6	0.0030
03	97	10:35	10:40	327.6	12.2	9.7	4.2	78.7	79.7	99.6	19.8	29.4	45.3	0.0	58.3	0.0030
05	97	10:45	10:50	329.3	11.4	9.5	4.9	78.9	80.3	100.3	20.0	27.9	41.1	0.0	57.7	0.0040
09	97	11:24	11:29	333.0	10.3	9.8	5.1	79.3	126.7	141.1	14.4	23.4	21.1	0.0	42.4	0.1480
10	97	11:48	11:53	330.0	10.7	9.7	6.5	78.6	128.2	142.4	14.2	22.1	6.0	0.0	41.6	0.1500
11	97	11:53	11:58	334.1	10.2	9.6	6.1	78.2	128.2	142.8	14.7	22.1	2.7	0.0	42.2	0.1500
12	97	11:58	12:03	333.2	10.0	9.6	5.2	79.3	128.4	143.2	14.9	22.0	- 0.7	0.0	42.7	0.1470
15	97	12:39	12:44	333.4	9.2	9.7	7.8	80.2	162.5	172.6	10.2	24.2	- 26.2	0.0	29.7	0.2470
16	97	13:25	13:30	330.6	10.0	9.7	5.4	79.8	162.6	172.9	10.3	30.3	- 47.5	0.0	30.5	0.2500
17	97	13:30	13:35	330.3	9.9	9.7	7.1	79.9	162.8	173.0	10.2	31.1	- 49.3	0.0	30.1	0.2510
18	97	13:35	13:40	328.1	10.4	9.8	5.7	80.0	162.6	172.9	10.2	32.0	- 51.1	0.0	30.5	0.2520
20	97	14:06	14:11	327.9	11.0	9.4	5.2	79.8	208.6	212.8	4.2	37.6	- 60.3	0.0	12.1	0.3930
21	97	14:11	14:16	325.7	11.7	9.5	5.5	79.9	208.6	213.2	4.6	38.6	- 61.6	0.0	13.3	0.3950
22	97	14:32	14:37	318.9	12.2	9.6	6.0	79.9	197.7	203.4	5.8	42.7	- 66.4	0.0	17.5	0.3690
23	97	14:37	14:42	319.8	11.9	9.6	5.6	79.5	197.7	203.5	5.7	43.7	- 67.5	0.0	17.3	0.3700

COLLECTOR I.D : E
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 20.350 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	107	14:28	14:33	320.3	14.6	10.1	5.8	81.9	82.6	101.8	19.3	39.8	- 70.3	0.0	60.7	0.0020
03	107	14:38	14:43	317.6	14.7	10.1	5.0	81.3	82.5	101.6	19.1	41.8	- 72.3	0.0	60.6	0.0040
04	107	14:43	14:48	316.8	14.8	10.1	5.0	82.0	82.3	101.6	19.3	42.9	- 73.3	0.0	61.3	0.0010
06	107	14:53	14:58	314.0	15.1	10.0	5.7	81.1	81.9	101.1	19.3	45.0	- 75.1	0.0	61.2	0.0030
07	107	15:31	15:36	302.5	16.8	9.6	5.8	79.2	143.5	155.8	12.3	53.2	- 81.1	0.0	39.0	0.2130
08	107	15:36	15:41	300.9	17.0	9.6	4.5	79.2	143.4	155.6	12.2	54.3	- 81.8	0.0	39.0	0.2130
09	107	15:41	15:46	298.2	17.2	9.6	5.3	79.1	143.5	155.4	11.9	55.3	- 82.5	0.0	38.3	0.2160
11	107	15:57	16:02	290.5	17.7	9.7	5.0	78.7	143.6	154.9	11.3	58.8	- 84.7	0.0	37.6	0.2230
17	108	9:53	9:58	319.7	18.9	9.5	5.1	78.1	196.4	202.3	6.0	34.1	64.6	0.0	18.0	0.3700
18	108	9:58	10:03	320.8	18.8	9.5	5.4	79.0	196.7	202.9	6.2	33.1	63.2	0.0	18.6	0.3670
19	108	10:03	10:08	321.2	18.6	9.5	5.2	79.2	196.5	202.8	6.3	32.1	61.9	0.0	18.7	0.3650
23	108	10:23	10:28	321.5	19.0	9.5	5.4	79.3	196.7	202.9	6.1	28.4	55.6	0.0	18.3	0.3650

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : E
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/07/79
GROSS AREA : 20.350 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	147	10:36	10:41	314.2	13.7	9.8	5.0	78.1	81.8	100.8	19.0	19.7	73.3	0.0	59.1	0.0120
03	147	10:41	10:46	316.8	13.1	9.8	4.9	77.8	81.6	100.8	19.2	18.6	71.7	0.0	59.4	0.0120
04	147	10:56	11:01	320.2	12.3	9.8	4.6	78.2	81.7	100.7	19.0	15.6	66.1	0.0	58.4	0.0110
05	147	11:01	11:06	318.3	12.4	9.8	4.0	78.5	81.7	100.7	19.0	14.6	63.7	0.0	58.6	0.0100
06	147	11:06	11:11	320.6	12.8	9.8	4.9	78.8	81.9	100.8	18.9	13.6	61.1	0.0	57.9	0.0100
07	147	12:30	12:35	317.6	12.8	9.8	4.8	79.7	139.1	151.3	12.2	10.3	- 48.2	0.0	37.5	0.1870
08	147	12:35	12:40	317.5	13.0	9.8	5.1	79.9	139.4	151.6	12.3	11.2	- 52.4	0.0	37.8	0.1870
09	147	12:40	12:45	319.3	12.5	9.7	5.0	79.4	139.3	151.6	12.3	12.1	- 56.2	0.0	37.3	0.1870
10	147	12:45	12:50	319.8	12.3	9.7	5.6	79.6	139.2	151.5	12.3	13.0	- 59.4	0.0	37.4	0.1860
11	147	13:16	13:21	317.4	14.0	9.5	5.9	79.4	196.8	201.5	4.7	19.3	- 72.7	0.0	14.1	0.3700
12	147	13:21	13:26	318.0	14.1	9.5	6.0	79.7	196.9	201.6	4.8	20.3	- 74.1	0.0	14.4	0.3690
13	147	13:26	13:31	317.1	14.2	9.6	7.0	79.7	197.4	201.9	4.5	21.4	- 75.5	0.0	13.8	0.3710

COLLECTOR I.D : E
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 05/24/79
GROSS AREA : 20.350 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	137	11:27	11:32	320.1	25.4	10.2	8.5	81.7	81.8	100.6	18.8	11.5	38.8	0.0	59.6	0.0000
02	137	11:32	11:37	315.8	26.1	10.2	9.2	81.5	81.8	100.3	18.5	10.8	33.7	0.0	59.3	0.0010
07	138	9:32	9:37	309.9	27.2	9.7	7.3	78.5	79.7	98.7	19.0	34.2	83.1	0.0	59.2	0.0040
11	138	10:47	10:52	316.0	20.5	9.8	7.8	78.9	80.1	99.1	19.1	18.4	64.8	0.0	59.2	0.0040
15	138	12:22	12:27	322.6	22.8	9.7	5.7	80.0	126.8	141.3	14.4	10.5	- 33.6	0.0	43.5	0.1450
17	138	15:00	15:05	341.2	30.7	9.8	7.6	78.3	125.7	142.0	16.3	42.4	- 88.3	0.0	46.8	0.1390
18	138	15:17	15:22	319.8	29.0	9.9	9.0	77.7	125.9	141.0	15.2	46.2	- 90.4	0.0	46.7	0.1510
21	139	12:04	12:09	320.5	10.9	9.7	5.5	79.4	169.4	179.4	10.0	8.3	- 10.2	0.0	30.4	0.2810
23	139	12:31	12:36	320.1	11.0	9.6	3.8	79.8	168.9	179.0	10.1	11.6	- 43.2	0.0	30.5	0.2780
25	139	12:45	12:50	319.7	11.2	9.7	4.5	79.3	169.0	179.4	10.5	13.9	- 53.9	0.0	31.8	0.2800
26	139	12:50	12:55	316.3	11.0	9.7	3.5	79.3	168.9	178.9	10.1	14.8	- 56.9	0.0	30.9	0.2830
27	139	12:55	13:00	317.1	12.3	9.6	4.7	79.1	168.8	179.1	10.3	15.7	- 59.6	0.0	31.3	0.2830
31	139	14:03	14:08	314.5	11.9	9.4	4.7	79.2	213.2	217.6	4.4	29.9	- 80.1	0.0	13.2	0.4260
33	139	14:28	14:33	311.6	12.3	9.5	5.5	78.6	199.3	205.3	5.9	35.3	- 84.2	0.0	18.1	0.3880
34	139	14:33	14:38	312.8	12.3	9.5	4.8	78.5	199.6	205.7	6.1	36.4	- 85.0	0.0	18.6	0.3870
35	139	14:38	14:43	311.5	12.7	9.5	4.5	78.6	199.6	205.6	6.0	37.5	- 85.7	0.0	18.5	0.3890

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : F
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 20.710 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	92	11:25	11:30	341.1	20.2	12.0	7.0	80.1	81.4	99.4	18.0	25.2	18.9	0.0	63.1	0.0040
04	92	11:35	11:40	340.9	20.2	12.0	6.5	80.5	81.5	99.5	18.0	24.6	13.1	0.0	63.2	0.0030
09	92	12:53	12:58	342.4	23.2	11.9	7.2	80.3	125.2	139.1	13.8	27.5	- 31.7	0.0	48.1	0.1310
14	92	13:18	13:23	335.8	25.3	11.9	8.2	80.5	125.3	138.7	13.5	30.8	- 42.6	0.0	47.9	0.1330
19	93	12:55	13:00	336.0	36.8	11.9	9.6	81.4	162.5	172.4	9.9	27.3	- 32.7	0.0	35.2	0.2410
20	93	13:00	13:05	334.1	37.6	11.9	8.5	81.2	162.6	172.3	9.8	27.9	- 35.1	0.0	34.7	0.2430
21	93	13:05	13:10	335.6	37.0	11.8	7.8	81.5	162.8	172.6	9.8	28.5	- 37.3	0.0	34.8	0.2420
22	96	9:44	9:49	342.1	14.5	12.1	4.5	74.3	75.3	93.0	17.7	38.7	61.0	0.0	62.5	0.0030
23	96	9:49	9:54	343.2	14.3	12.1	5.8	74.4	75.3	93.2	17.8	37.8	59.7	0.0	62.8	0.0030
27	96	11:01	11:06	349.7	13.6	12.0	8.8	74.5	126.0	139.5	13.5	26.1	33.4	0.0	46.3	0.1470
29	96	11:11	11:16	350.6	13.5	11.9	7.5	74.9	125.7	139.4	13.7	25.0	28.3	0.0	46.6	0.1450
35	96	12:01	12:06	351.9	13.0	11.8	7.6	75.9	160.2	170.7	10.5	22.4	- 2.4	0.0	35.4	0.2400
38	96	12:42	12:47	350.1	14.1	11.8	9.1	75.0	210.1	214.9	4.8	24.8	- 27.3	0.0	16.4	0.3360
40	96	13:18	13:23	348.9	15.0	11.8	8.1	74.6	197.1	203.4	6.2	29.4	- 44.2	0.0	21.2	0.3510
41	96	13:23	13:28	348.8	15.1	11.8	7.6	74.8	197.2	203.5	6.3	30.2	- 46.1	0.0	21.4	0.3510
42	96	13:28	13:33	348.5	15.3	11.8	8.2	74.8	197.2	203.5	6.4	31.0	- 48.0	0.0	21.7	0.3510

COLLECTOR I.D : F
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 20.710 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
03	106	11:05	11:10	334.2	10.6	12.1	6.5	77.1	78.8	97.0	18.1	22.3	36.0	0.0	65.4	0.0050
08	106	11:30	11:35	338.6	10.8	12.1	7.4	77.5	78.8	97.2	18.4	19.7	20.4	0.0	65.4	0.0040
10	106	11:40	11:45	334.3	11.8	12.1	8.3	77.0	78.9	96.9	18.0	19.1	13.3	0.0	65.0	0.0050
14	106	12:43	12:48	332.9	9.5	12.0	7.6	76.9	147.6	159.2	11.6	21.5	- 32.1	0.0	41.9	0.2120
15	106	12:48	12:53	335.0	9.2	12.0	7.6	77.1	147.4	159.2	11.8	22.1	- 35.0	0.0	42.4	0.2100
23	107	15:31	15:36	300.8	16.3	11.9	5.8	79.2	144.4	155.5	11.1	53.2	- 81.1	0.0	43.8	0.2170
24	107	15:36	15:41	299.1	16.5	11.9	4.5	79.2	144.4	155.5	11.1	54.3	- 81.8	0.0	43.9	0.2180
26	108	9:43	9:48	316.3	18.8	11.5	5.7	78.1	197.9	204.5	6.6	36.1	67.0	0.0	23.9	0.3790
31	108	10:08	10:13	319.5	18.2	11.5	5.6	79.0	199.0	205.7	6.7	31.2	60.4	0.0	24.4	0.3760
32	108	10:13	10:18	319.7	18.2	11.5	6.0	79.4	198.9	205.7	6.8	30.2	58.9	0.0	24.6	0.3740
35	108	10:28	10:33	321.5	18.5	11.5	7.4	79.7	198.7	205.6	6.9	27.5	53.8	0.0	25.0	0.3700

