DOE/NASA CONTRACTOR REPORT

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THERMAL PERFORMANCE EVALUATION OF SOLAR ENERGY PRODUCTS COMPANY (SEPCO) "SOLORON" COLLECTOR TESTED OUTDOORS

Prepared by Wyle Laboratories, Solar Energy Systems Division, Huntsville, Ala.
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16. ABSTRACT

This report presents the test results obtained during the performance of a test program conducted to determine the performance of a Soloron solar collector. The test article, Model EF-212, Serial Nr. 002, is a single glazed collector with a nonselective absorber plate using flowing air as the heat transfer medium. The absorber plate and box frame are aluminum and the insulation is one inch Isocyanurate foam board with thermal conductivity of 0.11 $BTU/Ft^2 \cdot Hr \cdot {}^0/Ft$. The tests included the following:

a. Time constant test
b. Collector efficiency test
c. Collector Stagnation test
d. Incident angle modifier test
e. Load test
f. Weathering test
g. Absorber plate optical properties test.

The results of these tests are tabulated, graphed, or otherwise recorded in this report.

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1.0 PURPOSE

The purpose of this documentation is to present the test results obtained during the performance of an evaluation test program. The evaluation test program was conducted to determine the conformance of a Soloron solar collector to the evaluation requirements specified in Reference 2.5 in accordance with Reference 2.7.

2.0 REFERENCES

2.1	NBS TECH NOTE 899	Development of Proposed Standards for Testing Solar Collectors and Thermal Storage Devices
2.2	ASHRAE 93-P	Method of Testing Solar Collectors Based on Thermal Performance
2.3	(TBD)	Procedure for Operating the MSFC Hot Air Loop
2.4	Contract No.:	NAS8-32036
2.5	IBM-K42-76-008	Test Evaluation Plan for Solar Energy Products Solar Collectors
2.6	MSFC MMI 5300.4C	Metrology and Calibration
2.7	MTCP-DC-SHAC-405	Test Procedure for Thermal Performance Evaluation of Solar Energy Products Company (SEPCO) "Soloron" Collector

3.0 MANUFACTURER

Solar Energy Products Company
121 Miller Road
Avon Lake, Ohio 44012

3.1 DESCRIPTION OF TEST SPECIMEN

The test article, a Soloron solar collector, Model EF-212, Serial Number 002, is a single glazed collector with a nonselective absorber plate utilizing flowing air as the heat transfer medium. The absorber plate and box frame are aluminum and the insulation is one inch Isocyanurate foam board with thermal conductivity of 0.11 BTU/Ft^2.Hr.°F/Ft. The collector measures 25 1/8 inches by 146 3/4 inches by 3 5/16 inches, provides 25.6 square feet of solar collector surface area and weighs 65 pounds. Figure 1 depicts a plan and sectional view of the collector.

4.0 SUMMARY

In accordance with References 2.5 and 2.7, a series of tests were conducted to evaluate the thermal performance of a Model EF-212 Soloron solar collector. These tests included the following:

a. Time Constant Test

b. Collector Efficiency Test

c. Collector Stagnation Test

d. Incident Angle Modifier Test

e. Load Test

f. Weathering Test

g. Absorber Plate Optical Properties Test

Data sheets for all tests are included in Appendix I. The time constant was determined to be 4 minutes and 30 seconds. Figures 8 and 9 depict collector efficiency curves for 2 SCFM and 5 SCFM per square foot of collector surface. Incident angle modifier data are shown in Figures 10 and 11. Stagnation test data are located in Paragraph 6.4.3 and the results of the optical properties test are contained in Paragraph 6.5.3. The collector was subjected to loads of up to 120 pounds per square feet with no apparent damage or leakage. (See Paragraph 6.6.3). The weathering test was conducted from December 1976 through April 1977. The only apparent deficiency noted during this test was a shrinking and separation of the trim from the frame. Weather conditions during this period were recorded and are presented in Appendix II. Detailed data which formed the basis for all analyzes concerning these tests are presented in Appendix I.

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5.0 TEST CONDITIONS AND TEST EQUIPMENT

5.1 Ambient Conditions

Unless otherwise specified herein, all tests were performed in the existing natural environment. The solar noon during the period of this test was at 11:47 Central Standard Time.

5.2 Instrumentation and Equipment

All test equipment and instrumentation used in the performance of this test program comply with the requirements of MSFC MMI 5300.4C, Metrology and Calibration. Instrumentation sensor and readout locations are indicated in Figures 4 and 5 respectively. (B) The four channel strip data recorder setup procedures are contained in Appendix II of Peference 2.7. Pictures of test setup and test equipment are shown in Photographs 1 and 2. A listing of the equipment used in each test follows:

Collector Time Constant Test

Apparatus	Manufacturer/Model	Range/Accuracy
Collector Shield	Hard Board	N/A
Pyranometer	Eppley	0-400 BTU/Hr·Ft^2/±10%
Air Source	MSFC Supplied	50 - 200 SCFM
Thermopile	Medtherm	0-20°F/±1°F (A)
Thermocouples	Medtherm	32°-200°F/±1°F
Wind Sensor	MSFC Supplied	0 - 60 MPH
Strip Chart Recorder	Hewlett-Packard	5 v-10v/±0.5%
Flow Converter	Foxboro	0 - 400 CFM ±1%
Flow Sensor	Cox-Turbine C-L-32	20-250 ACFM ±2%
Ice Bath	MSFC Supplied	N/A
Test Stand	MSFC Supplied	N/A
Differential Pressure Sensor	MSFC Supplied	0 - 2 in. H_2O ±5%

Collector Efficiency Test

Apparatus	Manufacturer/Model	Range/Accuracy
Pyranometer	Eppley	0-400 BTU/Hr·Ft^2/±10%
Air Source	MSFC Supplied	50 - 200 SCFM
Thermopile	Medtherm	0-20°F/±1°F (A)
Thermocouples	Medtherm	32°-200°F/±1°F
Wind Sensor	MSFC Supplied	0 - 60 MPH
Strip Chart Recorder	Hewlett-Packard	5 v-10v/±0.5%
Flow Converter	Foxboro	0 - 400 CFM±1%
Flow Sensor	Cox-Turbine C-L-32	20 - 250 ACFM ±2%
Ice Bath	MSFC Supplied	N/A
Test Stand	MSFC Supplied	N/A
Differential Pressure Sensor	MSFC Supplied	0-2 in. H_2O ±5%

5.0 TEST CONDITIONS AND TEST EQUIPMENT (Continued)

5.2 Instrumentation and Equipment (Continued)

Incident Angle Modifier Test

Apparatus	Manufacturer/Model	Range/Accuracy
Pyranometer	Eppley	0-400 BTU/Hr·Ft^2/±10%
Air Source	MSFC Supplied	50 - 200 SCFM
Thermopile	Medtherm	0-20°F/±0.05°F
Thermocouples	Medtherm	32°-200°F/±0.1°F
Wind Sensor	MSFC Supplied	0 - 60 MPH
Strip Chart Recorder	Hewlett-Packard	5 v-10v/±0.5%
Flow Converter	Foxoboro	0 - 400 CFM ±1%
Flow Sensor	Cox-Turbine C-L-32	20-250 ACFM ±2%
Ice Bath	MSFC Supplied	N/A
Test Stand	MSFC Supplied	N/A
Differential Pressure Sensor	MSFC Supplied	0-2 in. H_2O

Collector Stagnation Test

Apparatus	Manufacturer/Model	Range/Accuracy
Pyranometer	Eppley	0-400 BTU/Hr·Ft^2/±10%
Thermocouples	Medtherm	32°-200°F/±0.1°F
Test Stand	MSFC Supplied	

Collector Optical Properties Test

Apparatus	Manufacturer/Model	Range/Accuracy
Mobile Solar Reflectometer	Gier Dunkle Instruments/MS 251	0-100%/±2%
Infrared Reflectometer	Gier Dunkle Instruments/DD100	0-100%/±2%

Collector Load Test

Not applicable.

Collector Weathering Test

Not applicable.

6.0 TEST REQUIREMENTS AND PROCEDURES

Data obtained for each test is denoted in the results section. Some data is evaluated through the use of a SR-52 calculator. Program documentation is found in Appendix II of Reference 2.7, and program use is explained in Table III.

6.1 Collector Time Constant Test

6.1.1 Performance Criteria Requirements

The collector shall be mounted and insulated in such a way that the back and edge losses will be characteristic of those that will occur during operation on a structure. (See Figure 1.) The total solar flux shall be continuously greater than 250 $BTU/Hr \cdot Ft^2$ and data taken only during a "quasi-steady state" condition. The collector time constant shall be determined by abruptly reducing the solar flux to zero through shading. This will be done with the inlet temperature adjusted to within 2°F of ambient while the air is circulating at 48 ± 3 SCFM. The differential temperature across the collector shall be monitored to determine the time (t) required to reach the condition of:

$$\frac{\Delta T(t)}{\Delta T_0} < 0.30$$

where T(t) is the differential temperature after shading and ΔT_0 is the differential temperature prior to shading.

6.1.2 Test Procedure

1. Adjust the air flow rate to 48 ±3 SCFM.
2. Adjust the inlet temperature to ambient ±2°F.
3. Determine the corresponding SCFM value through temperature and pressure compensation.
4. Readjust the air flow and redetermine the SCFM value until the SCFM value is 48 ±3 SCFM.
5. Allow the system to stabilize to a "quasi-steady state" condition (approximately 20 minutes).
6. Reduce the solar flux to zero by shading the collector from the sun.

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.1.2 Test Procedure (Continued)

7. Continuously monitor and record the differential temperature until the ratio of $(\Delta T(t)/\Delta T_0)$ is less than 0.30 where $\Delta T(t)$ represents the differential temperature as a function of time referenced to the time of shading, and ΔT_o is the constant differential temperature prior to shading.

6.1.3 Results

The "time constant" is defined as the time required for

$$\frac{F_R U_L \, (t_{f,i} - t_a) + \frac{\dot{m}C_p}{A} \, \Delta T(t)}{F_R U_L \, (t_{f,i} - t_a) + \frac{\dot{m}C_p}{A} \, \Delta T_o} = 0.368$$

where

F_R: Solar heat removal factor

U_L: Solar collector transfer loss coefficient

from Section 6.3.3

$F_R U_L = 0.96$

from test data (See data sheet in Appendix I.)

$\frac{\dot{m}C_p}{A} = 0.0423 \times 49.5 = 2.094$ BTU/Hr·Ft^2·°F

ΔT_o = 57°F, air inlet temperature $t_{f,i}$ = 98.2°F, and from above equation as

$$\Delta T(t) = 0.368 \;\; T_o - \frac{0.632A}{\dot{m}C_p} \; F_R U_L \; (t_{f,i} - ta) = 17.7°F$$

From the strip chart recorder, this happened at 4 minutes and 30 seconds after shading. Hence, the time constant is 4 minutes and 30 seconds.

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6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.2 Collector Efficiency Test

6.2.1 Performance Criteria Requirements

The collector to be tested shall be pre-conditioned prior to initiation of the Test. Pre-conditioning shall consist of stagnation heat in a non-operational mode for three cumulative days in which the incident solar radiation measured in the plane of the collector shall be a mean of 1500 BTU/Ft^2/day (406 langleys). The tilt angle shall be 45°. The collector shall be mounted in a location such that there will be no significant energy reflected or reradiated onto the collector from surrounding buildings or any other surfaces in the vicinity of the test stand for the duration of the test (s). This requirement will be satisfied if the ground and immediately adjacent foreground surfaces are diffuse reflectors with a reflectivity of less than 0.20. If significant reflection can occur, provision shall be made to shield the collector by the use of a non-reflective shield. In addition, the test stand shall be located so that no shadow will be cast onto the collector by any obstruction at any time during the test period. The test shall be conducted at times having weather conditions such that the integrated average insolation measured in the plane of the collector or aperture, reported, and used for the computation of instantaneous efficiency values shall not be less than 315 W/m^2 (100 $BTU/Hr \cdot Ft^2$). The orientation of the collector shall be such that the incident angle (measured from the normal to the collector surface or aperture) is less than 30° during the period in which test data is being taken. The air velocity across the collector surface shall be measured and recorded as part of the test data. The velocity measurement shall be made at a distance of approximately 1 m (3.3 Ft.) from the collector, at a height corresponding to the mid-height of the collector, and at a location where the velocity sensor is not shielded from the wind and the sensor does not cast a shadow on the collector during the tests. The range of ambient temperatures for all reported test points comprising the "efficiency curve" shall be less than 30°C (86°F). Collector efficiency shall be determined at flow rates of 48 and 120 SCFM. The inlet temperature shall be maintained as close as attainable to 0, 25, 50, and 100°F above ambient for each flow rate.