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : F
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/05/79
GROSS AREA : 20.710 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	153	12:46	12:51	308.0	16.8	12.1	6.3	85.7	89.2	105.7	16.5	12.7	- 63.4	0.0	64.8	0.0110
03	153	12:51	12:56	305.5	16.8	12.1	6.2	86.0	89.0	105.5	16.5	13.7	- 66.0	0.0	65.6	0.0100
04	153	12:56	13:01	306.8	15.3	12.0	6.8	85.4	88.9	105.4	16.5	14.8	- 68.3	0.0	64.9	0.0110
05	153	13:01	13:06	307.3	14.8	12.1	5.5	85.4	88.8	105.5	16.6	15.8	- 70.3	0.0	65.3	0.0110
07	153	13:47	13:52	306.0	13.0	11.9	6.3	85.4	146.7	158.7	12.0	25.6	- 82.2	0.0	46.7	0.2000
08	153	14:03	14:08	306.7	11.9	11.8	6.0	85.5	146.7	158.6	11.9	29.1	- 84.9	0.0	46.1	0.2000
09	153	14:08	14:13	305.5	11.8	11.8	5.2	85.1	146.8	158.7	12.0	30.2	- 85.6	0.0	46.3	0.2020
11	153	14:22	14:27	305.6	11.6	12.0	6.3	84.3	146.9	158.6	11.7	33.3	- 87.6	0.0	45.9	0.2050
13	153	15:11	15:16	298.9	12.0	11.5	6.8	83.9	199.4	205.7	6.3	44.1	- 93.3	0.0	24.5	0.3860
14	153	15:16	15:21	297.5	11.9	11.5	5.7	84.1	199.1	205.6	6.5	45.1	- 93.8	0.0	25.4	0.3870
15	153	15:24	15:29	297.2	12.1	11.5	5.9	84.2	199.5	205.7	6.2	46.9	- 94.7	0.0	24.1	0.3880
16	153	15:31	15:36	294.8	12.4	11.6	5.5	84.3	200.1	206.4	6.3	48.4	- 95.4	0.0	24.9	0.3930

COLLECTOR I.D : F
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 06/04/79
GROSS AREA : 20.710 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	138	9:42	9:47	311.7	26.1	12.0	6.6	78.7	79.5	96.4	16.9	32.1	81.4	0.0	65.1	0.0020
03	138	10:37	10:42	320.7	21.7	12.1	8.3	78.9	79.8	97.1	17.3	20.4	68.5	0.0	64.9	0.0030
04	138	10:42	10:47	320.2	21.0	12.1	7.8	79.0	79.7	97.1	17.3	19.4	66.7	0.0	65.2	0.0020
05	138	10:47	10:52	318.3	21.1	12.1	7.8	78.9	79.9	97.1	17.2	18.4	64.8	0.0	65.0	0.0030
12	138	15:17	15:22	323.4	29.7	12.0	9.0	77.7	126.4	139.3	12.9	46.2	- 90.4	0.0	48.0	0.1510
13	139	8:24	8:29	310.4	22.9	11.9	3.9	75.2	126.7	139.2	12.5	49.1	92.2	0.0	48.1	0.1660
15	139	12:04	12:09	325.1	12.2	11.7	5.5	79.4	171.0	180.7	9.7	8.8	- 10.2	0.0	34.9	0.2820
16	139	12:26	12:31	324.1	12.4	11.7	4.5	79.4	170.5	180.0	9.5	10.9	- 38.4	0.0	34.4	0.2810
19	139	12:45	12:50	324.1	12.4	11.7	4.5	79.3	170.4	180.2	9.8	13.9	- 53.9	0.0	35.5	0.2810
21	139	12:55	13:00	321.4	13.4	11.8	4.7	79.1	170.4	179.9	9.4	15.7	- 59.6	0.0	34.7	0.2840
22	139	13:32	13:37	317.0	13.5	11.8	2.1	79.7	174.0	183.0	9.1	23.2	- 73.2	0.0	33.9	0.2970
24	139	13:58	14:03	316.8	12.8	11.6	3.7	79.1	216.4	221.3	4.9	28.8	- 79.1	0.0	18.2	0.4330
25	139	14:03	14:08	318.6	13.1	11.7	4.7	79.2	215.9	221.0	5.1	29.9	- 80.1	0.0	19.0	0.4290
26	139	14:08	14:13	315.7	13.6	11.6	3.2	79.1	215.9	220.9	5.0	31.0	- 81.0	0.0	18.6	0.4330
28	139	14:33	14:38	317.1	13.5	11.6	4.8	78.5	202.0	208.1	6.2	36.4	- 85.0	0.0	22.7	0.3690
29	139	14:38	14:43	315.6	13.8	11.6	4.5	78.6	202.0	208.2	6.2	37.5	- 85.7	0.0	22.8	0.3910

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : G
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 27.640 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	102	10:54	10:59	315.9	34.8	9.0	8.0	81.2	128.1	142.6	14.5	24.9	39.3	0.0	41.3	0.1480
02	102	10:59	11:04	319.8	29.2	8.9	7.0	81.4	128.3	142.7	14.4	24.3	36.8	0.0	40.2	0.1460
06	102	12:21	12:26	325.8	20.8	9.0	7.4	81.7	128.4	143.2	14.8	20.9	- 17.1	0.0	41.1	0.1430
07	102	12:45	12:50	330.1	25.0	8.9	7.1	81.9	161.2	172.8	11.6	23.1	- 31.9	0.0	31.2	0.2400
08	102	15:06	15:11	295.7	27.7	8.9	7.2	80.2	161.1	171.1	10.1	48.8	- 75.2	0.0	30.3	0.2740
11	103	13:48	13:53	318.3	29.4	9.0	7.5	83.6	83.9	102.8	18.9	32.7	- 58.3	0.0	53.6	0.0010
15	105	9:25	9:30	311.7	24.5	9.0	6.3	79.6	87.5	105.8	18.3	40.3	69.5	0.0	53.0	0.0250
17	105	9:35	9:40	311.2	23.5	9.0	7.6	79.9	87.5	105.4	18.0	38.3	67.4	0.0	52.0	0.0240
18	105	9:49	9:54	310.6	22.9	8.9	5.9	79.7	87.4	105.4	18.0	35.5	64.0	0.0	51.8	0.0250
21	105	10:59	11:04	323.1	17.4	8.8	8.8	80.2	167.5	178.0	10.5	23.3	38.3	0.0	28.6	0.2700
22	105	11:04	11:09	320.5	17.3	8.7	8.3	80.0	167.4	177.8	10.4	22.7	5.7	0.0	28.3	0.2730
27	105	12:16	12:21	331.0	18.4	8.8	6.4	83.0	205.1	211.9	6.9	19.5	- 14.4	0.0	18.4	0.3690
28	105	12:21	12:26	320.0	20.7	8.8	5.2	83.2	205.2	211.4	6.2	19.8	- 17.9	0.0	17.3	0.3810
29	105	12:26	12:31	320.2	21.3	8.8	5.7	83.4	205.4	211.4	6.0	20.2	- 21.3	0.0	16.7	0.3810
30	105	12:31	12:36	321.9	20.9	8.8	6.7	83.1	205.3	211.5	6.2	20.6	- 24.6	0.0	17.1	0.3800
31	105	13:47	13:52	307.6	28.0	8.9	4.9	82.8	143.8	157.0	13.2	32.1	- 59.2	0.0	38.1	0.1980

COLLECTOR I.D : G
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 27.640 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	107	14:33	14:38	317.7	14.2	8.9	7.0	81.5	82.7	101.3	18.6	40.8	- 71.3	0.0	52.3	0.0040
04	107	14:43	14:48	315.6	14.5	8.8	5.0	82.0	82.4	101.1	18.8	42.9	- 73.3	0.0	52.4	0.0010
05	107	14:48	14:53	314.2	14.6	8.8	7.1	81.6	82.1	100.9	18.8	43.9	- 74.2	0.0	52.4	0.0020
06	107	14:53	14:58	312.3	14.7	8.8	5.7	81.1	82.0	100.7	18.6	45.0	- 75.1	0.0	52.4	0.0030
07	107	15:31	15:36	298.9	15.8	8.8	5.8	79.2	144.9	156.8	11.9	53.2	- 81.1	0.0	35.0	0.2200
09	107	15:41	15:46	294.0	16.0	8.9	5.3	79.1	145.1	156.6	11.5	55.3	- 82.5	0.0	34.6	0.2250
10	107	15:46	15:51	291.3	15.9	8.9	5.0	78.8	145.4	156.6	11.2	56.4	- 83.2	0.0	33.9	0.2290
11	107	15:57	16:02	285.0	16.1	8.9	5.0	78.7	145.2	156.0	10.9	58.8	- 84.7	0.0	34.0	0.2330
18	108	9:58	10:03	320.9	18.8	8.7	5.4	79.0	199.9	206.4	6.6	33.1	63.2	0.0	17.9	0.3770
21	108	10:13	10:18	321.8	18.8	8.6	6.0	79.4	200.1	206.7	6.6	30.2	58.9	0.0	17.8	0.3750
22	108	10:18	10:23	323.7	18.7	8.6	5.8	79.1	200.2	206.8	6.7	29.3	57.3	0.0	17.9	0.3740
24	108	10:28	10:33	323.8	19.1	8.6	7.4	79.7	199.8	206.6	6.8	27.5	53.8	0.0	18.3	0.3710

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : G
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/05/79
GROSS AREA : 27.640 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	153	12:46	12:51	318.1	19.4	9.0	6.3	85.7	89.2	107.8	18.6	12.7	- 63.4	0.0	52.4	0.0110
03	153	12:51	12:56	315.6	19.5	9.0	6.2	86.0	89.0	107.8	18.9	13.7	- 66.0	0.0	53.5	0.0090
04	153	12:56	13:01	317.0	18.0	9.0	6.8	85.4	88.9	107.7	18.8	14.8	- 68.3	0.0	53.5	0.0110
05	153	13:01	13:06	317.2	17.5	9.0	5.5	85.4	88.8	107.7	18.9	15.8	- 70.3	0.0	53.2	0.0110
07	153	13:47	13:52	315.8	15.7	9.0	6.3	85.4	146.6	159.6	13.1	25.6	- 82.2	0.0	37.4	0.1940
09	153	14:08	14:13	314.9	14.4	8.9	5.2	85.1	146.6	159.6	13.0	30.2	- 85.6	0.0	36.8	0.1950
11	153	14:22	14:27	314.8	14.2	8.9	6.3	84.3	146.6	159.4	12.9	33.3	- 87.6	0.0	36.3	0.1980
12	153	14:27	14:32	314.5	14.1	8.8	7.2	84.3	146.6	159.6	13.0	34.4	- 88.2	0.0	36.3	0.1980
14	153	15:16	15:21	306.3	14.4	8.7	5.7	84.1	198.7	205.4	6.7	45.1	- 93.8	0.0	19.3	0.3740
18	154	7:57	8:02	278.1	24.0	8.7	4.8	83.2	198.3	202.9	4.5	54.0	98.1	0.0	14.3	0.4140
19	154	8:02	8:07	280.3	24.1	8.8	4.9	83.7	198.9	203.7	4.8	52.9	7.6	0.0	15.0	0.4110
22	154	8:30	8:35	289.1	24.6	8.9	4.7	84.9	203.0	208.0	5.0	46.8	94.8	0.0	15.4	0.4090

COLLECTOR I.D : G
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 05/15/79
GROSS AREA : 27.640 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
02	131	13:16	13:21	321.9	12.4	9.0	6.5	82.4	84.0	102.6	18.6	20.9	- 63.7	0.0	52.1	0.0050
03	131	13:21	13:26	322.1	12.8	9.0	7.1	83.1	84.0	102.7	18.7	21.9	- 65.5	0.0	52.4	0.0030
04	131	13:26	13:31	321.5	12.7	9.0	6.4	83.1	84.0	102.7	18.8	22.9	- 67.2	0.0	52.5	0.0030
05	131	13:31	13:36	321.2	12.8	9.0	6.5	82.8	83.9	102.6	18.7	23.9	- 68.7	0.0	52.6	0.0040
10	131	14:19	14:24	318.6	15.0	8.9	6.3	83.2	146.0	158.3	12.3	34.1	- 79.6	0.0	34.2	0.1970
16	132	11:34	11:39	318.9	15.5	8.9	5.9	83.3	129.5	143.6	14.2	11.7	28.6	0.0	39.7	0.1450
17	132	11:44	11:49	320.5	16.5	9.1	5.8	83.4	129.4	143.3	14.0	10.8	17.2	0.0	39.5	0.1430
18	132	11:49	11:54	320.6	17.1	9.0	6.3	83.8	129.8	143.8	14.0	10.5	10.9	0.0	39.4	0.1440
23	132	12:38	12:43	327.2	20.9	8.7	7.1	84.7	165.2	176.5	11.3	13.9	- 44.1	0.0	30.0	0.2460
25	132	12:48	12:53	326.0	21.7	8.7	6.3	83.9	165.7	176.5	10.9	15.6	- 51.0	0.0	28.9	0.2510
26	132	12:53	12:58	326.1	21.1	8.7	7.4	84.1	165.5	176.6	11.1	16.4	- 53.9	0.0	29.6	0.2500
27	132	12:58	13:03	329.3	21.5	8.7	6.4	84.1	165.4	176.5	11.0	17.3	- 56.5	0.0	29.3	0.2470
28	132	13:37	13:42	338.2	25.3	8.8	6.2	84.8	199.4	207.3	7.8	25.1	- 71.0	0.0	20.5	0.3390
29	132	13:42	13:47	340.3	25.7	8.9	7.2	84.2	199.5	207.2	7.7	26.1	- 72.3	0.0	20.3	0.3390
30	132	13:58	14:03	338.2	26.6	8.9	5.7	84.4	199.4	207.3	7.9	29.5	- 76.0	0.0	21.0	0.3400