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.2.1 Performance Criteria Requirements (Continued)

At least four "data points" shall be taken for each value of inlet temperature-flow ($t_{f,i}$); two during the time period preceding solar noon and two in the period following solar noon. The efficiency curve shall be established by data points that represent efficiency values determined by integrating the data over a time period equal to the time constant or 5 minutes, whichever is larger. The integrated value of incident solar energy will be divided into the integrated value of energy obtained from the collector to obtain the efficiency value for that instant.

6.2.2 Test Procedures

1. Establish the proper flowrate and inlet temperature ($t_{f,i}$) for each test designation a thru j specified below.

	Ambient °F	Amb. +10°F	Amb. +25°F	Amb. +50°F	Amb. +100°F
48 SCFM ± 3	a	c	e	g	i
120 SCFM ± 8	b	d	f	h	j

2. Continuously adjust the inlet temperature and flow rate to maintain the desired "data point" characteristics.

3. Continuously monitor and adjust the strip chart recorder to obtain accurate, real-time recordings of wind velocity, ΔT, and solar flux.

4. Continue recording data from two (2) hours preceding solar noon to two (2) hours following solar noon.

6.2.3 Results

For the test interval of each efficiency "data point" the efficiency value is calculated using the equation

$$\eta = \frac{\frac{\dot{m}C_p}{A}\int_{\tau_1}^{\tau_2} \Delta T(\tau)\,d\tau}{\int_{\tau_1}^{\tau_2} I\,d\tau}$$

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or alternately,

$$\eta = \frac{\dot{m}C_p}{A}\,\Delta\bar{T}/\bar{I}$$

where

$\Delta\bar{T} = \frac{1}{\tau_2-\tau_1}\int_{\tau_1}^{\tau_2} \Delta T(\tau)\,d\tau$ is the average differential temperature

6.2.3 Results (Continued)

across the collector during test interval

and

$$\bar{I} = \frac{1}{\tau_2 - \tau_1} \int_{\tau_1}^{\tau_2} I \, d\tau$$ is the average solar irradiation.

Due to the heat input to the system by the blower and the heat absorbed from the ambient, the inlet temperature at ambient temperature can not be obtained without a chiller. Hence, the tests were carried out for inlet temperatures at ambient plus 10°F, ambient plus 25°F, ambient plus 50°F and ambient plus 100°F.

The test data sheets are enclosed in Appendix I and tabulated in Table III. Flow rates of 48 SCFM and 120 SCFM, which corresponds to 2 SCFM and 5 SCFM per square foot of collector, were tested for each of 4 inlet temperatures stated above. Four (4) "data points" were taken for each inlet temperature; two during the time period preceding solar noon and two in the period following solar noon. Consequently, sixteen (16) data points were obtained for each flow rate to establish the "efficiency curve". Figure 10 depicts plots of efficiency data against $\left(\frac{t_i + t_e}{2} - t_a\right) / I$ with second-order least-square fitting curves.

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.3 Incident Angle Modifier Test

6.3. Performance Criteria Requirements

The collector to be tested shall be pre-conditioned prior to initiation of the test. Pre-conditioning shall consist of stagnation heat in a non-operational mode for three cumulative days in which the incident solar radiation measured in the plane of the collector shall be a mean of 1500 BTU/Ft^2/day (406 langleys). The tilt angle shall be 45°. The collector shall be mounted in a location such that there will be no significant energy reflected or re-radiated onto the collector from surrounding buildings or any other surfaces in the vicinity of the test stand for the duration of the test (s). This requirement will be satisfied if the ground and immediately adjacent foreground surfaces are diffuse reflectors with a reflectivity of less than 0.20. If significant reflection can occur, provision shall be made to shield the collector by the use of a non-reflective shield. In addition, the test stand shall be located so that no shadow will be cast onto the collector by any obstruction at any time during the test period. The test shall be conducted at times having weather conditions such that the integrated average insolation measured in the plane of the collector or aperture, reported, and used for the computation of instantaneous efficiency values shall be not less than 315 W/m^2 (100 BTU/Hr-Ft^2). The air velocity across the collector surface shall be measured and recorded as part of the test data. The velocity measurement shall be made at a distance of approximately 1 m (3.3 ft) from the collector, at a height corresponding to the mid-height of the collector, and at a location where the velocity sensor is not shielded from the wind and the sensor does not cast a shadow on the collector during the tests. The range of ambient temperatures for all reported test points comprising the "efficiency curve" shall be less than 30°C (86°F). The incident angle modifier shall be determined at a flow rate of 48 ±3 SCFM with the temperature maintained as close as possible to ambient.

6.3.2. Test Procedure

1. Adjust the flow rate to 48 ±3 SCFM.

2. Adjust the inlet temperature to within ±2°F of the ambient temperature.

3. Continuously adjust the inlet temperature and flow rate to maintain 48 ±3 SCFM and ambient ±2°F, respectively.

4. Continuously monitor and adjust the strip chart recorder to obtain accurate real-time recordings of wind velocity, ΔT, and solar flux.

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6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.3.2 Test Procedure (Continued)

5. The efficiency values are determined in three "pairs" where each "pair" includes a value of early in the day and a second value late in the day.

6. The data should be collected for average incident angles of approximately 45°, 60° and 75°.

6.3.3 Results

During the time of this test program, incident angle of 75°, which is five hours before or after solar noon, does not have solar irradiation above 100 BTU/Hr·Ft^2 that is required for every efficiency test. Hence, data points were obtained for incident angles of 37.5°, 45°, 52.5° and 60°. The test data sheets are enclosed in Appendix I and tabulated in Table IV. The incident angle can be computed as

$$(\tau\alpha)_{e,n} = \frac{\eta + \frac{F_R U_L (t_i - t_a)}{I}}{F_R(\tau\alpha)_{e,n}}$$

where

F_R : Solar heat removal factor

U_L : Solar collector heat transfer loss coefficient

$(\tau\alpha)_{e,n}$: Effective transmissivity-absorptively factor at normal incidence

If the efficiency is plotted against $(T_{f,i}-T_{amb})/I$ (as shown in Figure 9) the negative of the efficiency slope will be equal to $F_R U_L$ and the y interception will be equal to F_R $(\tau\alpha)_{e,n}$. Ⓑ Ⓐ

Hence, at 48 SCFM

$F_R(\tau\alpha)_{e,n} = 0.589$

$F_R U_L = \frac{-.565-.589}{.025-0.0} = 0.96$ BTU/Hr·Ft^2·°F

The efficiency at each incident angle were considered as the average of two data points which were collected at that particular incident angle, one in the period preceding solar noon and the other in the period following solar noon. The incident angle modifiers were computed using above mentioned efficiencies, $F_R(\tau\alpha)_{e,n}$ and $F_R U_L$ value. The results were plotted against incident angle (θ_i) in Figure 10. Alternately, a plot of incident angle modifier against $\left(\frac{1}{\cos(\theta_i)}-1\right)$ and a linear least-square fitting curve were presented in Figure 11. Ⓐ Ⓐ

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.4 Collector Stagnation Test

6.4.1 Performance Criteria Requirements

This test shall consist of exposure to ambient condition in a non-operational mode during a day in which the daily mean incident solar radiation measured in the plane of the collector shall be at least 1500 BTU/Ft^2/day. The exposure angle shall be the latitude angle, or the angle of test specified herein. The Collector shall be mounted in a location such that there will be no significant energy reflected or re-radiated onto the collector from surrounding buildings or any other surfaces in the vicinity of the test stand for the duration of the test (s). This requirement will be satisfied if the ground and immediately adjacent foreground surfaces are diffuse reflectors with a reflectivity of less than 0.20. If significant reflection can occur, provision shall be made to shield the collector by the use of a non-reflective shield. In addition, the test stand shall be located so that no shadow will be cast onto the collector by any obstruction at any time during the test period. The test shall be conducted at times having weather conditions such that the integrated average insolation measured in the plane of the collector or aperture, reported, and used for the computation of instantaneous efficiency values shall be not less than 315 W/m^2 (100 BTU/Hr-Ft^2). The air velocity across the collector surface shall be measured and recorded as part of the test data. The velocity measurement shall be made at a distance of approximately 1 m (3.3 ft.) from the collector, at a height corresponding to the mid-height of the collector, and at a location where the velocity sensor is not shielded from the wind and the sensor does not cast a shadow on the collector during the tests. The range of ambient temperatures for reported test points comprising the "efficiency curve" shall be less than 30° (86°F). This test shall be performed in accordance with Section 5.1.1 of Reference 2.2.

6.4.2 Test Procedure

Record temperature data for a minimum of three consecutive days in which the incident solar radiation measured in the plane of the collector shall be a mean of 1500 BTU/Ft^2/day.

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.4.3 Results

The results of this test are shown below:

Collector Identification SEPCO Model EF-212, SN-002

Date 4/19/77 Test Identification Collector Stagnation Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.6 Height of Collector (Inlet) 61"
(Outlet) 116"

Maximum Temperature (Top) (°F)	243	Ⓑ
(Bottom)	166	
Maximum Ambient Temperature (°F)	81	Ⓑ
Total Solar Flux	1525 BTU/Ft^2 day	
Mean Solar Flux	190 BTU/Ft^2 hr	
Maximum Solar Flux	304 BTU/Ft^2 hr	

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.5 Collector Optical Properties Test

6.5.1 Performance Criteria Requirements

The optical properties of the solar collector shall be determined by MSFC personnel. A collector shall be disassembled by Wyle personnel and delivered to EH-34 for optical measurements. Collector optical measurements are addressed by Reference 2.2.

6.5.2 Test Procedures

Collector Optical properties will be measured in accordance with standard procedures set up by MSFC measurement personnel.

6.5.3 Results

Test results are recorded below:

Collector Identification SEPCO Model EF-212, SN-002

Date 5/23/77 Test Identification Collector Optical Properties Test

Tested by B. Kennedy, EH-34 MSFC

	Emissivity	Absorptivity
1" sq. cut from SEPCO panel	0.88	0.96

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.6 Collector Load Test

6.6.1 Performance Criteria Requirements

One solar collector shall be subjected to load testing. The specified load requirements are listed in Table I. The collector shall be mounted as indicated in Figure 2 but shall be oriented such that the glazing is horizontal. Uniform loads shall be applied by means of a transparent flexible diaphragm which can be covered with a uniform layer of transparent liquid of varying depths to obtain the desired load variations. If either breakage or leakage to the collector occurs before all six tests steps have been conducted, the load testing shall be discontinued. If it is determined that the failure is the result of a collector which is not representative of the vendor's normal product, the collector shall be replaced and the load test started over. If it is determined that the ultimate load capability of the collector has been reached, the load testing shall be terminated.

6.6.2 Test Procedure

1. Mount the collector in the horizontal plane.

2. Place the load frame with liner over the collector.

3. Fill the load frame liner with water to a level corresponding to the Step 1 load of Table I and let stand for five minutes.

4. Drain and remove the load frame.

5. Flush the collector exposed surface with water and inspect for leaks.

6. If the collector leaked or was damaged due to the load, record and indicate what the load level is.

7. If the collector does not leak and is not damaged, record the load level and repeat steps 3 through 5 for the next load level.

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.6.3 Results

The results of this test are tabulated below

Service Load Steps

Step No.	Load (Lb/Ft^2)	Pass/Fail	Comments
1	10	pass	no leakage
2	20	pass	no leakage
3	30	pass	no leakage
4	50	pass	no leakage
5	80	pass	no leakage
6	120	pass	no leakage

6.0 TEST REQUIREMENTS AND PROCEDURES (Continued)

6.7 Collector Weathering Test

6.7.1 Performance Criteria Requirements

One solar collector shall be subjected to a weathering test.

The collector shall be subjected to long term exposure to sunlight and other weathering elements. The collector shall be exposed to the elements in the same manner as it will be during its service life so that the sides and bottom will be protected from the elements. The inlet and outlet ports of the collector shall be blocked to eliminate natural convection cooling. The ports shall be blocked with urethane foam with breathing tubes inserted as indicated in Figure 3. The collector shall face due south ±5 degrees at a tilt angle from the horizontal plane of 45°.

The test shall be conducted over a one year period. The collectors shall be visually inspected at least monthly for evidence of collector deterioration. If examination shows evidence of gross collector deterioration which is considered capable of affecting collector performance, weather testing shall be discontinued and spectral tests conducted.

If the spectral parameters have changed by more than 10% of the values initially measured, performance testing shall be conducted. After these tests have been performed, the collector shall be returned to the weather testing status.

Daily records of weather conditions occurring in the proximity of the test collector shall be kept. Weather measurements shall include the following:

- Daily solar radiation total (BTU/Ft^2/day)
- Daily temperature profile (high, low, average)
- Daily rain measurements (inches/day)
- Additional weather conditions such as hail, snow, exceptionally high winds shall be reported.

6.7.2 Test Procedure

Weathering tests for the collector shall be performed on test bed #1 of the breadboard facility located at the Marshall Space Flight Center. The necessary sequence of events are:

6.7.2 Test Procedure (Continued)

1. Prepare the collector as described in test requirements.

2. Mount the collector on test bed #1 in the manner that it would be installed on a building.

3. Inspect the collector monthly for apparent deterioration.

4. Obtain the necessary data from the National Weather Bureau located at the Huntsville Airport. This data is recorded hourly and summarized daily. Obtain only the daily summaries. Record this information on weathering data sheets.

6.7.3 RESULTS

The results of this test are tabulated monthly in the following pages. Due to the lack of facilities, total daily solar radiation was not recorded.

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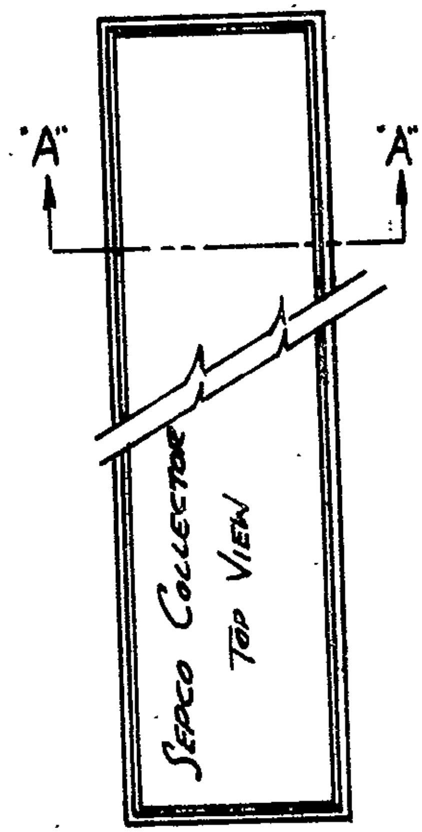

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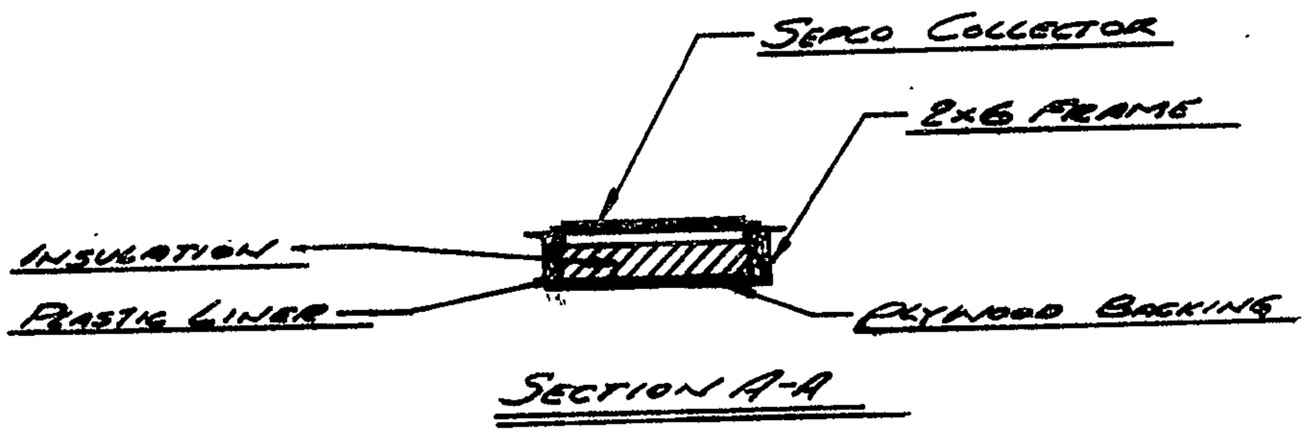