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : H
SERIES NO : 1
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 31.510 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	98	11:33	11:38	329.2	11.0	7.9	8.1	78.6	80.6	105.9	25.4	22.4	15.7	0.0	61.0	0.0060
03	98	11:43	11:48	329.8	10.8	7.9	7.4	78.4	80.7	106.3	25.5	21.9	9.2	0.0	61.3	0.0070
09	98	14:52	14:57	311.3	14.4	7.6	7.4	77.9	208.6	215.7	7.1	46.7	- 70.9	0.0	17.5	0.4200
10	98	14:57	15:02	308.9	14.7	7.6	8.7	77.8	208.5	216.0	7.5	47.7	- 71.9	0.0	18.6	0.4230
16	99	12:33	12:38	318.1	25.0	7.9	7.3	84.4	130.7	149.8	19.1	22.9	- 23.2	0.0	47.8	0.1460
20	102	10:59	11:04	322.5	29.8	7.8	7.0	81.4	127.6	147.4	19.8	24.3	36.8	0.0	48.2	0.1430
21	102	11:56	12:01	328.4	24.3	7.8	6.9	81.6	127.6	147.8	20.2	20.1	0.5	0.0	48.2	0.1400
24	102	12:21	12:26	328.4	21.4	7.9	7.4	81.7	127.7	147.8	20.1	20.9	- 17.1	0.0	48.6	0.1400
25	102	12:45	12:50	332.8	25.6	7.8	7.1	81.9	160.1	176.6	16.5	23.1	- 31.9	0.0	39.0	0.2350
28	105	9:25	9:30	317.0	25.8	8.0	6.3	79.6	87.4	110.8	23.4	40.3	69.5	0.0	59.3	0.0240
29	105	9:30	9:35	313.9	26.0	8.0	5.4	79.8	87.4	110.7	23.4	39.3	68.5	0.0	59.6	0.0240
34	105	10:59	11:04	327.5	18.5	7.8	8.8	80.2	166.4	181.0	14.6	23.3	38.3	0.0	35.0	0.2630
35	105	11:04	11:09	326.1	18.7	7.8	8.3	80.0	166.3	180.9	14.5	22.7	35.7	0.0	35.0	0.2650
37	105	11:14	11:19	328.8	18.5	7.8	7.1	80.7	166.3	181.0	14.7	21.5	29.9	0.0	35.0	0.2610
40	105	12:16	12:21	335.6	19.6	7.6	6.4	83.0	203.2	213.3	10.1	19.5	- 14.4	0.0	23.3	0.3580
41	105	12:21	12:26	325.3	22.0	7.6	5.2	83.2	203.4	212.5	9.2	19.8	- 17.9	0.0	21.7	0.3690

COLLECTOR I.D : H
SERIES NO : 2
LABORATORY NO : 2

TEST DATE : 05/14/79
GROSS AREA : 31.510 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	107	14:28	14:33	323.4	15.4	7.9	5.8	81.9	82.7	108.1	25.4	39.8	- 70.3	0.0	61.7	0.0020
03	107	14:38	14:43	320.1	15.4	7.8	5.0	81.3	82.5	107.8	25.2	41.8	- 72.3	0.0	61.7	0.0040
04	107	14:43	14:48	319.2	15.5	7.8	5.0	82.0	82.3	107.7	25.5	42.9	- 73.3	0.0	62.3	0.0010
05	107	14:48	14:53	317.8	15.6	7.8	7.1	81.6	82.0	107.5	25.4	43.9	- 74.2	0.0	62.5	0.0010
08	107	15:36	15:41	301.8	17.3	7.7	4.5	79.2	144.3	161.1	16.7	54.3	- 81.8	0.0	42.9	0.2160
09	107	15:41	15:46	299.0	17.5	7.7	5.3	79.1	144.5	160.9	16.4	55.3	- 82.5	0.0	42.5	0.2190
11	107	15:57	16:02	291.2	17.9	7.7	5.0	78.7	144.5	160.3	15.8	58.8	- 84.7	0.0	41.6	0.2260
13	107	16:07	16:12	284.9	18.1	7.7	6.2	77.4	144.4	159.6	15.2	61.0	- 86.0	0.0	40.9	0.2350
15	108	9:43	9:48	321.9	20.2	7.5	5.7	78.1	198.2	208.5	10.3	36.1	67.0	0.0	24.2	0.3730
18	108	9:58	10:03	324.7	19.8	7.5	5.4	79.0	198.9	209.6	10.7	33.1	63.2	0.0	24.9	0.3690
19	108	10:03	10:08	324.9	19.6	7.5	5.2	79.2	198.9	209.5	10.7	32.1	61.9	0.0	25.0	0.3680
23	108	10:23	10:28	325.5	20.0	7.5	5.4	79.3	199.1	209.8	10.7	28.4	55.6	0.0	25.0	0.3680

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : H
SERIES NO : 3
LABORATORY NO : 2

TEST DATE : 06/06/79
GROSS AREA : 31.510 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
03	147	10:41	10:46	324.3	15.1	8.0	4.9	77.8	81.5	106.2	24.8	18.6	71.7	0.0	60.7	0.0110
05	147	10:51	10:56	328.5	14.3	7.9	5.1	78.5	81.6	106.8	25.2	16.6	68.1	0.0	60.8	0.0090
06	147	10:56	11:01	327.8	14.4	8.0	4.6	78.2	81.5	106.6	25.1	15.6	66.1	0.0	60.9	0.0100
07	147	11:01	11:06	326.1	14.5	8.0	4.0	78.5	81.6	106.5	24.9	14.6	63.7	0.0	60.8	0.0100
10	147	12:25	12:30	325.1	14.3	7.9	4.7	78.7	140.0	157.9	17.9	9.6	- 43.2	0.0	43.4	0.1890
12	147	12:35	12:40	325.2	15.1	7.9	5.1	79.9	140.4	158.1	17.7	11.2	- 52.4	0.0	43.3	0.1860
13	147	12:40	12:45	326.9	14.6	7.9	5.0	79.4	140.2	158.1	17.9	12.1	- 56.2	0.0	43.2	0.1860
14	147	12:45	12:50	327.2	14.3	7.9	5.6	79.6	140.2	158.2	18.0	13.0	- 59.4	0.0	43.3	0.1850
15	147	13:16	13:21	324.3	15.8	7.7	5.9	79.4	199.4	207.9	8.5	19.3	- 72.7	0.0	20.3	0.3700
16	147	13:21	13:26	325.0	15.9	7.7	6.0	79.7	199.6	208.2	8.6	20.3	- 74.1	0.0	20.4	0.3690
17	147	13:26	13:31	323.9	16.0	7.7	7.0	79.7	200.0	208.5	8.4	21.4	- 75.5	0.0	20.2	0.3720
18	148	8:12	8:17	277.2	31.6	7.7	3.5	80.2	202.3	208.9	6.6	51.1	95.6	0.0	18.4	0.4400

COLLECTOR I.D : H
SERIES NO : 4
LABORATORY NO : 2

TEST DATE : 05/12/79
GROSS AREA : 31.510 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	131	13:11	13:16	322.1	12.3	7.9	7.4	82.6	83.8	108.4	24.6	19.9	- 61.8	0.0	60.2	0.0040
02	131	13:16	13:21	321.9	12.4	7.9	6.5	82.4	83.8	108.3	24.5	20.9	- 63.7	0.0	60.4	0.0040
03	131	13:21	13:26	322.1	12.8	7.9	7.1	83.1	83.8	108.4	24.6	21.9	- 65.5	0.0	60.6	0.0020
04	131	13:26	13:31	321.5	12.7	7.9	6.4	83.1	83.8	108.4	24.6	22.9	- 67.2	0.0	60.6	0.0020
13	131	14:34	14:39	316.9	15.4	7.7	6.4	82.1	146.1	163.3	17.2	37.4	- 82.2	0.0	41.9	0.2020
16	132	11:34	11:39	320.6	15.9	7.8	5.9	83.3	129.7	148.5	18.8	11.7	28.6	0.0	45.6	0.1450
19	132	11:54	11:59	323.2	17.5	7.7	6.0	83.8	129.9	148.7	18.8	10.4	4.5	0.0	45.0	0.1430
21	132	12:04	12:09	324.7	18.7	7.7	6.2	83.9	129.8	148.8	19.0	10.5	- 8.7	0.0	44.9	0.1420
23	132	12:38	12:43	328.1	21.1	7.6	7.1	84.7	165.6	180.5	14.9	13.9	- 44.1	0.0	34.6	0.2470
25	132	12:48	12:53	327.1	21.9	7.6	6.3	83.9	166.2	181.0	14.8	15.6	- 51.9	0.0	34.6	0.2520
26	132	12:53	12:58	326.7	21.3	7.6	7.4	84.1	165.9	180.8	14.9	16.4	- 53.9	0.0	34.9	0.2500
27	132	12:58	13:03	329.9	21.7	7.6	6.4	84.1	165.9	180.8	15.0	17.3	- 56.5	0.0	34.6	0.2480
28	132	13:37	13:42	339.4	25.6	7.7	6.2	84.8	200.1	210.9	10.8	25.1	- 71.0	0.0	24.6	0.3400
29	132	13:42	13:47	341.5	26.0	7.7	7.2	84.2	200.2	211.0	10.8	26.1	- 72.3	0.0	24.6	0.3400
30	132	13:58	14:03	340.4	27.0	7.7	5.7	84.4	200.0	211.4	11.3	29.5	- 76.0	0.0	25.9	0.3400

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : A
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 11/12/72
GROSS AREA : 22.810 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
42	318	11:25	11:31	309.0	7.0	13.4	3.0	59.7	127.3	138.7	11.4	55.5	0.0	6.9	48.6	0.2190
42	318	11:43	11:52	312.0	6.0	13.4	2.0	60.4	128.3	139.9	11.6	55.5	0.0	2.0	49.1	0.2170
42	318	12:09	12:15	316.0	7.0	13.4	2.0	60.3	129.5	141.3	11.8	55.5	0.0	3.7	49.3	0.2190
42	318	12:27	12:33	311.0	6.0	13.4	2.0	62.0	130.4	141.9	11.5	55.5	0.0	7.9	48.6	0.2200
43	319	11:33	11:39	317.0	9.0	13.1	2.0	60.4	164.1	173.6	9.5	55.8	0.0	5.0	40.3	0.3420
43	319	11:49	11:55	311.0	10.0	13.1	2.0	61.0	164.7	173.7	9.0	55.8	0.0	1.3	39.5	0.3510
43	319	12:05	12:11	317.0	11.0	13.1	2.0	61.7	165.4	174.2	8.9	55.8	0.0	2.7	38.9	0.3510
43	319	12:21	12:27	317.0	13.0	13.1	2.0	63.7	165.8	174.9	9.1	55.8	0.0	6.4	39.0	0.3400
44	321	11:25	11:31	289.0	16.0	12.9	2.0	63.2	196.8	203.0	6.2	56.3	0.0	7.0	28.9	0.4840
44	321	11:43	11:49	283.0	16.0	12.9	3.0	64.3	197.1	203.6	6.6	56.3	0.0	2.7	30.1	0.4680
44	321	12:10	12:16	301.0	12.0	12.9	3.0	64.1	197.0	204.1	7.1	56.3	0.0	4.0	30.4	0.4410
44	321	12:31	12:37	291.0	13.0	12.9	3.0	65.7	197.1	204.0	6.8	56.3	0.0	8.7	30.2	0.4590
45	338	11:19	11:25	271.0	10.0	13.3	1.0	59.9	61.8	74.8	13.0	59.6	0.0	8.7	61.9	0.0070
45	338	11:37	11:43	275.0	10.0	13.3	1.0	60.7	62.6	75.6	13.0	59.6	0.0	4.5	60.8	0.0070
45	338	12:19	12:25	280.0	10.0	13.3	2.0	62.7	63.8	77.3	13.6	59.6	0.0	5.2	62.3	0.0040
45	338	12:37	12:43	276.0	10.0	13.3	2.0	63.7	64.6	77.8	13.1	59.6	0.0	9.3	61.1	0.0030

COLLECTOR I.D : A
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 12/13/79
GROSS AREA : 22.810 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
47	349	11:20	11:26	307.0	5.0	16.1	2.0	63.9	96.0	106.7	10.6	60.7	0.0	8.4	54.3	0.1050
47	349	11:46	11:52	311.0	6.0	16.1	2.0	63.9	96.3	107.2	10.9	60.7	0.0	2.5	54.7	0.1040
47	349	12:06	12:12	311.0	5.0	16.1	2.0	64.7	96.6	107.5	10.9	60.7	0.0	2.1	54.6	0.1030
47	349	12:32	12:38	309.0	5.0	16.1	2.0	65.9	97.2	108.0	10.8	60.7	0.0	8.1	54.7	0.1010
48	353	11:23	11:29	326.0	17.0	13.6	2.0	55.4	130.2	141.6	11.4	60.8	0.0	7.7	46.8	0.2290
48	353	12:16	12:22	303.0	11.0	13.6	2.0	56.2	128.0	138.3	10.3	60.8	0.0	4.3	45.5	0.2370
50	356	11:02	11:08	273.0	9.0	13.5	1.0	54.5	151.6	159.5	7.9	60.8	0.0	12.5	38.8	0.3570
50	356	11:29	11:35	281.0	10.0	13.5	1.0	56.7	151.8	160.1	8.3	60.8	0.0	6.4	39.3	0.3360
01	16	12:56	12:66	304.0	5.0	13.4	2.0	59.7	191.3	198.7	7.5	58.4	0.0	8.5	32.8	0.4330
1	16	12:80	12:90	296.0	5.0	13.4	2.0	59.7	191.8	199.1	7.3	58.4	0.0	11.9	32.8	0.4450