FIGURE 1. TYPICAL COLLECTOR MOUNTING ARRANGEMENT

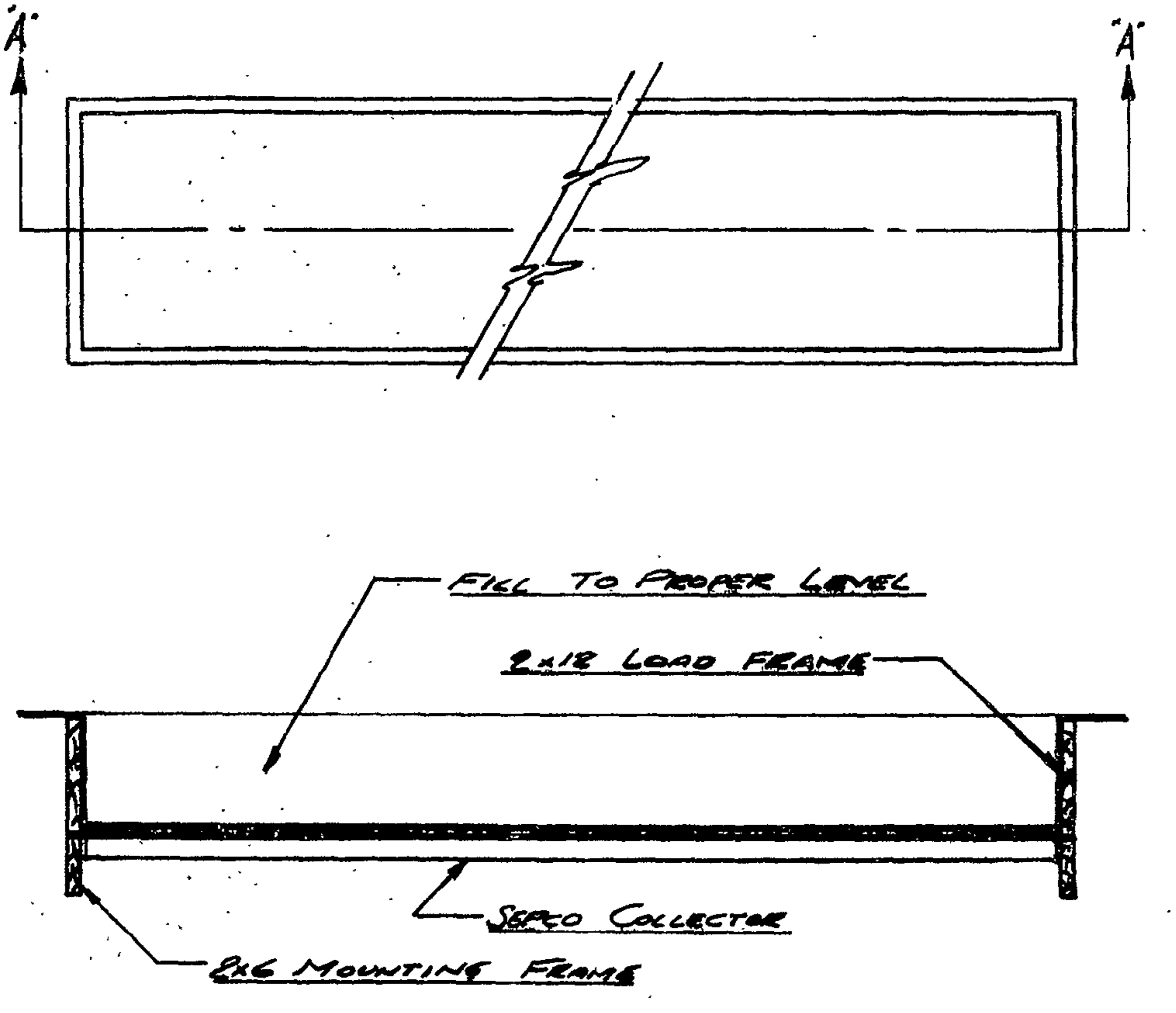


FIGURE 2. LOAD TEST ARRANGEMENT

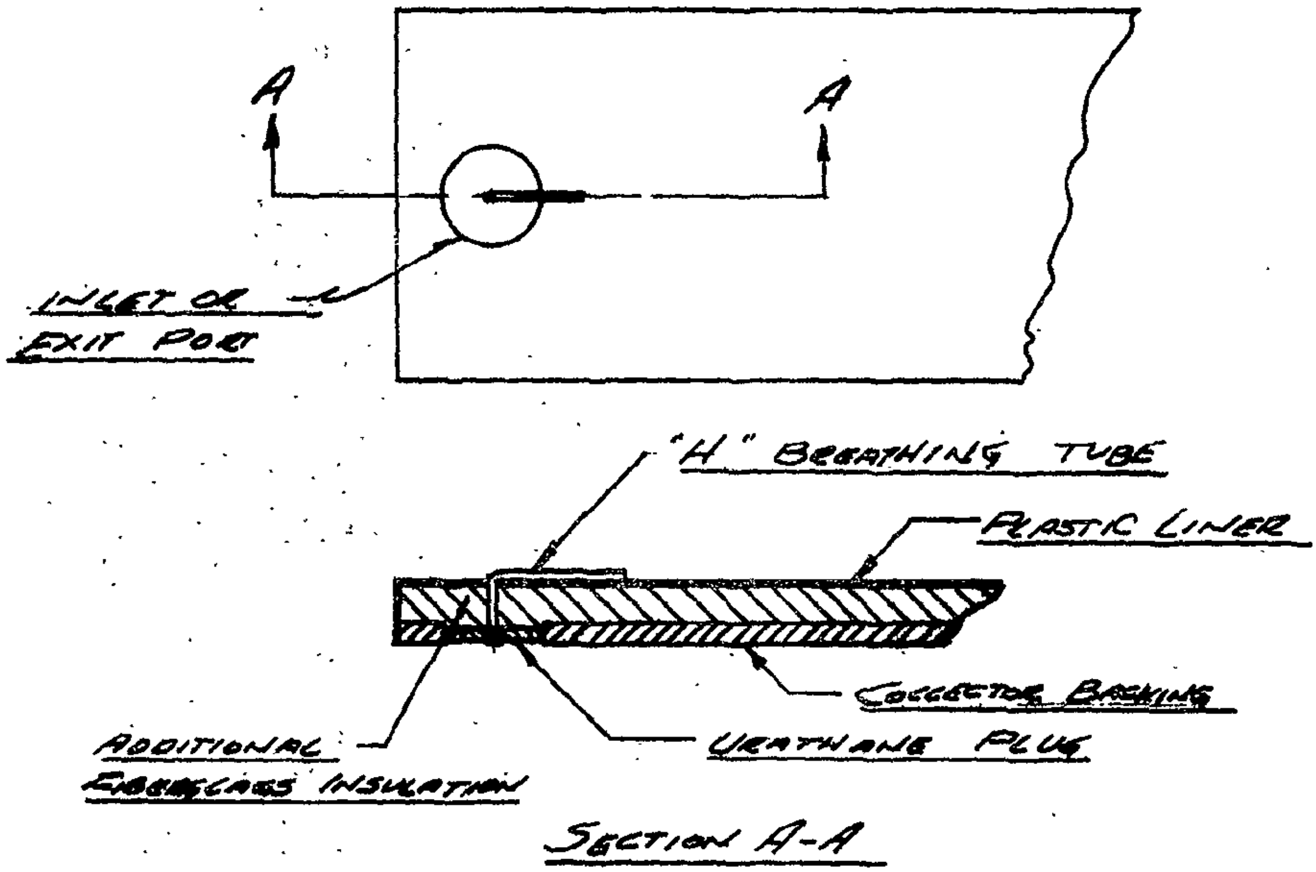


FIGURE 3. STAGNATION TEST PORT ASSEMBLY

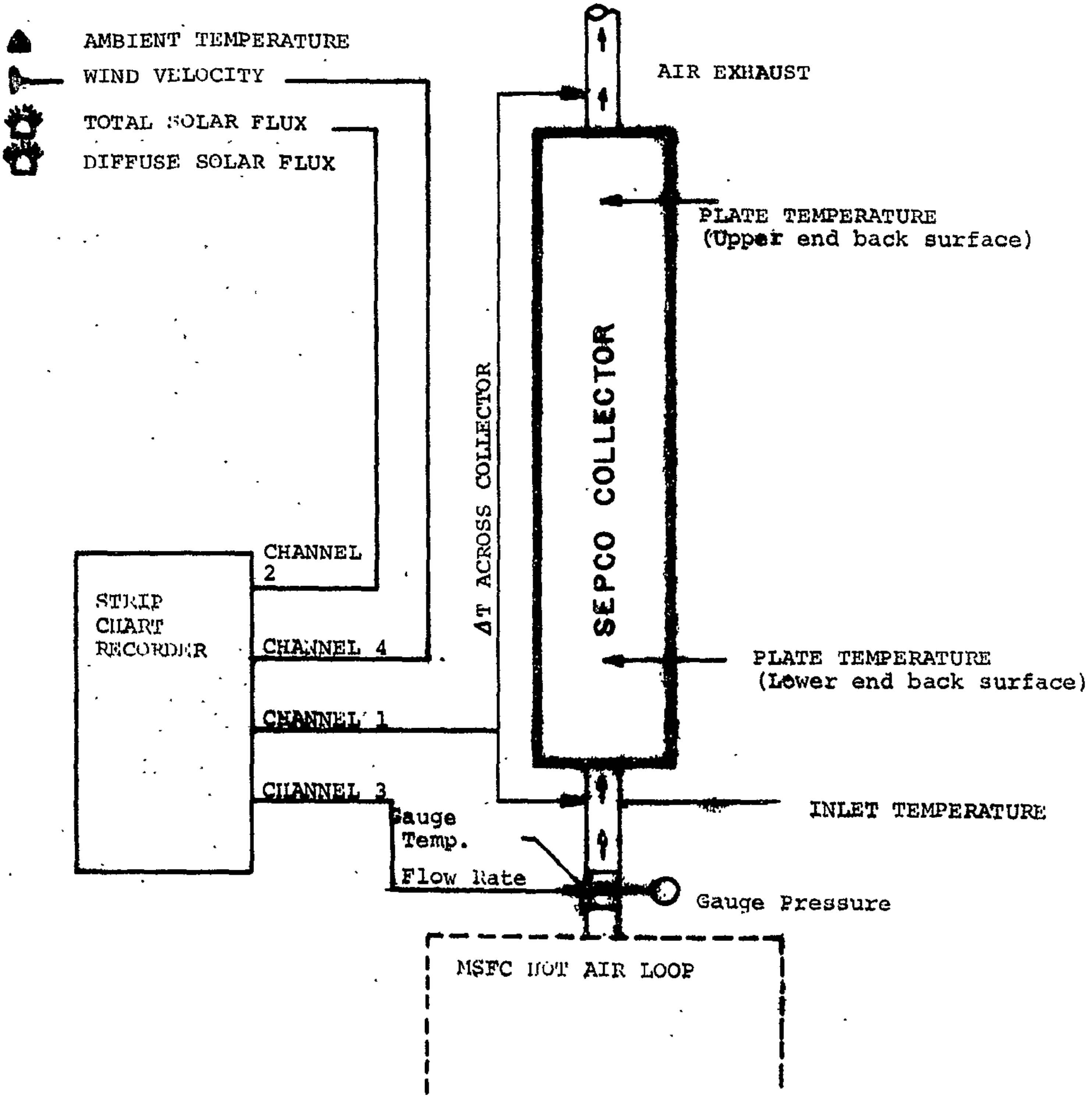


FIGURE 4. AIR FLOW AND MEASUREMENT POINTS

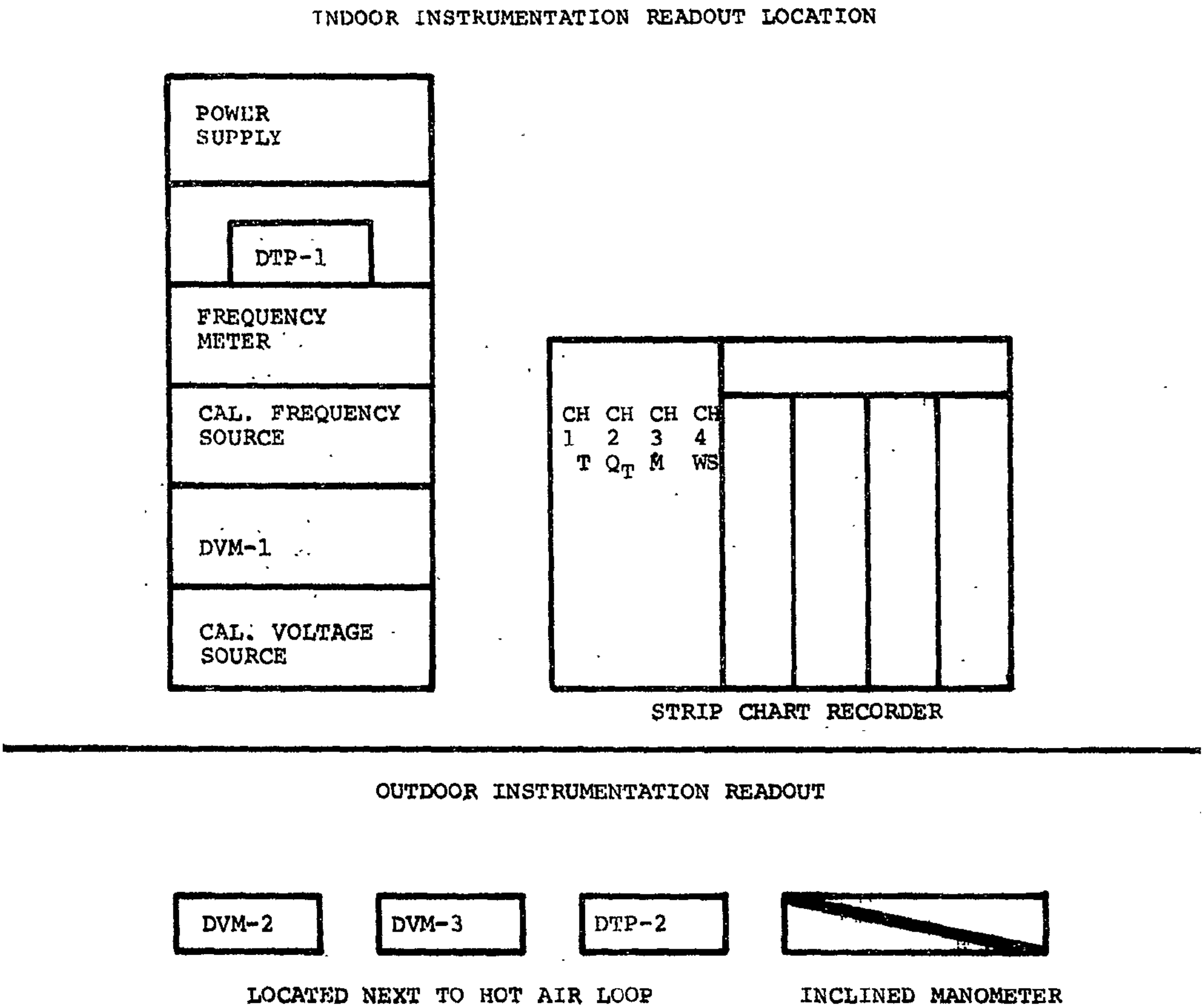


FIGURE 5. INSTRUMENTATION READOUT LOCATIONS

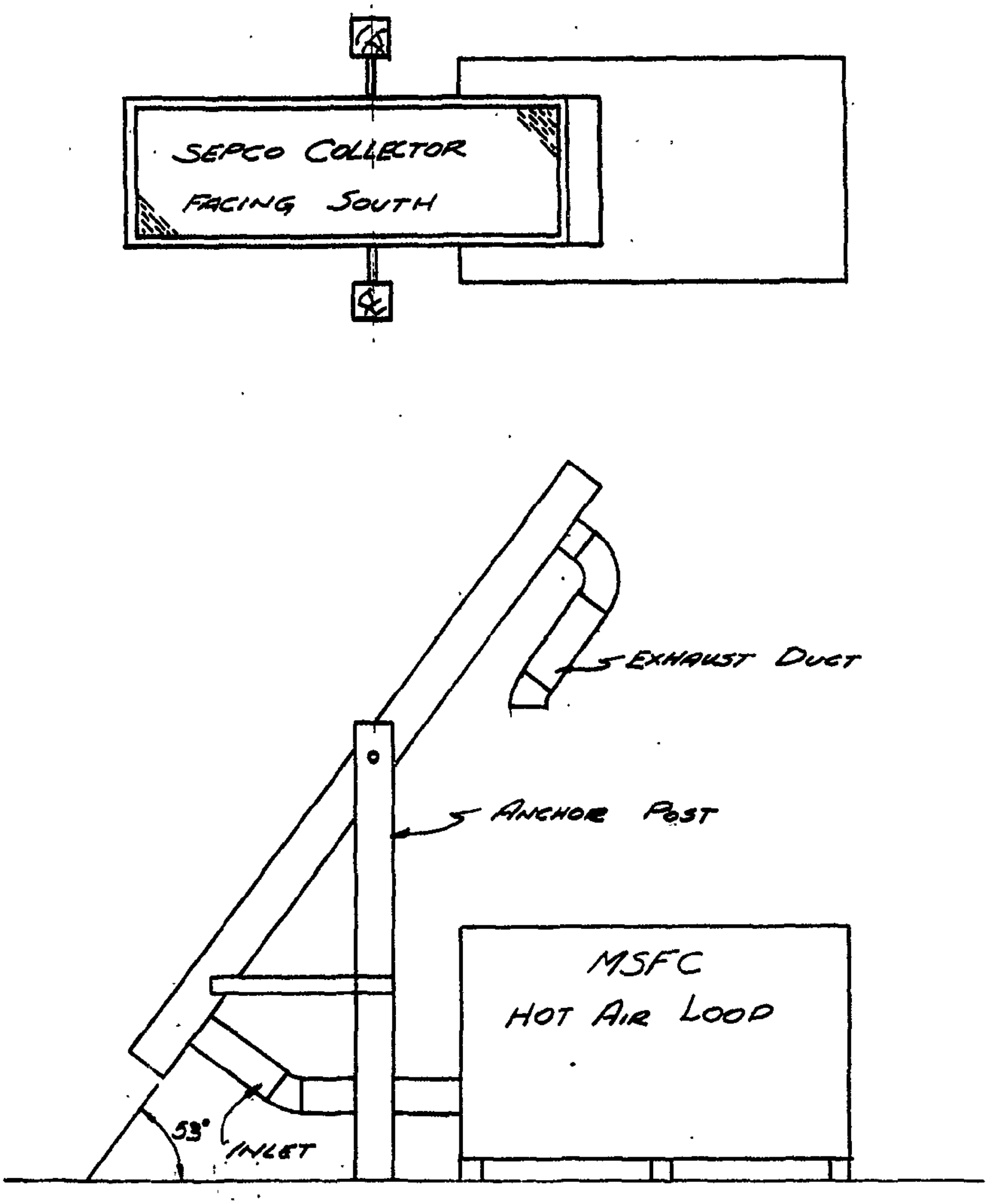


FIGURE 6. SKETCH OF TEST SETUP

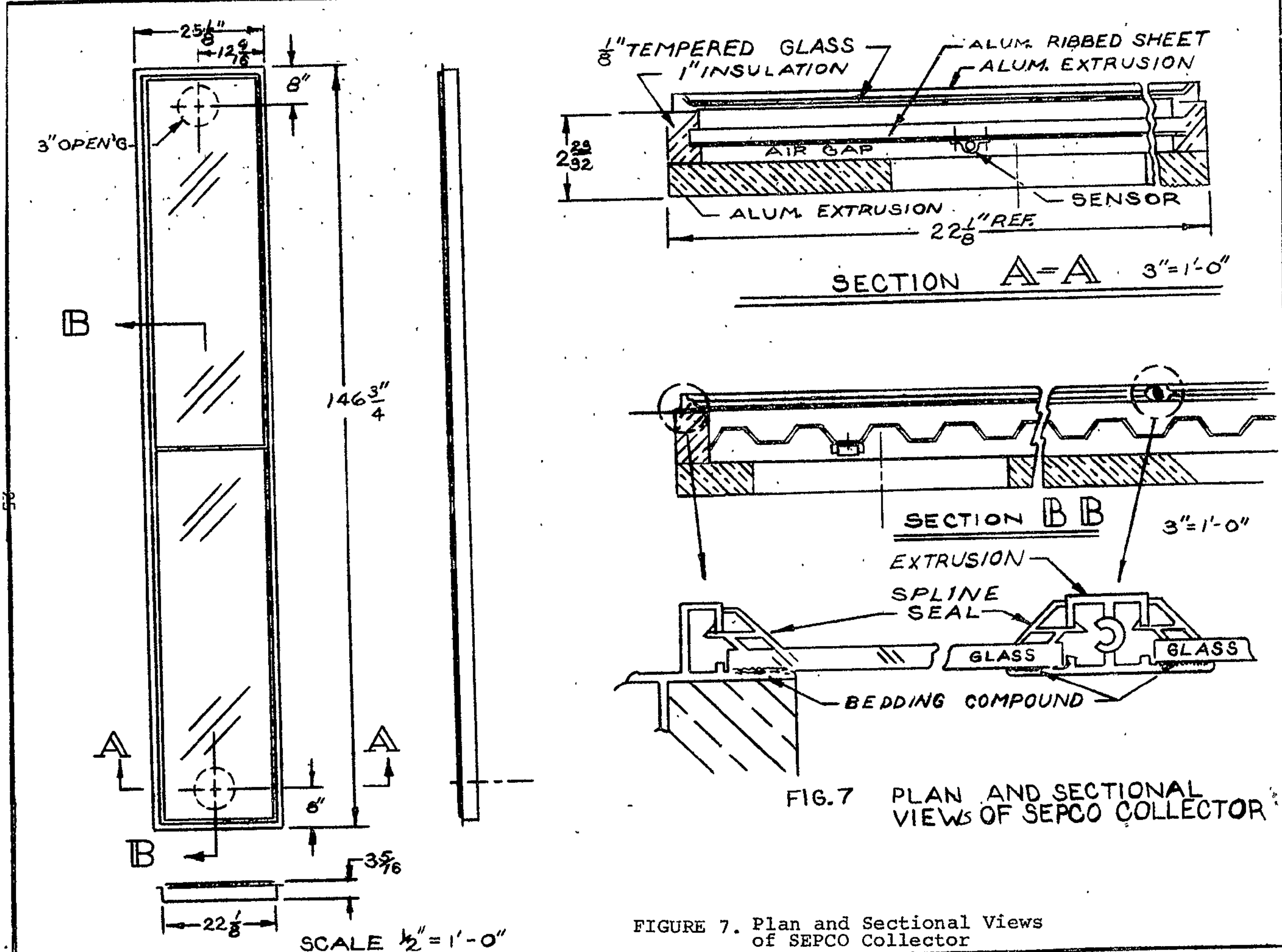


FIGURE 7. Plan and Sectional Views of SEPCO Collector

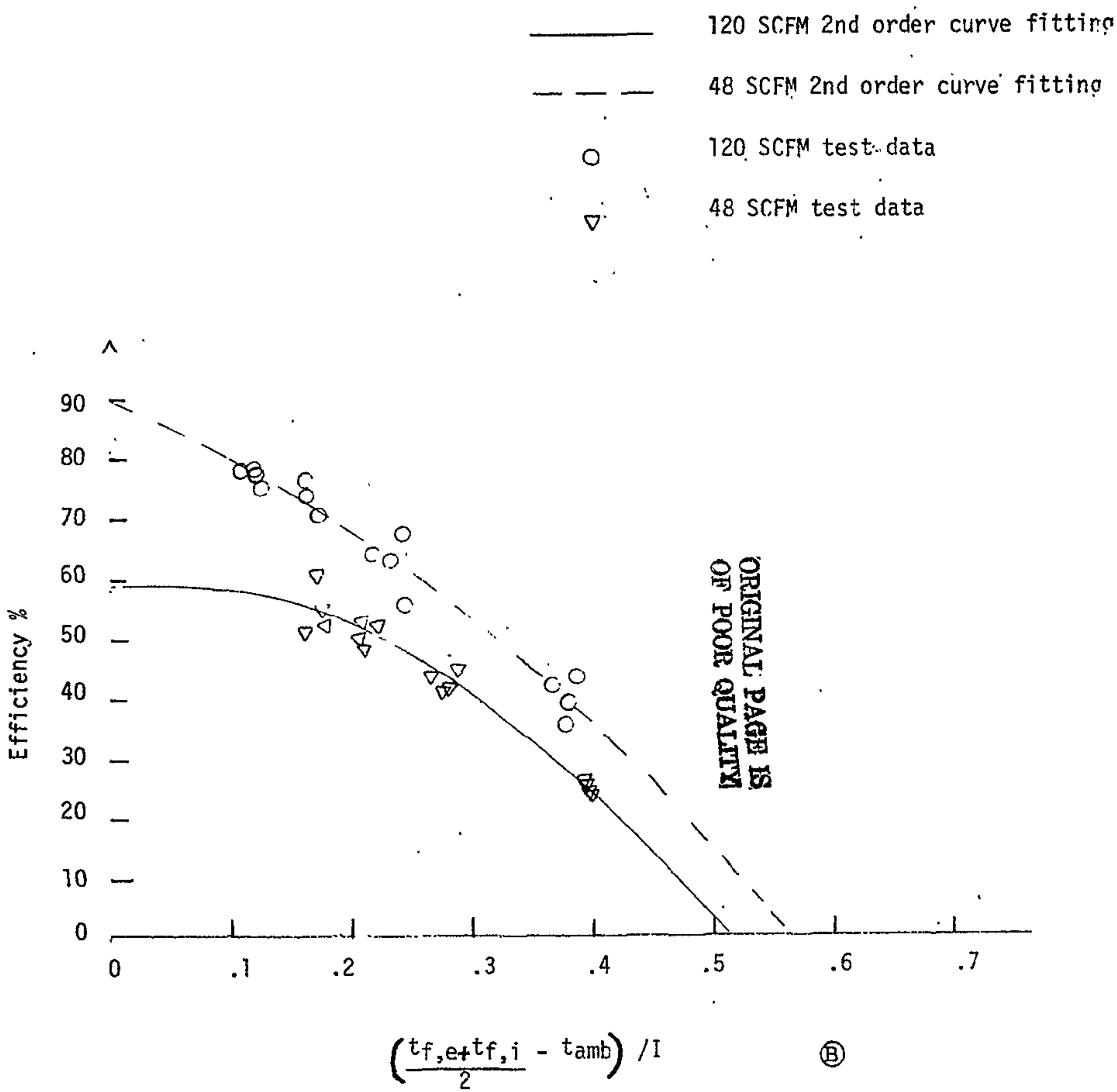


Figure 8. Efficiency vs. $\left(\frac{t_{f,e}+t_{f,i}}{2} - t_{amb}\right)/I$

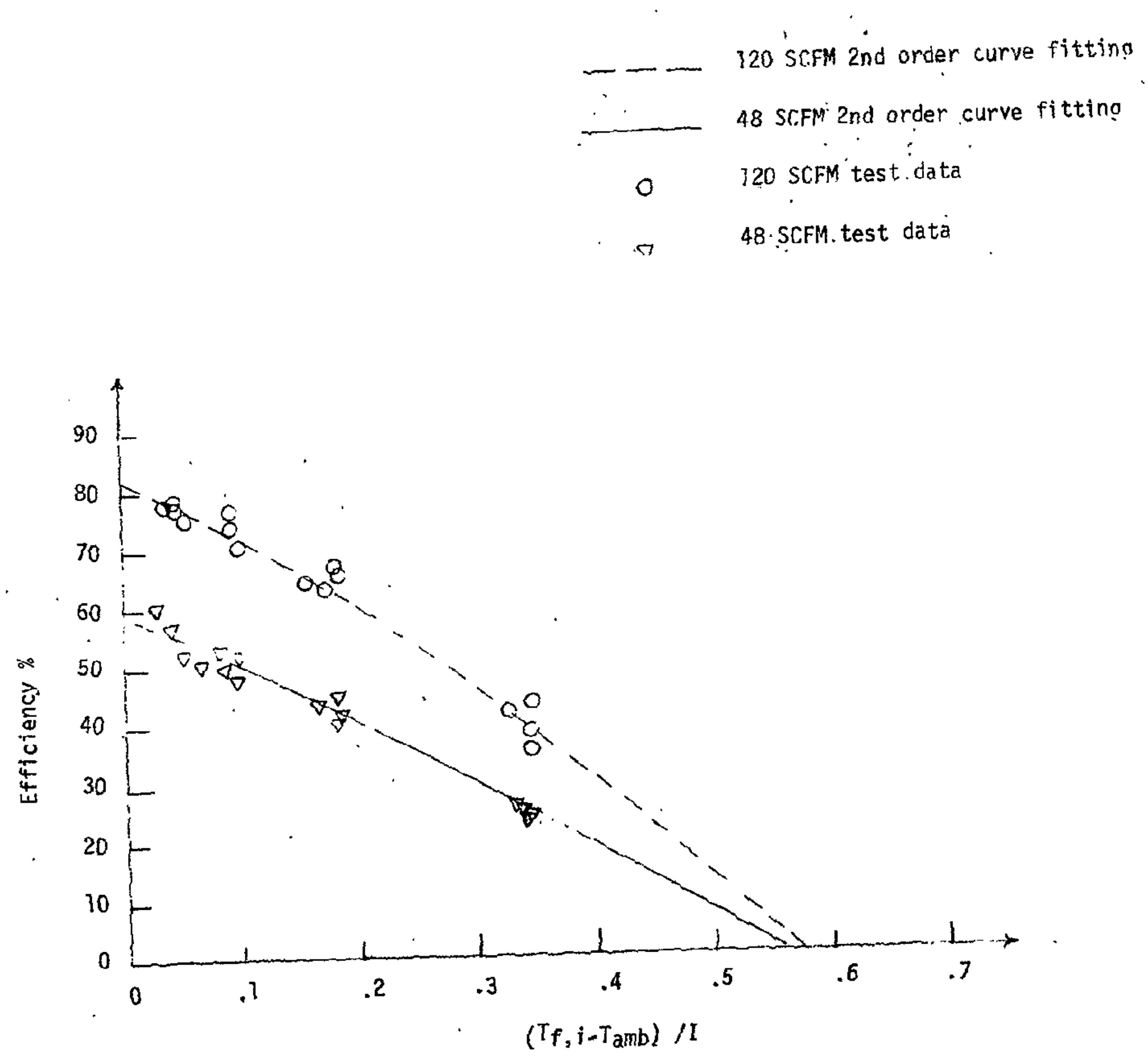


Figure 9. Efficiency vs. $(T_{f,i}-T_{amb})/I$

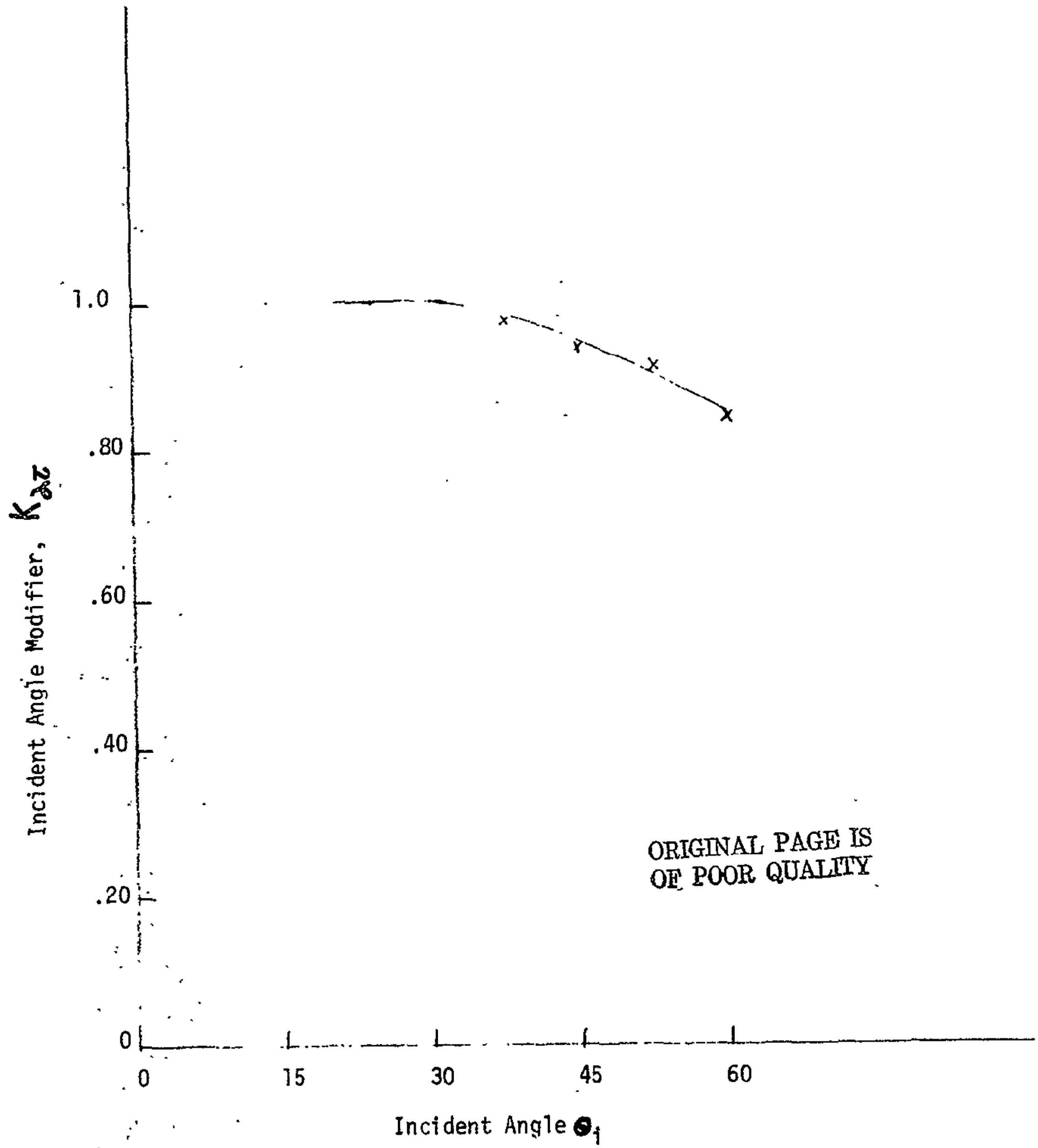


Figure 10. Incident Angle Modifier vs. Incident Angle

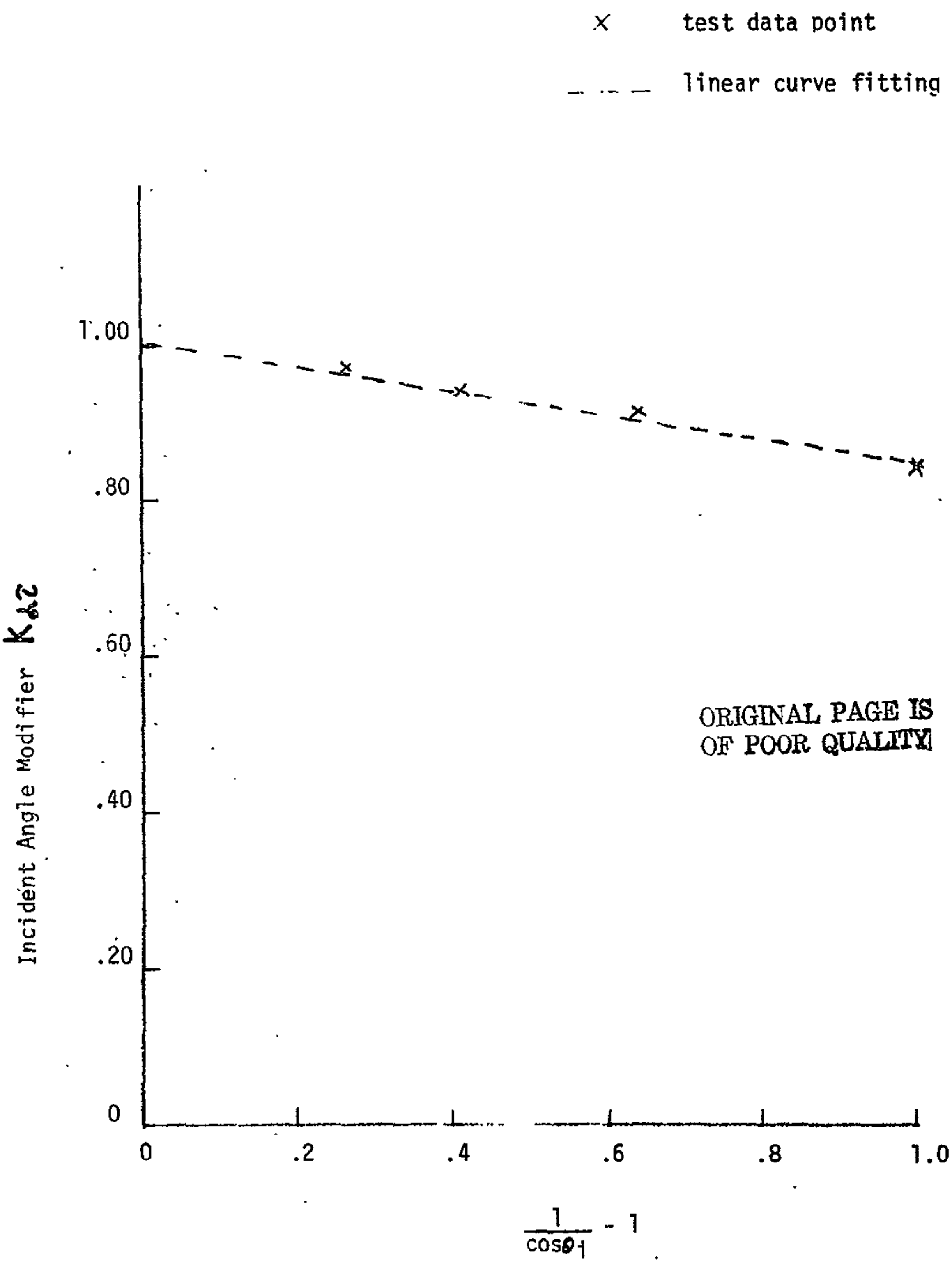


Figure 11. Incident Angle Modifier vs. $\frac{1}{\cos\theta_i} - 1$

TABLE I

SERVICE LOAD STEPS

Step No.	
1	10 pounds per square foot
2	20 pounds per square foot
3	30 pounds per square foot
4	50 pounds per square foot
5	80 pounds per square foot
6	120 pounds per square foot

TABLE II

MEASUREMENT TECHNIQUES

1. Barometric pressure is available from the weather station by calling 837-5655.

2. The ambient temperature is measured with the mini-mite thermocouple bridge.

3. Gauge pressure is determined by entering the indicated gauge voltage in millivolts and pressing B on the TI-SR-52 calculator.*

4. Gauge temperature is indicated on the digital thermometer (DT-1).

5. Differential pressure is determined by the inclined manometer and read in tenths of an inch of water.

6. Diffuse solar flux is determined by entering the millivolts indicated on the digital voltmeter (DVM-2) and pressing D on the calculator.

7. Plate temperatures are indicated on the digital thermometer (DT-2); each must be plugged in separately.

8. Mass flow is determined by the following process.

   Using the SR-52 calculator:

   Enter gauge temperature (°F), press A.
   Enter gauge voltage (MV), press B.
   Enter flow sensor frequency (Hz), press C.

   The result upon pressing C is the flow rate in standard cubic feet per minute.

9. The inlet temperature is determined by use of the National Bureau of Standards table for type T thermocouples with an ice bath. The millivolt reading from DVM-3 is looked up in the NBS table.

*Computation program must be read into the calculator prior to operation. See Appendix II for program documentation.

TABLE III

TEST DATA AND RESULTS FOR SEPCO EFFICIENCY TEST

4/11/77	1	2	3	4	5	6	7	8
Time of starting test	0942	1050	1140	1211	1230	1315	1332	1405
Time of ending test	0947	1055	1145	1216	1235	1320	1337	1410
Mean absorber upper plate temperature °F	143.5	158.5	181	213	210	183	162.5	149.5
Mean absorber lower plate temperature °F	112	128	152	187	191	154	130.5	117.5
Ambient temperature °F	80	81	83	84	84	86	85	85
Mean inlet temperature °F	88.7	106.7	132.7	184.6	184.6	136.8	111.3	97.8
Mean ΔT across collector °F	38.88	42.2	36.2	20.0	21.8	30.0	37.2	33.9