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : B
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 09/10/78
GROSS AREA : 18.370 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
26	255	11:13	11:20	320.0	4.0	13.5	3.0	83.3	124.7	137.8	13.1	33.1	0.0	9.9	54.0	0.1300
26	255	11:43	11:49	326.0	4.0	13.5	3.0	85.1	125.2	138.5	13.3	33.1	0.0	2.7	54.1	0.1250
26	255	12:13	12:19	326.0	5.0	13.5	3.0	84.7	125.0	138.4	13.4	33.1	0.0	4.9	54.0	0.1250
26	255	12:37	12:43	319.0	5.0	13.5	4.0	85.5	125.2	138.3	13.1	33.1	0.0	10.9	54.1	0.1250
27	257	14:08	11:14	312.0	5.0	13.7	3.0	78.6	76.7	92.1	15.4	33.9	0.0	11.5	65.5	0.0060
27	257	11:44	11:50	319.0	5.0	13.7	3.0	80.7	78.2	93.8	15.6	33.9	0.0	2.6	64.9	0.0060
27	257	12:08	12:14	320.0	5.0	13.7	2.0	82.1	78.3	94.5	16.2	33.9	0.0	3.6	65.4	0.0060
27	257	12:44	12:50	310.0	6.0	13.7	2.0	83.5	80.0	95.3	15.3	33.9	0.0	12.5	65.2	0.0110
28	258	11:14	11:20	312.0	6.0	13.3	2.0	84.5	211.2	217.4	6.2	34.2	0.0	9.9	26.8	0.4080
28	258	11:38	11:44	317.0	6.0	13.3	4.0	85.4	211.7	218.3	7.6	34.2	0.0	4.2	27.6	0.3970
28	258	12:14	12:20	314.0	7.0	13.3	5.0	86.4	211.7	217.9	6.2	34.2	0.0	5.2	26.3	0.3970
28	258	12:38	12:44	311.0	7.0	13.3	5.0	87.7	211.9	217.9	6.0	34.2	0.0	11.1	25.9	0.3970
29	261	11:22	11:28	321.0	6.0	13.3	4.0	71.3	170.3	178.8	8.5	35.4	0.0	9.7	35.2	0.3060
29	261	11:40	11:46	327.0	6.0	13.3	6.0	71.9	170.2	179.2	9.0	35.4	0.0	3.7	36.8	0.3010
29	261	12:16	12:22	329.0	6.0	13.3	5.0	71.8	170.5	179.5	9.0	35.4	0.0	5.4	36.2	0.3010
29	261	12:38	12:44	323.0	6.0	13.3	3.0	72.1	170.7	179.5	8.8	35.4	0.0	11.4	36.1	0.3060

COLLECTOR I.D : B
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 09/04/78
GROSS AREA : 18.370 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
23	249	12:30	12:37	345.0	13.0	13.6	3.0	76.4	79.4	45.8	16.4	30.8	0.0	9.3	61.9	0.0110
24	250	11:35	11:43	329.0	5.0	13.3	3.0	73.1	150.9	161.8	10.9	31.2	0.0	4.1	43.8	0.2380
24	250	12:53	13:00	322.0	5.0	13.3	3.0	73.1	195.3	202.1	6.7	31.2	0.0	14.9	27.8	0.3800

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : C
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 09/10/78
GROSS AREA : 27.560 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
26	255	11:13	11:20	320.0	4.0	12.6	3.0	83.3	124.9	137.6	12.7	33.1	0.0	9.9	49.5	0.1300
26	255	11:43	11:49	326.0	4.0	12.6	3.0	85.1	125.2	138.4	13.2	33.1	0.0	2.7	50.1	0.1240
26	255	12:13	12:19	326.0	5.0	12.6	3.0	84.7	125.0	138.1	13.1	33.1	0.0	4.9	49.8	0.1240
26	255	12:37	12:43	319.0	5.0	12.6	4.0	85.5	125.1	137.8	12.7	33.1	0.0	10.9	49.2	0.1240
27	257	11:08	11:14	312.0	5.0	11.8	3.0	78.6	76.5	90.9	14.4	33.9	0.0	11.5	53.0	-0.0060
27	257	11:44	11:50	319.0	5.0	11.8	3.0	80.7	78.0	92.8	14.8	33.9	0.0	2.6	53.0	-0.0110
27	257	12:08	12:14	320.0	5.0	11.8	2.0	82.1	78.5	93.4	14.9	33.9	0.0	3.6	53.5	-0.0110
27	257	12:44	12:50	310.0	6.0	11.8	2.0	83.5	79.7	93.9	14.3	33.9	0.0	12.5	52.7	-0.0110
28	258	11:14	11:20	312.0	6.0	11.5	2.0	84.5	212.4	219.0	6.6	34.2	0.0	9.9	24.5	0.4080
28	258	11:38	11:44	317.0	6.0	11.5	4.0	85.4	212.9	219.7	6.8	34.2	0.0	4.0	24.9	0.4030
28	258	12:14	12:20	314.0	7.0	11.5	5.0	86.4	212.8	219.2	6.4	34.2	0.0	5.2	23.4	0.4030
28	258	12:38	12:44	311.0	7.0	11.5	5.0	87.7	212.9	219.2	6.2	34.2	0.0	11.1	23.1	0.4030
29	261	11:22	11:28	321.0	6.0	11.5	4.0	71.3	171.7	180.4	8.7	35.4	0.0	9.7	30.8	0.3120
29	261	11:40	11:46	327.0	6.0	11.5	6.0	71.9	171.5	180.7	9.2	35.4	0.0	3.7	32.0	0.3060
29	261	12:16	12:22	329.0	6.0	11.5	5.0	71.8	171.8	180.9	9.0	35.4	0.0	5.4	31.3	0.3060
29	261	12:38	12:44	323.0	6.0	11.5	8.0	72.1	171.9	180.7	8.8	35.4	0.0	11.4	31.0	0.3120

COLLECTOR I.D : C
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 09/04/78
GROSS AREA : 27.560 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
24	250	11:35	11:43	329.0	5.0	11.5	3.0	73.1	151.8	162.4	10.6	31.2	0.0	4.1	36.6	0.2380
23	249	12:30	12:37	345.0	13.0	11.7	3.0	76.4	79.4	94.7	15.3	30.8	0.0	9.3	50.2	0.0110
24	250	12:53	13:00	322.0	5.0	11.5	3.0	73.1	197.0	203.4	6.5	31.2	0.0	14.9	23.1	0.3860

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : D
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 11/12/78
GROSS AREA : 17.530 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
42	318	11:25	11:31	309.0	7.0	12.4	3.0	59.7	126.0	140.2	14.2	55.5	0.0	6.9	56.0	0.2150
42	318	11:43	11:52	312.0	6.0	12.4	2.0	60.4	126.9	141.2	14.3	55.5	0.0	2.0	55.7	0.2130
42	318	12:09	12:15	316.0	7.0	12.4	2.0	60.3	128.2	142.7	14.5	55.5	0.0	3.7	55.7	0.2150
42	318	12:27	12:33	311.0	6.0	12.4	2.0	62.0	129.1	143.3	14.2	55.5	0.0	7.9	55.4	0.2160
43	319	11:33	11:39	317.0	9.0	12.1	2.0	60.4	162.2	174.9	12.8	55.8	0.0	5.0	50.4	0.3350
43	319	11:49	11:55	311.0	10.0	12.1	2.0	61.0	162.7	175.0	12.4	55.8	0.0	1.3	50.1	0.3440
43	319	12:05	12:11	317.0	11.0	12.1	2.0	61.7	163.4	175.7	12.3	55.8	0.0	2.7	50.0	0.3440
43	319	12:21	12:27	317.0	13.0	12.1	2.0	63.7	164.1	176.4	12.3	55.8	0.0	6.4	49.3	0.3340
44	321	11:25	11:31	289.0	16.0	12.0	2.0	63.2	194.3	204.1	9.8	56.3	0.0	7.0	42.4	0.4750
44	321	11:43	11:49	283.0	16.0	12.0	3.0	64.3	194.6	204.9	10.4	56.3	0.0	2.7	43.8	0.4600
44	321	12:10	12:16	301.0	12.0	12.0	3.0	64.1	194.5	205.7	11.2	56.3	0.0	4.0	44.3	0.4330
44	321	12:31	12:37	291.0	13.0	12.0	3.0	65.7	194.8	205.5	10.7	56.3	0.0	8.7	43.8	0.4420
45	338	11:19	11:25	271.0	10.0	12.5	1.0	59.9	67.6	76.0	14.4	59.6	0.0	8.7	64.2	0.0060
45	338	11:37	11:43	275.0	10.0	12.5	2.0	60.7	62.4	76.9	14.6	59.6	0.0	4.5	64.1	0.0060
45	338	12:19	12:25	280.0	10.0	12.5	2.0	62.7	63.6	78.5	14.9	59.6	0.0	5.2	64.4	0.0030
45	338	12:37	12:43	276.0	10.0	12.5	2.0	63.7	64.5	79.0	14.4	59.6	0.0	9.3	63.2	0.0030

COLLECTOR I.D : D
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 12/13/79
GROSS AREA : 17.530 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
47	349	11:20	11:26	307.0	5.0	12.7	2.0	63.9	95.4	110.1	14.7	60.7	0.0	8.4	59.2	0.1030
47	349	11:46	11:52	311.0	6.0	12.7	2.0	63.9	95.7	110.7	15.1	60.7	0.0	2.5	60.0	0.1020
47	349	12:06	12:12	311.0	5.0	12.7	2.0	64.7	96.1	111.1	15.1	60.7	0.0	2.1	59.9	0.1010
47	349	12:32	12:38	309.0	5.0	12.7	2.0	65.9	96.5	111.3	14.8	60.7	0.0	8.1	59.2	0.0990
48	353	11:23	11:29	326.0	17.0	10.3	2.0	55.4	128.7	146.6	17.9	60.8	0.0	7.7	55.5	0.2250
48	353	12:16	12:22	303.0	11.0	10.3	2.0	56.2	126.6	142.9	16.3	60.8	0.0	4.3	54.4	0.2330
49	354	13:24	13:30	285.0	9.0	11.6	2.0	57.6	150.6	163.0	12.4	60.8	0.0	19.9	49.9	0.3260
01	16	12:56	12:66	304.0	5.0	12.6	2.0	59.7	190.5	201.9	11.3	58.4	0.0	8.5	46.7	0.4300
01	16	12:80	12:90	296.0	5.0	12.6	2.0	59.7	191.1	202.3	11.2	58.4	0.0	11.9	47.2	0.4430

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : E
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 04/30/79
GROSS AREA : 20.170 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
18	122	11:43	11:49	321.0	9.0	13.6	9.0	75.3	76.9	91.7	14.7	22.1	0.0	3.5	60.5	0.0050
18	122	11:50	12:56	319.0	9.0	13.6	8.0	75.8	76.8	91.2	15.1	22.1	0.0	1.6	62.2	0.0030
18	122	12:02	12:08	319.0	12.0	13.6	2.0	75.2	75.7	90.7	15.0	22.1	0.0	1.3	61.9	0.0020
18	122	12:10	12:16	321.0	11.0	13.6	1.0	75.6	75.3	90.4	15.1	22.1	0.0	3.2	61.7	-0.0010
19	129	11:37	11:43	329.0	61.0	13.5	8.0	67.1	109.2	121.2	12.0	20.7	0.0	4.7	48.2	0.1280
19	129	11:49	11:55	320.0	8.0	13.5	2.0	67.5	109.5	121.1	11.6	20.7	0.0	1.9	47.8	0.1320
19	129	12:05	12:11	330.0	7.0	13.5	2.0	68.7	109.8	121.8	12.1	20.7	0.0	1.9	48.2	0.1240
19	129	12:17	12:33	332.0	6.0	13.5	2.0	69.0	110.3	122.2	12.0	20.7	0.0	4.7	47.6	0.1240
20	130	11:37	11:43	326.0	5.0	13.3	0.4	76.8	145.9	155.8	9.9	20.0	0.0	4.7	39.6	0.2100
20	130	11:49	11:55	329.0	6.0	13.3	0.5	77.8	146.0	155.9	9.9	20.0	0.0	1.9	39.7	0.2070
20	130	12:05	12:11	328.0	5.0	13.3	0.2	79.1	145.9	156.2	10.3	20.0	0.0	1.9	41.3	0.2040
20	130	12:17	12:22	327.0	6.0	13.3	0.7	79.0	145.6	155.5	9.9	20.0	0.0	4.7	39.8	0.2040
21	131	11:37	11:43	324.0	6.0	13.2	1.0	79.5	181.6	188.2	6.6	19.6	0.0	4.7	26.6	0.3150
21	131	11:37	11:43	324.0	6.0	13.2	1.0	80.0	181.9	188.5	6.6	19.6	0.0	1.8	27.0	0.3160
21	131	12:05	12:11	322.0	6.0	13.2	2.0	80.7	182.6	188.8	6.3	19.6	0.0	4.7	25.5	0.3170

COLLECTOR I.D : E
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 05/23/79
GROSS AREA : 20.170 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
26	145	10:07	10:13	282.0	8.0	13.6	0.5	79.8	186.7	91.3	4.6	16.7	0.0	25.7	22.0	0.3790
26	145	10:19	10:25	289.0	8.0	13.6	0.5	80.5	186.7	191.4	4.8	16.7	0.0	22.9	22.3	0.3670
26	145	11:55	12:01	318.0	8.0	13.7	0.9	85.4	140.2	150.8	10.6	16.7	0.0	0.5	44.2	0.1670
26	145	12:04	12:10	318.0	7.0	13.7	0.7	87.0	140.2	150.9	10.7	16.7	0.0	1.6	44.6	0.1720
26	145	13:31	13:37	296.0	8.0	13.8	1.0	88.8	89.8	102.7	12.9	16.7	0.0	21.9	58.0	0.0040
26	145	13:43	13:49	288.0	7.0	13.8	0.6	89.7	91.1	103.8	12.7	16.7	0.0	24.7	58.8	0.0050

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : F
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 11/21/78
GROSS AREA : 20.380 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
42	318	11:25	11:31	309.0	7.0	13.2	3.0	59.7	210.8	132.9	12.1	55.5	0.0	6.9	50.8	0.1980
43	218	11:43	11:52	312.0	6.0	13.2	2.0	60.4	120.1	132.4	12.3	55.5	0.0	2.0	51.1	0.1910
42	318	12:09	12:15	316.0	7.0	13.2	2.0	60.3	119.6	132.2	12.6	55.5	0.0	3.7	51.7	0.1880
42	318	12:27	12:33	311.0	6.0	13.2	2.0	62.0	119.4	131.7	12.4	55.5	0.0	7.9	51.6	0.1850
43	319	11:33	11:39	317.0	9.0	13.0	2.0	60.4	159.5	168.6	9.1	55.8	0.0	5.0	38.7	0.3270
43	319	11:49	11:55	311.0	10.0	13.0	2.0	61.0	159.2	168.0	8.7	55.8	0.0	1.3	38.0	0.3330
43	319	12:05	12:11	317.0	11.0	13.3	2.0	61.7	158.9	167.7	8.8	55.8	0.0	2.7	38.1	0.3290
43	319	12:21	12:27	317.0	13.0	13.0	2.0	63.7	158.8	167.8	8.8	55.8	0.0	6.4	38.2	0.3170
44	321	11:25	11:31	289.0	16.0	12.7	2.0	63.2	190.3	195.5	5.2	56.3	0.0	7.0	24.1	0.4610
44	321	11:43	11:49	283.0	16.0	12.7	3.0	64.3	190.1	195.7	5.6	56.3	0.0	2.7	25.2	0.4440
44	321	12:10	12:16	301.0	12.0	12.7	3.0	64.1	189.8	196.1	6.3	56.3	0.0	4.0	26.5	0.4170
44	321	12:31	12:37	291.0	13.0	12.7	3.0	65.7	190.2	196.1	6.0	56.3	0.0	8.7	25.8	0.4260
45	338	11:19	11:25	271.0	10.0	13.5	1.0	59.9	63.7	77.3	13.6	59.6	0.0	8.7	65.6	0.0140
45	338	11:37	11:43	275.0	10.0	13.5	2.0	60.7	64.2	78.1	13.9	59.6	0.0	4.5	65.9	0.0130
45	338	12:19	12:25	280.0	10.0	13.5	2.0	62.7	65.5	79.7	14.2	59.6	0.0	5.2	66.2	0.0100
45	338	12:37	12:43	276.0	10.0	13.5	2.0	63.7	65.8	80.0	14.0	59.6	0.0	9.3	66.0	0.0070

COLLECTOR I.D : F
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 12/13/79
GROSS AREA : 20.380 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
47	349	11:20	11:26	307.0	5.0	13.8	2.0	63.9	105.7	118.1	12.5	60.7	0.0	8.4	54.5	0.1360
47	349	11:46	11:52	311.0	6.0	13.8	2.0	63.9	106.0	118.6	12.6	60.7	0.0	2.5	54.5	0.1350
47	349	12:06	12:12	311.0	5.0	13.8	2.0	64.7	106.4	119.0	12.6	60.7	0.0	2.1	54.5	0.1340
47	349	12:32	12:38	309.0	5.0	13.8	2.0	65.9	107.1	119.7	12.6	60.7	0.0	8.1	54.6	0.1330
48	353	11:23	11:29	326.0	17.0	13.6	2.0	55.4	145.4	155.4	10.0	60.8	0.0	7.7	41.0	0.2760
48	353	12:16	12:22	303.0	11.0	13.6	2.0	56.2	143.8	153.0	9.2	.	0.0	4.3	40.7	0.2890
49	354	13:24	13:30	285.0	9.0	13.6	2.0	57.6	148.0	156.0	8.1	60.8	0.0	19.9	37.9	0.3170
01	16	12:56	12:66	304.0	5.0	13.6	2.0	59.7	187.0	193.6	6.7	58.4	0.0	8.5	29.7	0.4190
01	16	12:80	12:90	296.0	5.0	13.6	2.0	59.7	186.6	193.0	6.1	58.4	0.0	11.9	29.1	0.4280

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : C
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 04/30/79
GROSS AREA : 27.250 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
18	122	11:43	11:49	321.0	9.0	14.1	0.9	75.3	77.2	90.6	13.4	22.1	0.0	3.5	57.2	0.0060
18	122	11:50	12:56	319.0	9.0	14.1	0.8	75.8	77.1	90.8	13.9	22.1	0.0	1.6	58.9	0.0040
18	122	12:02	12:08	319.0	12.0	14.1	2.0	75.2	75.9	89.7	13.8	22.1	0.0	1.3	58.9	0.0020
18	122	12:10	12:16	321.0	11.0	14.1	1.0	75.6	75.5	89.2	13.7	22.1	0.0	3.2	58.3	-0.0000
19	129	11:37	11:43	329.0	6.0	13.9	1.0	67.1	109.2	120.3	11.2	20.7	0.0	4.7	46.1	0.1280
19	129	11:49	11:55	320.0	8.0	13.9	2.0	67.5	109.5	120.4	10.9	20.7	0.0	1.9	46.4	0.1320
19	129	12:05	12:11	330.0	7.0	13.9	2.0	68.7	109.8	121.0	11.2	20.7	0.0	1.9	46.1	0.1240
19	129	12:17	12:23	332.0	6.0	13.9	2.0	69.0	110.3	121.5	11.3	20.7	0.0	4.7	46.0	0.1240
20	130	11:37	11:43	328.0	5.0	14.0	0.4	76.8	146.1	155.6	9.5	20.0	0.0	4.7	39.7	0.2110
20	130	11:49	11:55	329.0	6.0	14.0	0.5	77.8	446.3	155.8	9.6	20.0	0.0	1.9	40.1	0.2080
20	130	12:05	12:11	328.0	5.0	14.0	0.2	79.1	146.2	155.8	9.6	20.0	0.0	1.9	40.4	0.2040
20	130	12:17	12:22	327.0	6.0	14.0	0.7	79.0	145.6	155.6	9.6	20.0	0.0	4.7	40.4	0.2040
21	131	11:37	11:43	324.0	6.0	13.7	1.0	79.5	181.9	188.6	6.8	19.6	0.0	4.7	28.4	0.3160
21	131	11:49	11:55	322.0	6.0	13.7	1.0	80.0	182.2	189.1	6.9	19.6	0.0	1.8	29.2	0.3170
21	131	12:05	12:11	321.0	6.0	13.7	2.0	81.2	182.6	189.4	6.8	19.6	0.0	1.9	28.6	0.3150
21	131	12:17	12:23	321.0	6.0	13.7	2.0	80.7	183.0	189.6	6.6	19.6	0.0	4.7	27.9	0.3180

COLLECTOR I.D : C
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 05/23/79
GROSS AREA : 27.250 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
26	145	10:07	10:13	282.0	8.0	13.4	0.5	79.8	186.3	191.4	5.1	16.7	0.0	25.7	24.1	0.3780
26	145	10:19	10:25	289.0	8.0	13.4	0.5	80.5	186.2	191.6	5.4	16.7	0.0	22.9	24.8	0.3660
26	145	11:55	12:01	318.0	8.0	13.6	0.9	85.4	139.1	149.5	10.4	16.7	0.0	0.5	43.0	0.1640
26	145	12:04	12:10	318.0	7.0	13.6	0.7	87.0	139.2	149.7	10.5	16.7	0.0	1.6	43.3	0.1690
26	145	13:31	13:37	296.0	8.0	13.8	1.0	88.8	88.5	100.5	12.1	16.7	0.0	21.9	54.0	-0.0010
26	145	13:43	13:49	288.0	7.0	13.8	0.6	89.7	89.8	101.6	11.8	16.7	0.0	24.7	54.3	0.0000

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : H
SERIES NO : 1
LABORATORY NO : 3

TEST DATE : 09/10/78
GROSS AREA : 30.940 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
26	255	11:13	11:20	320.0	4.0	13.5	3.0	83.3	125.6	138.3	12.7	33.1	0.0	9.9	52.7	0.1300
26	255	11:43	11:49	326.0	4.0	13.5	3.0	85.1	126.0	138.9	12.9	33.1	0.0	2.7	52.6	0.1250
26	255	12:13	12:19	326.0	5.0	13.5	3.0	84.7	125.0	138.1	13.1	33.1	0.0	4.9	52.3	0.1250
26	255	12:37	12:43	319.0	5.0	13.5	4.0	85.5	126.1	138.7	12.6	33.1	0.0	10.9	52.7	0.1250
27	257	11:08	11:14	312.0	5.0	13.7	3.0	78.6	76.7	91.7	15.0	33.9	0.0	11.5	63.9	-0.0060
27	257	11:44	11:50	319.0	5.0	13.7	3.0	80.7	78.3	93.6	15.3	33.9	0.0	2.6	63.4	-0.0060
27	257	12:08	12:14	320.0	5.0	13.7	2.0	82.1	79.0	94.2	15.2	33.9	0.0	3.6	63.5	-0.0110
27	257	12:44	12:50	310.0	6.0	13.7	2.0	83.5	80.2	95.1	14.9	33.9	0.0	12.5	63.6	-0.0110
28	258	11:14	11:20	312.0	6.0	13.3	2.0	84.5	213.7	219.1	5.4	34.2	0.0	9.9	23.1	0.4140
28	258	11:38	11:44	317.0	6.0	13.3	4.0	85.4	214.3	219.8	5.5	34.2	0.0	4.0	23.0	0.4080
28	258	12:14	12:20	314.0	7.0	13.3	5.0	86.4	214.5	219.8	5.0	34.2	0.0	5.2	21.1	0.4080
28	258	12:38	12:44	311.0	7.0	13.3	5.0	87.7	214.7	219.7	5.0	34.2	0.0	11.1	21.4	0.4080
29	261	11:22	11:28	321.0	6.0	13.3	4.0	71.3	171.9	180.2	8.3	35.4	0.0	9.7	34.0	0.3120
29	261	11:40	11:46	327.0	6.0	13.3	6.0	71.9	171.8	180.2	8.4	35.4	0.0	3.7	34.1	0.3060
29	261	12:16	12:22	329.0	6.0	13.3	5.0	71.8	172.1	180.5	8.4	35.4	0.0	5.4	33.9	0.3060
29	261	12:38	12:44	323.0	6.0	13.3	8.0	72.1	172.2	180.4	8.2	35 4	0.0	11.4	33.6	0.3120

COLLECTOR I.D : H
SERIES NO : 2
LABORATORY NO : 3

TEST DATE : 09/04/78
GROSS AREA : 30.940 FT2
TRANSFER FLUID : WATER / 9% ETH. GLY

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
23	249	12:30	12:37	345.0	13.0	13.7	3.0	76.4	79.5	95.4	15.9	30.8	0.0	9.3	60.9	0.0110
24	250	11:35	11:43	329.0	5.0	13.3	3.0	73.1	152.0	162.3	10.3	31.2	0.0	4.1	41.3	0.2380
24	250	12:53	13:00	322.0	5.0	13.3	3.0	73.1	197.5	203.2	5.7	31.2	0.0	14.9	23.7	0.3860

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : A
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 05/02/79
GROSS AREA : 23.161 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	122	11:45	11:46	311.8	15.0	16.3	1.0	65.8	82.0	92.9	10.9	21.0	0.0	4.4	56.6	0.0520
02	122	11:50	11:51	310.2	15.0	16.2	2.1	66.4	82.4	93.4	11.0	21.0	0.0	3.6	57.3	0.0516
03	122	11:55	11:56	311.5	15.0	16.3	6.1	66.2	82.8	93.7	10.9	21.0	0.0	3.0	56.9	0.0532
04	122	12:00	12:01	312.6	15.0	16.2	0.1	67.3	83.3	94.2	10.9	21.0	0.0	2.9	56.0	0.0513
05	127	10:25	10:26	273.5	20.0	16.4	3.4	73.4	109.9	118.6	8.6	21.0	0.0	22.4	51.4	0.1336
06	127	10:30	10:31	281.7	20.0	16.3	4.9	74.1	110.1	118.9	8.7	21.0	0.0	21.2	50.5	0.1278
07	127	10:35	10:36	285.2	20.0	16.3	4.7	73.9	110.1	119.2	9.1	21.0	0.0	20.0	52.0	0.1269
08	127	10:40	10:41	287.3	20.0	16.3	2.1	73.2	110.7	119.8	9.1	21.0	0.0	18.8	51.5	0.1303
09	127	11:47	11:48	311.3	20.0	15.6	6.8	76.8	148.3	156.7	8.4	21.0	0.0	3.1	42.2	0.2295
10	127	11:52	11:53	311.5	20.0	15.9	5.2	77.2	148.8	157.1	8.3	21.0	0.0	2.1	42.3	0.2300
11	127	11:57	11:58	310.1	20.0	16.0	5.9	78.3	149.4	157.7	8.4	21.0	0.0	1.5	43.2	0.2293
12	127	12:02	12:03	314.5	20.0	16.0	3.4	78.6	149.9	158.4	8.5	21.0	0.0	1.6	43.1	0.2267
13	136	11:39	11:40	324.4	16.0	15.6	2.2	66.2	190.4	197.0	6.6	21.0	0.0	4.9	31.9	0.3829
14	136	11:47	11:48	328.0	16.0	15.6	3.5	66.2	191.7	198.1	6.5	21.0	0.0	3.1	30.9	0.3826
15	136	11:57	11:58	325.7	16.0	15.5	7.5	67.8	192.7	199.6	6.9	21.0	0.0	1.1	32.7	0.3836
16	136	12:15	12:16	324.6	16.0	15.5	0.1	66.9	192.9	199.6	6.7	21.0	0.0	3.8	32.0	0.3881