Mean flow rate SCFM	120	118.9	121	120.2	120.0	120.7	120.9	122.3
Mean diffuse solar flux $BTU/Hr \cdot Ft^2$	–	–	–	–	–	–	–	–
Mean total solar flux $BTU/Hr \cdot Ft^2$	254.2	290	295	292	291	278	270	235
Mean wind speed MPH	4	4	3	3	3	4	3	3
Pressure drop across collector in. H_2O	.35	.35	.38	.42	.42	.27	.35	.33
$\left(\frac{T_{f,e} + T_{f,i}}{2} - T_{amb}\right)/I$	0.11	0.162	0.378	0.383	.241	0.241	0.172	0.126
Efficiency η %	77.58	73.16	62.82	34.79	38.07	55.26	70.44	74.67

TABLE III

TEST DATA AND RESULTS FOR SEPCO EFFICIENCY TEST

4/12/77	1	2	3	4	5	6	7	8
Time of starting test	1010	1042	1112	1155	1230	1310	1330	1405
Time of ending test	1015	1047	1117	1200	1235	1315	1335	1410
Mean absorber upper plate temperature °F	180.0	189.5	210	226.5	230	212	195	129
Mean absorber lower plate temperature °F	128.0	141.5	166	202	204	168	144	101
Ambient temperature °F	80.0	81	83	83	84	85	86	86
Mean inlet temperature °F	91.7	105.6	134.4	179.5	179.5	135.2	111.2	97.8
Mean ΔT across collector °F	71.6	68.6	57.6	36.5	36.6	59.2	65.2	58.5
Mean flow rate SCFM	48	48	48	48	48	48	48	48
Mean diffuse solar flux $BTU/Hr \cdot Ft^2$	-	48.6	49.8	52.1	50.6	49.4	48.8	45.8
Mean total solar flux $BTU/Hr \cdot Ft^2$	268.6	282.8	288	289	288.4	271	258	232.3
Mean wind speed MPH	3	3	3	3	3	3	3	3
Pressure drop across collector in. H_2O	-	.07	.09	.07	.07	.08	.07	.07
$\left(\frac{T_{f,e} + T_{f,i}}{2} - T_{amb}\right)/I$	0.177	0.208	0.278	0.396	0.394	0.29	0.224	0.176
Efficiency η %	54.14	49.13	40.6	25.3	25.82	44.37	51.39	51.15