COLLECTOR I.D : A
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 05/29/79
GROSS AREA : 23.161 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	149	10:16	10:17	291.4	19.6	16.2	4.6	73.2	105.3	115.3	10.0	21.0	0.0	24.3	55.4	0.1099
02	149	10:21	10:22	293.9	19.0	16.1	3.6	72.1	105.4	116.0	10.5	21.0	0.0	23.2	57.6	0.1133
03	149	10:26	10:27	292.5	19.0	16.2	3.9	71.6	106.0	116.0	10.0	21.0	0.0	22.0	54.9	0.1175
04	149	10:31	10:32	293.7	19.0	16.1	1.9	72.9	106.3	116.9	10.5	21.0	0.0	20.9	57.5	0.1140
05	149	11:02	11:03	315.5	19.0	16.4	4.2	73.0	77.0	89.1	12.1	21.0	0.0	13.7	62.9	0.0126
07	149	11:12	11:13	315.6	19.0	16.5	1.7	73.8	77.2	89.3	12.1	21.0	0.0	11.5	63.0	0.0108
08	149	11:17	11:18	326.6	19.0	16.7	3.4	73.4	77.4	89.5	12.1	21.0	0.0	10.4	61.6	0.0121
09	149	12:51	12:52	316.1	19.0	16.4	4.5	75.9	129.4	138.3	9.0	21.0	0.0	12.8	46.4	0.1691
10	149	12:56	12:57	319.0	19.0	16.3	7.5	75.4	130.1	139.5	9.4	21.0	0.0	14.0	47.8	0.1715
11	149	13:01	13:02	314.0	19.0	16.3	0.8	76.1	130.5	139.8	9.3	21.0	0.0	15.1	48.5	0.1731
12	149	13:06	13:07	308.4	19.0	16.2	3.2	76.6	131.4	140.6	9.2	21.0	0.0	16.2	48.4	0.1775
13	156	13:14	13:15	279.4	29.0	16.1	3.2	84.4	195.8	200.8	5.0	21.0	0.0	18.2	28.8	0.3988
14	156	13:19	13:20	277.8	29.0	16.0	5.8	82.6	196.7	201.1	4.4	21.0	0.0	19.3	25.7	0.4109
15	156	13:24	13:25	269.9	29.0	15.7	2.7	83.5	198.0	202.0	4.1	21.0	0.0	20.5	23.8	0.4242
16	156	13:29	13:30	264.6	29.0	15.9	2.9	83.8	199.2	203.0	3.8	21.0	0.0	21.6	22.8	0.4360

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : B
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 09/26/78
GROSS AREA : 18.711 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	269	10:48	10:49	307.0	13.0	15.2	0.0	63.1	90.9	103.2	12.3	39.0	0.0	18.1	59.7	0.0910
02	269	10:53	10:54	309.0	13.0	15.2	0.0	64.2	90.9	103.2	12.3	39.0	0.0	16.9	59.5	0.0860
03	269	11:01	11:02	314.0	13.0	15.2	0.0	62.4	91.0	103.4	12.4	39.0	0.0	14.9	59.1	0.0850
04	269	11:14	11:15	318.0	13.0	15.2	0.0	65.5	91.3	104.2	12.9	39.0	0.0	11.7	60.5	0.0810
05	269	13:09	13:10	308.0	13.0	15.2	0.0	66.7	114.7	125.6	11.0	39.0	0.0	17.4	53.2	0.1560
06	269	13:14	13:15	305.0	13.0	15.2	0.0	68.2	114.6	125.5	10.9	39.0	0.0	18.6	53.3	0.1520
07	269	13:19	13:20	303.0	13.0	15.2	0.0	68.0	115.0	125.7	10.6	39.0	0.0	19.9	52.5	0.1550
08	269	13:24	13:25	299.0	13.0	15.2	0.0	69.1	114.6	125.5	10.9	39.0	0.0	21.1	54.5	0.1530
09	270	11:29	11:30	313.0	19.0	15.1	0.0	70.9	190.6	197.3	6.7	39.0	0.0	8.2	31.7	0.3630
10	270	11:35	11:36	310.0	19.0	15.0	0.0	70.2	191.8	198.6	6.9	39.0	0.0	6.8	32.6	0.3920
11	270	11:38	11:39	313.0	19.0	15.1	0.0	70.9	192.4	190.0	6.6	39.0	0.0	6.1	31.2	0.3860
12	270	13:06	13:07	292.0	19.0	15.2	0.0	73.6	119.6	129.9	10.3	39.0	0.0	16.7	52.5	0.1580
13	270	13:20	13:21	288.0	19.0	15.2	0.0	72.7	121.4	131.0	9.6	39.0	0.0	20.2	49.7	0.1690
14	270	13:25	13:26	281.0	19.0	15.2	0.0	73.0	122.5	131.8	9.3	39.0	0.0	21.4	49.5	0.1760

COLLECTOR I.D : B
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 10/09/78
GROSS AREA : 18.711 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	282	10:58	10:59	313.0	13.0	15.7	1.0	55.8	62.5	76.1	13.6	39.0	0.0	17.2	67.0	0.0210
02	282	11:06	11:07	321.0	13.0	16.2	5.0	56.3	63.2	76.4	13.2	39.0	0.0	15.4	65.4	0.0220
03	282	11:16	11:17	319.0	13.0	16.3	4.0	56.5	64.3	77.0	12.7	39.0	0.0	13.3	63.7	0.0250
04	282	11:27	11:28	323.0	13.0	15.6	2.0	57.4	65.4	78.8	13.4	39.0	0.0	11.1	63.5	0.0250
05	282	11:44	11:45	327.0	13.0	15.5	3.0	57.7	105.7	117.3	11.6	39.0	0.0	8.5	54.1	0.1470
06	282	11:48	11:49	323.0	13.0	15.5	1.0	58.5	105.5	116.8	11.3	39.0	0.0	8.0	53.2	0.1450
07	282	11:57	11:58	326.0	13.0	15.4	1.0	59.4	106.0	117.6	11.6	39.0	0.0	7.5	53.7	0.1430
08	282	12:01	12:02	330.0	13.0	15.4	3.0	58.5	106.6	118.1	11.5	39.0	0.0	7.5	52.5	0.1460
09	282	12:20	12:21	325.0	13.0	15.8	1.0	59.5	121.4	131.1	9.7	39.0	0.0	9.0	46.3	0.1910
10	282	13:13	13:14	303.0	13.0	14.8	7.0	60.3	150.2	157.5	7.3	39.0	0.0	19.7	35.1	0.2970
11	282	13:16	13:17	301.0	13.0	14.7	5.0	62.4	151.2	158.5	7.3	39.0	0.0	20.4	34.7	0.2950

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : C
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 10/09/78
GROSS AREA : 27.868 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	282	11:01	11:02	310.0	13.0	15.4	0.0	57.7	76.7	87.3	10.6	39.0	0.0	16.5	52.2	0.0610
02	282	11:02	11:03	316.0	13.0	15.5	0.0	58.4	76.8	87.5	10.7	39.0	0.0	16.3	51.4	0.0590
03	282	11:11	11:12	318.0	13.0	15.4	0.0	57.2	77.9	88.1	10.2	39.0	0.0	14.3	48.7	0.0650
04	282	11:13	11:14	317.0	13.0	15.4	0.0	56.8	78.1	88.7	10.6	39.0	0.0	13.9	50.3	0.0670
05	282	13:09	13:10	304.0	13.0	15.6	0.0	59.6	134.3	141.6	7.3	39.0	0.0	18.7	36.5	0.2450
06	282	13:15	13:16	300.0	13.0	15.6	0.0	62.2	135.1	142.1	7.0	39.0	0.0	20.1	35.5	0.2430
07	282	13:18	13:19	299.0	13.0	15.5	0.0	61.6	135.6	142.8	7.2	39.0	0.0	20.8	36.4	0.2470
08	283	12:25	12:26	346.0	23.0	15.5	3.0	66.0	177.7	184.8	7.1	39.0	0.0	9.7	31.3	0.3230
09	283	12:29	12:30	345.0	23.0	15.6	3.0	65.8	177.7	185.1	7.4	39.0	0.0	10.4	32.7	0.3240
10	283	12:38	12:39	345.0	23.0	15.5	2.0	68.0	178.9	185.9	7.0	39.0	0.0	12.0	31.2	0.3220
11	283	12:46	12:47	323.0	23.0	15.4	3.0	66.2	177.7	184.6	6.9	39.0	0.0	13.7	29.5	0.3450
12	284	10:49	10:50	292.0	.0	15.5	3.0	68.5	153.6	160.1	6.5	39.0	0.0	19.5	34.2	0.2910
13	284	11:25	11:26	298.0	.0	15.2	6.0	69.6	151.4	158.5	7.1	39.0	0.0	12.0	35.7	0.2740
14	284	11:57	11:58	309.0	.0	15.0	2.0	69.6	148.5	156.5	8.0	39.0	0.0	8.2	38.2	0.2550
15	284	12:15	12:16	307.0	.0	15.1	2.0	70.7	147.4	155.3	7.9	39.0	0.0	9.0	38.1	0.2500
16	284	12:32	12:33	297.0	.0	15.0	4.0	69.8	146.0	153.3	7.3	39.0	0.0	11.4	36.7	0.2570

COLLECTOR I.D : C
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 10/21/78
GROSS AREA : 27.868 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	294	10:33	10:34	288.0	12.0	15.6	3.0	63.7	73.0	82.9	9.9	39.0	0.0	24.6	52.8	0.0330
02	294	10:38	10:39	290.0	12.0	15.7	3.0	64.6	73.0	82.9	9.9	39.0	0.0	23.6	52.3	0.0290
03	294	10:43	10:44	293.0	12.0	15.7	3.0	63.9	73.0	83.0	10.0	39.0	0.0	22.5	52.5	0.0310
04	294	10:48	10:49	295.0	12.0	15.7	4.0	64.8	73.2	83.2	10.0	39.0	0.0	21.4	52.1	0.0290
05	294	11:04	11:05	303.0	12.0	15.7	3.0	65.7	109.9	118.7	8.8	39.0	0.0	18.3	44.6	0.1460
06	294	11:09	11:10	306.0	12.0	15.7	5.0	66.6	110.5	119.2	8.7	39.0	0.0	17.3	44.4	0.1440
07	294	11:15	11:16	308.0	12.0	15.7	6.0	66.4	110.7	119.6	8.9	39.0	0.0	16.3	44.9	0.1440
08	294	11:20	11:21	308.0	12.0	15.8	0.0	6.9	111.0	119.9	8.9	39.0	0.0	15.5	44.8	0.1430
09	294	12:03	12:04	312.0	12.0	15.6	3.0	66.9	140.4	148.2	7.8	39.0	0.0	11.9	39.0	0.2360
10	294	12:08	12:09	310.0	12.0	15.6	3.0	67.8	140.9	148.6	7.7	39.0	0.0	12.0	38.2	0.2360
11	294	12:13	12:14	311.0	12.0	15.5	3.0	67.8	141.1	149.1	8.0	39.0	0.0	12.3	39.5	0.2360
12	294	13:25	13:26	279.0	12.0	15.3	2.0	71.0	185.7	190.2	4.7	39.0	0.0	24.2	24.1	0.4110

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : D
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 09/26/78
GROSS AREA : 17.883 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	269	10:47	10:48	306.0	12.0	16.0	5.0	63.2	78.8	91.0	12.3	39.0	0.0	18.1	62.2	0.0510
02	269	10:56	10:57	310.0	12.0	16.0	0.0	64.6	78.7	91.0	12.4	39.0	0.0	16.9	61.8	0.0460
03	269	11:08	11:09	317.0	12.0	16.0	1.0	63.4	78.5	91.2	12.7	39.0	0.0	13.2	62.5	0.0480
04	269	11:20	11:21	319.0	12.0	16.0	2.0	66.0	78.4	91.4	12.9	39.0	0.0	10.3	63.1	0.0390
05	269	13:09	13:14	308.0	12.0	16.0	5.0	66.7	103.6	115.0	11.4	39.0	0.0	17.4	57.6	0.0670
06	269	13:24	13:29	299.0	12.0	16.0	1.0	69.1	102.8	114.6	11.8	39.0	0.0	21.1	61.5	0.0630
07	269	13:39	13:44	290.0	12.0	16.0	2.0	68.3	102.7	113.6	10.9	39.0	0.0	24.9	58.2	0.0660
08	269	13:44	13:49	286.0	12.0	16.0	1.0	68.2	102.2	113.0	10.8	39.0	0.0	26.1	58.6	0.0660
09	270	11:41	11:42	313.0	19.0	15.7	0.0	71.2	186.4	195.5	9.1	39.0	0.0	5.5	44.4	0.3680
10	270	11:24	11:25	311.0	19.0	15.8	0.0	70.6	181.7	191.1	9.4	39.0	0.0	9.4	46.6	0.3570
11	270	11:30	11:31	313.0	19.0	15.9	0.0	70.9	184.1	172.9	8.8	39.0	0.0	8.0	43.6	0.3620
12	270	11:36	11:37	311.0	19.0	15.6	0.0	70.2	185.4	194.1	8.7	39.0	0.0	6.6	42.3	0.3700
13	270	13:04	13:05	288.0	19.0	15.9	0.0	73.5	109.5	120.1	10.6	39.0	0.0	16.2	57.2	0.1250
14	270	13:14	13:15	287.0	19.0	15.5	0.0	73.0	111.3	122.0	10.7	39.0	0.0	18.7	56.3	0.1330
15	270	13:18	13:19	286.0	19.0	15.9	0.0	72.3	111.6	121.9	10.3	39.0	0.0	19.7	55.8	0.1370
16	270	13:24	13:25	284.0	19.0	15.6	0.0	72.8	112.8	122.8	10.0	39.0	0.0	21.2	54.0	0.1400