TABLE III

TEST DATA AND RESULTS FOR SEPCO EFFICIENCY TEST

4/14/77	1	2	3	4	5	6	7	8
Time of starting test	0945	1117	1150	1245	1255	1330	1355	1425
Time of ending test	0950	1122	1155	1250	1300	1335	1400	1430
Mean absorber upper plate temperature °F	175	186	200.5	228.4	223.4	200	186	169
Mean absorber lower plate temperature °F	124	148.5	167	201.2	201.2	166	141	126
Ambient temperature °F	80.5	84	82.5	84.5	84.5	85.5	87.5	87.5
Mean inlet temperature °F	88	107.3	130	17918	180.25	134.7	111.6	98.2
Mean ΔT across collector °F	72.35	74.9	59.45	30.93	30.26	53.0	59.8	53.7
Mean flow rate SCFM	48.9	47.5	49.1	51.0	51.6	48.7	47.8	50.1
Mean diffuse solar flux $BTU/Hr \cdot Ft^2$	73.5	61.4	67.4	73.5	73.5	64.4	71.0	73.5
Mean total solar flux $BTU/Hr \cdot Ft^2$	250	288	288	278	280	266.5	254.0	231
Mean wind speed MPH	3	2	3	2	3	3	2	3
Pressure drop across collector in. H_2O	-	-	-	-	-	-	-	-
$\left(\frac{T_{f,e} + T_{f,i}}{2} - T_{amb}\right)/I$	0.175	0.211	0.268	0.398	0.386	0.284	0.212	0.162
Efficiency η %	59.88	52.27	42.89	24.01	23.6	41.09	47.65	49.28

TABLE III

TEST DATA AND RESULTS FOR SEPCO EFFICIENCY TEST

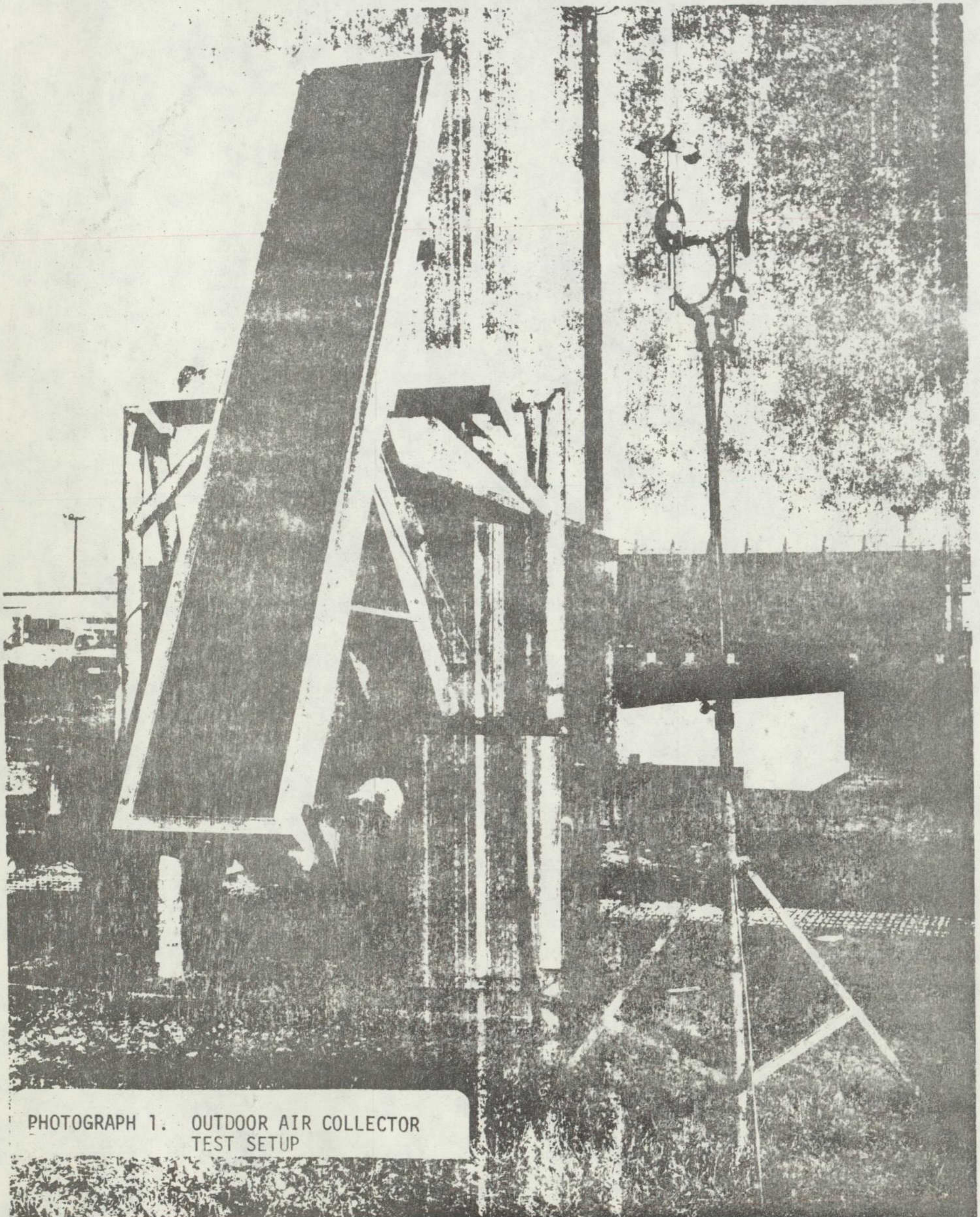
4/15/77	5	6	7	8	9	10	11	12
Time of starting test	947	1012	1037	1117	1148	1242	1312	1357
Time of ending test	953	1017	1042	1122	1153	1247	1317	1402
Mean absorber upper plate temperature °F	135.5	150.5	173	201	201	175.5	162.5	144
Mean absorber lower plate temperature °F	106	120	144	195	194	129	127.5	122
Ambient temperature °F	79	79	81	84	84	85	86	86
Mean inlet temperature °F	90.1	103	127.6	180.25	181.4	130.2	110.3	97.4
Mean ΔT across collector °F	38.64	38.8	36.06	23.5	24.73	35.75	41.1	36.4
Mean flow rate SCFM	120.3	119.8	121.8	120.2	120.5	121.2	120.9	119.5
Mean diffuse solar flux $BTU/Hr \cdot Ft^2$	57.9	59	59.9	60.2	59.9	59.2	61.8	53.9
Mean total solar flux $BTU/Hr \cdot Ft^2$	252	266.7	277.5	291	293.4	286.7	275	241
Mean wind speed MPH	3	3	3	2	2	3	4	3
Pressure drop across collector in. H_2O	-	-	-	-	-	-	-	-
$\left(\frac{T_{f,e} + T_{f,i}}{2} - T_{amb}\right)/I$	0.12	0.163	0.233	0.371	0.374	0.220	0.163	0.123
Efficiency η %	78.06	73.75	66.99	41.13	42.99	63.95	76.5	76.4

TABLE IV

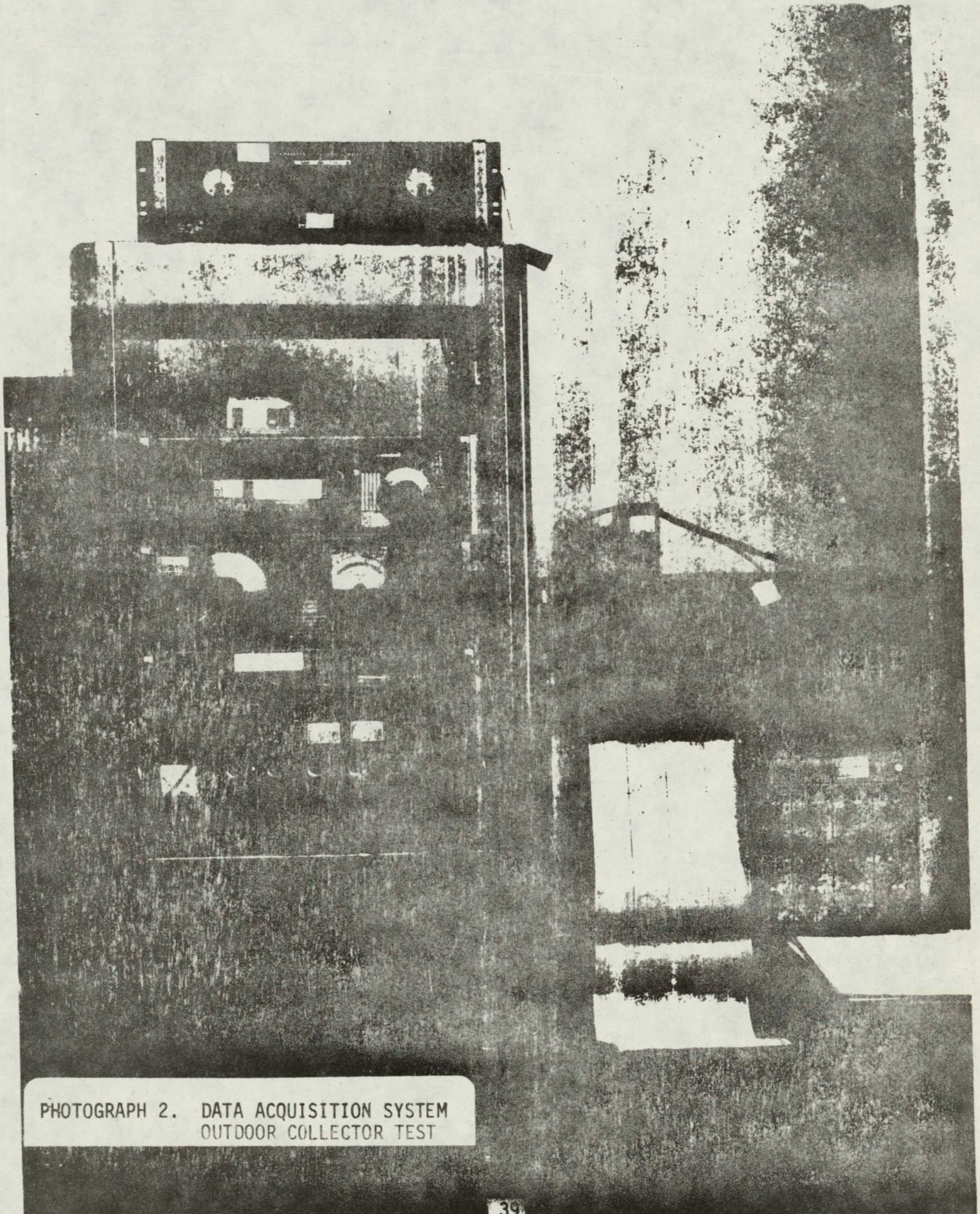
TEST DATA AND RESULTS FOR SEPCO INCIDENT ANGLE MODIFIER TEST

TEST ID / ITEM								
Time of starting test	1417	1450	1515	1545	0745	0815	0845	0915
Time of ending test	1422	1455	1520	1550	0750	0820	0850	0920
Mean absorber upper plate temperature °F	129.0	156	149	141	110	126	145	154
Mean absorber lower plate temperature °F	101.0	121	116	112	90	99	106	113
Ambient temperature °F	86.0	86.5	86	86.5	66	70	75	74
Mean inlet temperature °F	97.0	98.2	97.8	98.2	66	81.2	82.5	86
Mean ΔT across collector °F	59.5	43.85	37.8	29.4	28.97	39.8	50.07	59.2
Mean flow rate SCFM	47.1	48	48.8	49.2	49.5	47	46.9	46.68
Mean diffuse solar flux BTU/Hr·Ft^2	44.6	53.7	46.4	43.4	43.5	47	51.7	55.7
Mean total solar flux BTU/Hr·Ft^2	226	180	170	140.5	128.3	163.2	193.6	223.7
Mean wind speed MPH	3	3	3	3	3	4	3	3
Pressure drop across collector in. H_2O	.07	-	-	-	-	-	-	-
$\left(\frac{T_{f,e} + T_{f,i}}{2} - T_{amb}\right)/I$	0.18	0.187	0.181	0.188	0.226	0.19	0.168	0.186
Efficiency η %	52.47	49.48	45.92	43.5	47.3	48.5	51.35	52.28

PHOTOGRAPHS



PHOTOGRAPH 1. OUTDOOR AIR COLLECTOR TEST SETUP



PHOTOGRAPH 2. DATA ACQUISITION SYSTEM
OUTDOOR COLLECTOR TEST

APPENDIX I

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} + 10 Data I.D. Number 4-11-77-1

Record at Start and Finish of Test

	Start	Finish
Local Time	09:42	09:47
Barometric Pressure (inches of Mercury)	29.79	29.79
Ambient Temperature (°F)	80	80
Mass Flow (SCFM)	120	120
Gauge Temperature (°F)	87	87
ΔP Across Collector ("H_2O)	.35	.35
Diffuse Solar Flux (BTU/Hr·Ft^2)	—	—
Upper Plate Temperature (°F)	143	144
Lower Plate Temperature (°F)	112	112

Record every one minute during test.