COLLECTOR I.D : D
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 10/09/78
GROSS AREA : 17.883 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	282	11:03	11:04	310.0	13.0	16.7	0.0	57.7	75.7	88.0	12.3	39.0	0.0	16.0	65.0	0.0580
02	282	11:04	11:05	316.0	13.0	16.7	0.0	58.4	75.7	88.3	12.6	39.0	0.0	15.8	64.7	0.0550
03	282	11:15	11:14	318.0	13.0	17.2	0.0	57.2	76.2	88.0	11.8	39.0	0.0	13.9	60.2	0.0600
04	282	11:15	11:16	317.0	13.0	17.1	0.0	56.8	76.4	88.4	12.0	39.0	0.0	13.5	61.9	0.0620
05	282	11:47	11:48	327.0	13.0	16.3	0.0	56.6	93.0	105.5	12.5	39.0	0.0	8.1	60.5	0.1110
06	282	11:52	11:53	324.0	13.0	16.0	0.0	62.6	93.3	106.4	13.1	39.0	0.0	7.7	63.4	0.0950
07	282	11:57	11:58	326.0	13.0	16.1	0.0	59.4	93.4	106.1	12.7	39.0	0.0	7.5	61.3	0.1040
08	282	12:01	12:02	330.0	13.0	16.0	0.0	58.4	93.9	106.8	12.9	39.0	0.0	7.4	61.1	0.1070
09	282	13:07	13:08	306.0	13.0	15.6	0.0	59.7	138.9	149.0	10.1	39.0	0.0	18.3	49.8	0.2590
10	282	13:11	13:12	304.0	13.0	15.6	0.0	59.6	140.6	150.8	10.2	39.0	0.0	19.2	50.9	0.2660
11	282	13:17	13:18	300.0	13.0	15.5	0.0	62.2	141.7	152.0	10.3	39.0	0.0	20.6	51.8	0.2650
12	282	13:20	13:21	299.0	13.0	16.0	0.0	61.6	142.4	152.4	10.0	39.0	0.0	21.3	50.1	0.2700
13	283	11:23	11:24	346.0	23.0	15.4	0.0	66.0	184.0	195.0	11.0	39.0	0.0	12.1	47.4	0.3410
14	283	11:27	11:28	346.0	23.0	15.1	0.0	66.0	184.6	195.6	11.0	39.0	0.0	11.4	46.8	0.3430
15	283	11:31	11:32	345.0	23.0	14.9	0.0	65.8	184.8	195.7	10.9	39.0	0.0	10.7	46.1	0.3450
16	283	11:37	11:38	346.0	23.0	15.0	0.0	64.7	185.0	196.1	11.1	39.0	0.0	9.7	46.8	0.3480

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : E
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 05/02/79
GROSS AREA : 20.323 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	122	10:41	10:42	295.1	15.0	15.0	2.4	62.4	74.3	85.5	11.2	21.0	0.0	18.9	56.5	0.0403
02	122	10:46	10:47	296.2	15.0	15.0	5.2	63.7	74.7	85.9	11.2	21.0	0.0	17.7	56.9	0.0371
03	122	10:51	10:52	299.4	15.0	14.9	3.9	61.2	74.8	86.1	11.2	21.0	0.0	16.5	55.7	0.0457
04	122	10:56	10:57	300.5	15.0	14.9	1.0	63.1	75.0	86.4	11.4	21.0	0.0	15.4	56.2	0.0395
05	122	11:43	11:44	312.5	15.0	14.9	3.2	66.0	109.0	118.9	9.9	21.0	0.0	4.8	47.0	0.1377
06	122	11:48	11:49	310.2	15.0	14.9	2.6	66.2	109.4	119.4	10.0	21.0	0.0	3.9	47.8	0.1393
07	122	11:53	11:54	310.2	15.0	14.8	2.1	66.0	109.2	119.3	10.1	21.0	0.0	3.2	48.2	0.1393
08	122	11:58	11:59	311.8	15.0	14.9	2.0	67.8	109.2	119.2	10.0	21.0	0.0	2.9	47.4	0.1328
09	122	13:10	13:11	294.8	15.0	14.9	7.8	70.5	145.8	152.8	7.0	21.0	0.0	17.2	35.6	0.2552
10	122	13:12	13:13	292.4	15.0	14.9	5.2	71.2	145.6	152.5	6.9	21.0	0.0	17.7	35.5	0.2542
11	122	13:17	13:18	290.6	15.0	14.9	6.1	70.7	145.8	152.5	6.7	21.0	0.0	18.9	34.7	0.2583
12	122	13:22	13:23	287.6	15.0	14.9	3.0	72.0	145.6	152.3	6.7	21.0	0.0	20.1	34.5	0.2559
13	122	14:00	14:01	265.2	15.0	15.5	4.2	72.0	171.7	174.7	3.0	21.0	0.0	29.1	17.5	0.3761
14	122	14:05	14:06	263.6	15.0	15.5	3.8	72.0	172.2	175.3	3.1	21.0	0.0	30.3	18.4	0.3804
15	122	14:10	14:11	257.9	15.0	15.5	5.4	72.5	172.4	175.7	3.3	21.0	0.0	31.5	19.6	0.3874
16	122	14:15	14:16	252.8	15.0	15.6	3.8	72.7	171.5	174.5	3.0	21.0	0.0	32.6	18.4	0.3910

COLLECTOR I.D : E
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 05/09/79
GROSS AREA : 20.323 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	129	10:07	10:08	270.9	21.0	14.6	4.4	80.4	83.1	94.2	11.1	21.0	0.0	26.6	59.2	0.0100
02	129	10:12	10:13	279.8	21.0	14.6	5.2	80.4	83.1	94.4	11.3	21.0	0.0	25.4	58.5	0.0097
03	129	10:17	10:18	279.8	21.0	14.6	6.2	81.0	83.1	94.5	11.4	21.0	0.0	24.2	59.2	0.0077
04	129	10:22	10:23	282.0	21.0	14.5	5.2	82.0	83.3	95.0	11.7	21.0	0.0	23.0	59.8	0.0045
05	129	10:43	10:44	301.9	21.0	14.1	4.8	83.3	120.4	130.0	9.6	21.0	0.0	18.0	44.5	0.1228
06	129	10:48	10:49	304.1	21.0	14.1	4.3	82.9	121.6	131.1	9.5	21.0	0.0	16.8	43.8	0.1272
07	129	10:53	10:54	317.0	21.0	14.1	4.4	84.4	123.4	133.1	9.7	21.0	0.0	15.6	43.0	0.1232
08	129	10:58	10:59	307.2	21.0	14.1	4.1	84.4	124.2	134.1	10.0	21.0	0.0	14.4	45.7	0.1295
09	135	11:00	11:01	312.6	20.0	15.2	4.2	74.8	146.1	153.7	7.6	21.0	0.0	14.1	36.7	0.2281
10	135	11:05	11:06	311.7	20.0	15.2	2.4	74.3	146.5	154.0	7.5	21.0	0.0	12.9	36.4	0.2316
11	135	11:10	11:11	313.0	20.0	15.3	3.5	76.8	146.8	154.1	7.3	21.0	0.0	11.7	35.5	0.2237
12	135	11:15	11:16	314.8	20.0	15.2	0.0	76.5	147.0	154.6	7.5	21.0	0.0	10.6	36.5	0.2242
13	135	12:38	12:39	315.2	20.0	15.4	4.4	80.1	188.2	192.4	4.2	21.0	0.0	9.2	20.5	0.3432
14	135	12:43	12:44	315.2	20.0	15.4	6.3	79.2	188.6	193.2	4.6	21.0	0.0	10.4	22.4	0.3472
15	135	13:03	13:04	313.0	20.0	15.5	3.3	80.2	188.6	193.0	4.4	21.0	0.0	15.1	21.7	0.3462
16	135	13:08	13:09	313.5	20.0	15.5	3.8	79.5	187.7	192.3	4.6	21.0	0.0	16.3	22.7	0.3451

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : F
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 05/02/79
GROSS AREA : 20.699 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	122	10:41	10:42	295.1	15.0	14.8	2.4	62.4	61.3	74.2	12.9	21.0	0.0	18.9	64.5	-0.0037
02	122	10:46	10:47	296.2	15.0	14.9	5.2	63.7	61.3	74.4	13.0	21.0	0.0	17.7	65.2	-0.0079
03	122	10:51	10:52	299.4	15.0	14.7	3.9	61.2	61.5	74.7	13.2	21.0	0.0	16.5	64.6	0.0012
04	122	10:56	10:57	300.5	15.0	14.7	1.0	63.1	61.7	74.9	13.2	21.0	0.0	15.4	64.4	-0.0048
05	122	11:43	11:44	312.5	15.0	14.7	3.2	66.0	97.9	109.8	11.9	21.0	0.0	4.8	56.0	0.1020
06	122	11:48	11:49	310.2	15.0	14.7	2.6	66.2	98.1	110.0	11.9	21.0	0.0	3.9	56.5	0.1027
07	122	11:53	11:54	310.2	15.0	14.6	2.1	66.0	98.1	110.1	12.0	21.0	0.0	3.2	56.4	0.1033
08	122	11:58	11:59	311.8	15.0	14.7	2.0	67.8	98.1	109.9	11.9	21.0	0.0	2.9	55.7	0.0970
09	122	13:10	13:11	294.8	15.0	14.7	7.8	70.5	137.8	146.4	8.6	21.0	0.0	17.2	42.9	0.2283
10	122	13:12	13:13	292.4	15.0	14.7	5.2	71.2	137.8	146.5	8.6	21.0	0.0	17.7	43.5	0.2278
11	122	13:17	13:18	290.6	15.0	14.7	6.1	70.7	138.0	146.5	8.5	21.0	0.0	18.9	43.1	0.2316
12	122	13:22	13:23	287.6	15.0	14.7	3.0	72.0	138.2	146.5	8.3	21.0	0.0	20.1	42.2	0.2303
13	122	14:00	14:01	265.2	15.0	15.3	4.2	72.0	169.0	173.6	4.6	21.0	0.0	29.1	26.4	0.3659
14	122	14:05	14:06	263.6	15.0	15.3	3.8	72.0	169.3	173.9	4.6	21.0	0.0	30.3	26.6	0.3695
15	122	14:10	14:11	257.9	15.0	15.2	5.4	72.5	169.3	173.8	4.5	21.0	0.0	31.5	26.3	0.3756
16	122	14:15	14:16	252.8	15.0	15.3	3.8	72.7	168.8	173.1	4.3	21.0	0.0	32.6	26.2	0.3803

COLLECTOR I.D : F
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 05/09/79
GROSS AREA : 20.699 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	129	10:07	10:08	270.9	21.0	14.2	4.4	80.4	93.9	105.0	11.1	21.0	0.0	26.6	57.9	0.0498
02	129	10:12	10:13	279.8	21.0	14.2	5.2	80.4	94.1	105.5	11.4	21.0	0.0	25.4	57.8	0.0489
03	129	10:17	10:18	279.8	21.0	14.2	6.2	81.0	94.3	105.8	11.5	21.0	0.0	24.2	58.1	0.0476
04	129	10:22	10:23	282.0	21.0	14.1	5.2	82.0	94.6	106.4	11.8	21.0	0.0	23.0	58.7	0.0447
05	129	10:43	10:44	301.9	21.0	13.9	4.8	83.3	109.4	120.8	11.4	21.0	0.0	13.0	52.2	0.0864
06	129	10:48	10:49	304.1	21.0	13.9	4.3	82.9	110.8	122.3	11.5	21.0	0.0	15.8	52.5	0.0917
07	129	10:53	10:54	317.0	21.0	13.9	4.4	84.4	112.3	124.0	11.7	21.0	0.0	15.6	51.2	0.0880
08	129	10:58	10:59	307.2	21.0	14.0	4.1	84.4	112.8	124.6	11.8	21.0	0.0	14.4	53.3	0.0926
09	135	11:00	11:01	312.6	20.0	15.0	4.2	74.8	138.0	146.8	8.8	21.0	0.0	14.1	42.1	0.2021
10	135	11:05	11:06	311.7	20.0	15.0	2.4	74.3	138.0	147.1	9.1	21.0	0.0	12.9	43.8	0.2044
11	135	11:10	11:11	313.0	20.0	15.1	3.5	76.8	138.4	147.4	9.0	21.0	0.0	11.7	43.2	0.1967
12	135	11:15	11:16	314.8	20.0	15.0	0.0	76.5	138.6	147.5	9.0	21.0	0.0	10.6	42.8	0.1973
13	135	12:38	12:39	315.2	20.0	15.2	4.4	80.1	183.6	189.7	6.1	21.0	0.0	9.2	29.4	0.3283
14	135	12:43	12:44	315.2	20.0	15.2	6.3	79.2	183.9	190.1	6.2	21.0	0.0	10.4	29.7	0.3323
15	135	13:03	13:04	313.0	20.0	15.2	3.3	80.2	183.7	189.8	6.1	21.0	0.0	15.1	29.8	0.3307
16	135	13:08	13:09	313.5	20.0	15.3	3.8	79.5	183.0	189.2	6.2	21.0	0.0	16.3	30.1	0.3302

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : G
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 05/02/79
GROSS AREA : 27.602 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	122	11:45	11:46	311.8	15.0	13.7	1.0	65.8	68.7	81.7	13.0	21.0	0.0	4.4	57.0	0.0092
02	122	11:50	11:51	310.2	15.0	13.6	2.1	66.4	68.9	82.0	13.1	21.0	0.0	3.6	57.4	0.0081
03	122	11:55	11:56	311.5	15.0	13.7	6.1	66.2	69.1	82.1	13.0	21.0	0.0	3.0	57.1	0.0092
04	122	12:00	12:01	312.6	15.0	13.6	0.1	67.3	69.8	82.8	13.0	21.0	0.0	2:9	56.4	0.0081
05	127	10:25	10:26	273.5	20.0	13.8	3.4	73.4	99.9	110.0	10.2	21.0	0.0	22.4	51.2	0.0967
06	127	10:30	10:31	281.7	20.0	13.7	4.9	74.1	99.9	110.3	10.4	21.0	0.0	21.2	50.8	0.0914
07	127	10:35	10:36	285.2	20.0	13.8	4.7	73.9	99.9	110.5	10.7	21.0	0.0	20.0	51.4	0.0909
08	127	10:40	10:41	287.3	20.0	13.7	2.1	73.2	99.9	110.7	10.8	21.0	0.0	18.8	51.4	0.0927
09	127	11:47	11:48	311.3	20.0	13.2	6.8	76.8	139.6	148.8	9.2	21.0	0.0	3.1	38.8	0.2018
10	127	11:52	11:53	311.5	20.0	13.4	5.2	77.2	140.2	149.4	9.2	21.0	0.0	2.1	39.5	0.2023
11	127	11:57	11:58	310.1	20.0	13.5	5.9	78.3	140.9	149.8	8.9	21.0	0.0	1.5	38.7	0.2020
12	127	12:02	12:03	314.5	20.0	13.5	3.4	78.6	141.8	150.4	8.6	21.0	0.0	1.6	37.0	0.2009
13	136	11:39	11:40	324.4	16.0	13.1	2.2	66.2	185.5	191.2	5.6	21.0	0.0	4.9	22.7	0.3678
14	136	11:47	11:48	328.0	16.0	13.1	3.5	66.2	187.2	192.8	5.6	21.0	0.0	3.1	22.4	0.3688
15	136	11:57	11:58	325.7	16.0	13.0	7.5	67.8	188.2	193.8	5.5	21.0	0.0	1.1	22.2	0.3697
16	136	12:15	12:16	324.6	16.0	13.0	0.1	66.9	188.4	193.8	5.4	21.0	0.0	3.8	21.7	0.3743

COLLECTOR I.D : G
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 05/29/79
GROSS AREA : 27.602 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	140	10:16	10:17	291.4	19.0	13.6	4.6	73.2	94.8	105.8	11.0	21.0	0.0	24.3	51.2	0.0741
02	149	10:21	10:22	293.9	19.0	13.6	3.6	72.1	95.2	106.2	11.0	21.0	0.0	23.2	50.7	0.0784
03	149	10:26	10:27	292.5	19.0	13.6	3.9	71.6	95.4	106.5	11.1	21.0	0.0	22.0	51.5	0.0812
04	149	10:31	10:32	293.7	19.0	13.6	1.9	72.9	95.4	106.6	11.3	21.0	0.0	20.9	51.9	0.0766
05	149	11:02	11:03	315.5	19.0	13.7	4.2	73.0	89.4	101.7	12.2	21.0	0.0	13.7	53.1	0.0519
06	149	11:07	11:08	314.5	10.0	13.7	2.3	72.3	89.4	101.7	12.3	21.0	0.0	12.6	53.5	0.0544
07	149	11:12	11:13	315.6	19.0	13.8	1.7	73.8	89.4	101.7	12.3	21.0	0.0	11.5	53.7	0.0496
08	149	11:17	11:18	326.6	19.0	14.0	3.4	73.4	89.6	102.0	12.4	21.0	0.0	10.4	52.9	0.0496
09	149	12:51	12:52	316.1	19.0	13.7	4.5	75.9	137.7	146.3	8.7	21.0	0.0	12.8	37.5	0.1953
10	149	12:56	12:57	319.0	19.0	13.6	7.5	75.4	138.6	147.6	9.0	21.0	0.0	14.0	38.4	0.1981
11	149	13:01	13:02	314.0	19.0	13.6	0.8	76.1	139.3	148.2	8.9	21.0	0.0	15.1	38.8	0.2012
12	149	13:06	13:07	308.4	19.0	13.5	3.2	76.6	140.0	148.9	8.9	21.0	0.0	16.2	39.2	0.2055
13	156	13:14	13:15	279.4	29.0	13.5	3.2	84.4	199.4	202.8	3.4	21.0	0.0	18.2	16.7	0.4117
14	156	13:19	13:20	277.8	29.0	13.4	5.8	82.6	199.6	202.8	3.2	21.0	0.0	19.3	15.5	0.4212
15	156	13:24	13:25	269.9	29.0	13.2	2.7	83.5	200.5	203.5	3.0	21.0	0.0	20.5	14.7	0.4335
16	156	13:29	13:30	264.6	29.0	13.4	2.9	83.8	201.6	204.1	2.6	21.0	0.0	21.6	13.1	0.4448

*LB/HR-FT2
**F/(BTU/HR-FT2)

INSTANTANEOUS EFFICIENCY DATA

COLLECTOR I.D : H
SERIES NO : 1
LABORATORY NO : 4

TEST DATE : 10/09/78
CROSS AREA : 31.505 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	282	11:01	11:02	310.0	13.0	10.6	0.0	57.7	63.0	77.3	14.3	39.0	0.0	16.5	62.1	0.0170
02	282	11:02	11:03	316.0	13.0	10.7	0.0	58.4	63.1	77.5	14.4	39.0	0.0	16.3	62.0	0.0150
03	282	11:11	11:12	318.0	13.0	10.6	0.0	57.2	64.1	78.6	14.5	39.0	0.0	14.3	61.6	0.0220
04	282	11:13	11:14	317.0	13.0	10.6	0.0	56.8	64.2	78.8	14.6	39.0	0.0	13.9	62.2	0.0230
05	282	13:09	13:10	304.0	13.0	10.7	0.0	59.6	125.7	135.9	10.2	39.0	0.0	18.7	45.3	0.2170
06	282	13:15	13:16	300.0	13.0	10.7	0.0	62.2	126.7	136.5	9.8	39.0	0.0	20.1	44.8	0.2150
07	282	13:17	13:18	299.0	13.0	10.7	0.0	61.6	127.1	136.9	9.8	39.0	0.0	20.6	44.4	0.2190
08	283	11:25	11:26	346.0	23.0	10.7	3.0	66.0	169.7	179.3	9.6	39.0	0.0	11.7	36.9	0.3000
09	283	11:31	11:32	346.0	23.0	10.7	6.0	65.7	169.7	179.2	9.5	39.0	0.0	10.7	36.6	0.3010
10	283	11:39	11:40	344.0	23.0	10.8	1.0	63.0	171.4	180.6	9.2	39.0	0.0	9.4	36.1	0.3010
11	283	11:48	11:49	324.0	23.0	10.8	2.0	66.4	172.0	179.7	7.7	39.0	0.0	8.4	32.2	0.3270
12	284	10:51	10:52	288.0	.0	10.6	2.0	68.7	146.2	155.0	8.8	39.0	0.0	19.1	40.3	0.2690
13	284	11:25	11:26	300.0	.0	10.5	6.0	69.6	142.9	152.7	9.8	39.0	0.0	12.0	43.0	0.2440
14	284	11:58	11:59	310.0	.0	10.4	2.0	69.6	139.1	149.6	10.5	39.0	0.0	8.2	44.3	0.2240
15	284	12:16	12:17	307.0	.0	10.4	3.0	70.5	138.0	148.6	10.6	39.0	0.0	9.1	44.5	0.2200
16	284	12:30	12:31	300.0	.0	10.3	3.0	69.8	136.7	146.9	10.2	39.0	0.0	11.1	43.9	0.2230

COLLECTOR I.D : H
SERIES NO : 2
LABORATORY NO : 4

TEST DATE : 10/21/78
CROSS AREA : 31.505 FT2
TRANSFER FLUID : WATER

RESULTS

RUN #	DAY #	SOLAR TIME START	SOLAR TIME END	SOLAR RAD B/HFT2	DIF-FUSE %	MASS FLOW *LB/H	WIND VEL. MPH	TEMP AMB. F	TEMP IN F	TEMP OUT F	TEMP DIFF F	TILT ANG. DEG.	AZM ANG. DEG.	INCID ANG. DEG.	EFF GROS %	OPER PARM. **
01	294	10:33	10:34	288.0	12.0	10.8	3.0	63.7	82.6	95.2	12.6	39.0	0.0	24.6	59.0	0.0660
02	294	10:38	10:39	290.0	12.0	10.8	3.0	64.6	82.6	95.3	12.7	39.0	0.0	23.6	59.3	0.0620
03	294	10:43	10:44	293.0	12.0	10.9	3.0	63.9	82.8	95.5	12.7	39.0	0.0	22.5	58.8	0.0640
04	294	10:48	10:49	295.0	12.0	10.8	4.0	64.8	82.8	95.6	12.8	39.0	0.0	21.4	58.9	0.0610
05	294	11:04	11:05	303.0	12.0	10.8	3.0	65.7	98.6	110.8	12.2	39.0	0.0	18.3	54.5	0.1090
06	294	11:09	11:10	306.0	12.0	10.9	5.0	66.6	99.0	111.5	12.5	39.0	0.0	17.3	55.5	0.1060
07	294	11:15	11:16	308.0	12.0	10.9	6.0	66.4	99.0	111.6	12.6	39.0	0.0	16.3	55.6	0.1120
08	294	11:20	11:21	308.0	12.0	10.9	0.0	66.9	99.1	111.9	12.8	39.0	0.0	15.5	56.4	0.1050
09	294	12:03	12:04	312.0	12.0	10.8	3.0	66.9	131.4	142.0	10.6	39.0	0.0	11.9	46.0	0.2070
10	294	12:08	12:09	310.0	12.0	10.7	3.0	67.8	131.7	142.1	10.7	39.0	0.0	12.0	46.3	0.2060
11	294	12:13	12:14	311.0	12.0	10.7	3.0	67.8	131.9	142.7	10.8	39.0	0.0	12.3	46.6	0.2060
12	294	13:25	13:26	279.0	12.0	10.5	2.0	71.0	183.4	189.1	5.7	39.0	0.0	24.2	27.0	0.4030

*LB/HR-FT2
**F/(BTU/HR-FT2)

APPENDIX D: DESCRIPTION OF SOLAR SPACE HEATING AND DOMESTIC WATER HEATING SYSTEM SIMULATED USING F-CHART

Collector

o Area: Sized for each collector in each city to provide 50% and 75% of the seasonal space heating and hot water load

o Orientation: Tilted equal to the latitude, 0°, azimuth (south facing)

o

	Collector Type	$F_R(\tau\alpha)_e$	$F_R U_L$ (Btu/°F·ft^2·h)	IAM B_o
1	One glass cover Black paint absorber	0.670	-1.080	-0.08
2	Two glass cover Selective absorber	0.642	-0.56	-0.175

Collector Loop Heat Exchanger

o None

Main Storage Tank

o Capacity: 15 Btu/°F·ft^2 (1.85 gal/ft^2)

Space Heating Load Heat Exchanger

o $\frac{\varepsilon_L C_{min}}{UA} = 2.0$

Space Heating Load

o Building Effective UA: 12912 Btu/°F·day
(8 Btu/degree day·ft^2 for a residence having a floor area of 1614 ft^2)

o Internal Heat Generation: None (Building Effective UA given above is assumed to be a net value including the effect of internal heat generation)

Domestic Hot Water System

o Daily Draw: 70 gal/day

o Cold Water Temperature: 55°F

o Hot Water Temperature: 140°F

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Elmer Streed, David Waksman

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Department of Energy
Office of Solar Applications for Buildings
1000 Independence Avenue, SW
Washington, DC 20585

10. SUPPLEMENTARY NOTES

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

Thermal performance measurements of eight liquid-heating flat-plate solar collectors were conducted with two to four collectors of each type at four outdoor test sites. Tests were performed in accordance with the procedure prescribed by ASHRAE Standard 93-77. Statistical analysis of data sets for each collector type within test sites and between test sites was done using ASTM recommended methods to evaluate test method measurement uncertainty. Illustrations of the influence of thermal performance data uncertainty are presented for collector material degradation, collector rating and calculated system performance.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

collector rating; measurement; solar collector; standards; thermal performance; uncertainty

13. AVAILABILITY

☒ Unlimited

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