Inlet Temperature (°F) 88.7

Mean Inlet Temperature (T_{in} °F) = 88.7

Reduce from Strip Chart after Test

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Mean ΔT (°F)	38.88
Mean Wind Speed (MPH)	4
Mean Solar Flux (BTU/Hr·Ft^2), I	254.2
Mean Mass Flow (SCFM)	120.

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I(BTU/Hr{\cdot}Ft^2) =$ 77.58 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.11

$(T_{in} - T_{amb}) \div I =$ 0.034

TEST RESULTS

Collector Identification SEPCO, "Scloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} + 25 Data I.D. Number 4-11-77-2

Record at Start and Finish of Test

	Start	Finish
Local Time	10:50	10:55
Barometric Pressure (inches of Mercury)	29.77	29.77
Ambient Temperature (°F)	81	81
Mass Flow (SCFM)	118.9	118.9
Gauge Temperature (°F)	108	108
ΔP Across Collector ("H_2O)	.35	.35
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	—	—
Upper Plate Temperature (°F)	158	159
Lower Plate Temperature (°F)	128	128

Record every one minute during test.

Inlet Temperature (°F) 106.7 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 106.7

Reduce from Strip Chart after Test

Mean ΔT (°F)	42.2
Mean Wind Speed (MPH)	4
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	290
Mean Mass Flow (SCFM)	118.9

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2)$ = 73.16 %

$[\ (\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.162

$(T_{in} - T_{amb}) \div I$ = 0.088

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +50 Data I.D. Number 4-11-77-3

Record at Start and Finish of Test

	Start	Finish
Local Time	11:40	11:45
Barometric Pressure (inches of Mercury)	29.76	29.76
Ambient Temperature (°F)	83	83
Mass Flow (SCFM)	121	121
Gauge Temperature (°F)	135	135
ΔP Across Collector ("H_2O)	.38	.38
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	—	—
Upper Plate Temperature (°F)	181	181
Lower Plate Temperature (°F)	152	152

Record every one minute during test.

Inlet Temperature (°F) 132.7

Mean Inlet Temperature (T_{in} °F) = 132.7

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Reduce from Strip Chart after Test

Mean ΔT (°F)	36.2
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	295
Mean Mass Flow (SCFM)	121

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 62.82 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.233

$(T_{in} - T_{amb}) \div I =$ 0.168

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area $25.52\ ft^2$ Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +100 Data I.D. Number 4-11-77-4

Record at Start and Finish of Test

	Start	Finish
Local Time	12:11	12:16
Barometric Pressure (inches of Mercury)	29.75	29.75
Ambient Temperature (°F)	84	84
Mass Flow (SCFM)	120.2	120.2
Gauge Temperature (°F)	190.	190.
ΔP Across Collector ("H_2O)	.42	.42
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	—	—
Upper Plate Temperature (°F)	213	213
Lower Plate Temperature (°F)	197	197

Record every one minute during test.

Inlet Temperature (°F) 184.6 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 184.6

Reduce from Strip Chart after Test

Mean ΔT (°F)	20.0
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	292
Mean Mass Flow (SCFM)	120.2

Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T / Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2) =$ 34.79 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.378

$(T_{in} - T_{amb}) \div I =$ 0.344

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +100 Data I.D. Number 4-11-77-5

Record at Start and Finish of Test

	Start	Finish
Local Time	12:30	12:35
Barometric Pressure (inches of Mercury)	29.74	29.74
Ambient Temperature (°F)	84	84
Mass Flow (SCFM)	120	120
Gauge Temperature (°F)	190	190
ΔP Across Collector ("H_2O)	.42	.42
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	—	—
Upper Plate Temperature (°F)	210	210
Lower Plate Temperature (°F)	191	191

Record every one minute during test.

Inlet Temperature (°F) 184.6

Mean Inlet Temperature (T_{in} °F) = 184.6

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Reduce from Strip Chart after Test

Mean ΔT (°F)	21.8
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	291
Mean Mass Flow (SCFM)	120

Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 38.07 %

$[\ (\Delta T \div 2) + T_{in} - T_{amb}]\ \div I =$ 0.383

$(T_{in} - T_{amb}) \div I =$ 0.346

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +50 Data I.D. Number 4-11-77-6

Record at Start and Finish of Test

	Start	Finish
Local Time	13:15	13:20
Barometric Pressure (inches of Mercury)	29.73	29.73
Ambient Temperature (°F)	86	86
Mass Flow (SCFM)	120.7	120.7
Gauge Temperature (°F)	142	142
ΔP Across Collector ("H_2O)	.37	.37
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	—	—
Upper Plate Temperature (°F)	183	183
Lower Plate Temperature (°F)	154	154

Record every one minute during test.

Inlet Temperature (°F) 136.8

Mean Inlet Temperature (T_{in} °F) = 136.8

Reduce from Strip Chart after Test

Mean ΔT (°F)	30.0
Mean Wind Speed (MPH)	4
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	278
Mean Mass Flow (SCFM)	120.7

Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T/Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 55.26 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.241

$(T_{in} - T_{amb}) \div I =$ 0.183

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +25 Data I.D. Number 4-11-77-7

Record at Start and Finish of Test

	Start	Finish
Local Time	13:32	13:37
Barometric Pressure (inches of Mercury)	29.73	29.73
Ambient Temperature (°F)	85	85
Mass Flow (SCFM)	120.9	120.9
Gauge Temperature (°F)	113	113
ΔP Across Collector ("H_2O)	.35	.35
Diffuse Solar Flux (BTU/Hr·Ft^2)	—	—
Upper Plate Temperature (°F)	163	162
Lower Plate Temperature (°F)	131	130

Record every one minute during test.

Inlet Temperature (°F) 111.3

Mean Inlet Temperature (T_{in} °F) = 111.3

Reduce from Strip Chart after Test

Mean ΔT (°F)	37.2
Mean Wind Speed (MPH)	3
Mean Solar Flux (BTU/Hr·Ft^2), I	270
Mean Mass Flow (SCFM)	120.9

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2) =$ 70.44 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.172

$(T_{in} - T_{amb}) \div I =$ 0.097

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/11/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-11-77-8

Record at Start and Finish of Test

	Start	Finish
Local Time	14:05	14:10
Barometric Pressure (inches of Mercury)	29.72	29.72
Ambient Temperature (°F)	85	85
Mass Flow (SCFM)	122.3	122.3
Gauge Temperature (°F)	98	98
ΔP Across Collector ("H_2O)	.33	.33
Diffuse Solar Flux (BTU/Hr·Ft^2)	—	—
Upper Plate Temperature (°F)	150	149
Lower Plate Temperature (°F)	118	117

Record every one minute during test.

Inlet Temperature (°F) 97.8 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 97.8

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Reduce from Strip Chart after Test

Mean ΔT (°F)	33.9
Mean Wind Speed (MPH)	3
Mean Solar Flux (BTU/Hr·Ft^2), I	235
Mean Mass Flow (SCFM)	122.3

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I\,(BTU/Hr\cdot Ft^2) =$ 74.67 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.126

$(T_{in} - T_{amb}) \div I =$ 0.054

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-12-77-1

Record at Start and Finish of Test

	Start	Finish
Local Time	10:10	10:15
Barometric Pressure (inches of Mercury)	29.79	29.79
Ambient Temperature (°F)	80.	80
Mass Flow (SCFM)	48.	48.
Gauge Temperature (°F)	93.	93.
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	40.4	45.6
Upper Plate Temperature (°F)	180.	180.
Lower Plate Temperature (°F)	128.	128.

Record every one minute during test.

Inlet Temperature (°F) 91.7

Mean Inlet Temperature (T_{in} °F) = 91.7

Reduce from Strip Chart after Test

Mean ΔT (°F) 71.6
Mean Wind Speed (MPH) 3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I 268.6
Mean Mass Flow (SCFM) 48.

Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T / Q_t {*} A = 0.0423 {*} \dot{m}(SCFM) {*} \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2)$ = 54.14 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.177

$(T_{in} - T_{amb}) \div I$ = 0.043

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +25°F Data I.D. Number 4-12-77-2

Record at Start and Finish of Test

	Start	Finish
Local Time	10:42	10:47
Barometric Pressure (inches of Mercury)	29.77	29.77
Ambient Temperature (°F)	81	81
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	108	108
ΔP Across Collector ("H_2O)	.07	.07
Diffuse Solar Flux (BTU/Hr·Ft^2)	49.7	47.6
Upper Plate Temperature (°F)	189	190
Lower Plate Temperature (°F)	141	142

Record every one minute during test.

Inlet Temperature (°F) 105.6

Mean Inlet Temperature (T_{in} °F) = 105.6

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Reduce from Strip Chart after Test

Mean ΔT (°F)	68.6
Mean Wind Speed (MPH)	3
Mean Solar Flux (BTU/Hr·Ft^2), I	282.8
Mean Mass Flow (SCFM)	48.

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I\,(BTU/Hr\cdot Ft^2)$ = 49.13 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.208

$(T_{in} - T_{amb}) \div I$ = 0.086

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} + 50 Data I.D. Number 4-12-77-3

Record at Start and Finish of Test

	Start	Finish
Local Time	11:12	11:17
Barometric Pressure (inches of Mercury)	29.75	29.75
Ambient Temperature (°F)	83	83
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	140	140
ΔP Across Collector ("H_2O)	.09	.09
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	49.7	49.9
Upper Plate Temperature (°F)	210	210
Lower Plate Temperature (°F)	166	166

Record every one minute during test.

Inlet Temperature (°F) 134.4

Mean Inlet Temperature (T_{in} °F) = 134.4

Reduce from Strip Chart after Test

Mean ΔT (°F)	57.6
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	288
Mean Mass Flow (SCFM)	48.

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Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T / Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2) =$ 40.6 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.278

$(T_{in} - T_{amb}) \div I =$ 0.18

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +100 Data I.D. Number 4-12-77-4

Record at Start and Finish of Test

	Start	Finish
Local Time	11:55	12:00
Barometric Pressure (inches of Mercury)	29.73	29.73
Ambient Temperature (°F)	83	83
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	190	190
ΔP Across Collector ("H_2O)	.07	.07
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	52.4	57.8
Upper Plate Temperature (°F)	228	225
Lower Plate Temperature (°F)	202	202

Record every one minute during test.

Inlet Temperature (°F) 179.5

Mean Inlet Temperature (T_{in} °F) = 179.5

Reduce from Strip Chart after Test

Mean ΔT (°F)	36.5
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	289
Mean Mass Flow (SCFM)	48

Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2)$ = 25.3 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.396

$(T_{in} - T_{amb}) \div I$ = 0.334

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +100 Data I.D. Number 4-12-77-5

Record at Start and Finish of Test

	Start	Finish
Local Time	12:30	12:35
Barometric Pressure (inches of Mercury)	29.71	29.71
Ambient Temperature (°F)	84	84
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	190	190
ΔP Across Collector ("H_2O)	.07	.07
Diffuse Solar Flux (BTU/Hr·Ft^2)	50.6	50.6
Upper Plate Temperature (°F)	230	230
Lower Plate Temperature (°F)	204	204

Record every one minute during test.

Inlet Temperature (°F) 179.5 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 179.5

Reduce from Strip Chart after Test

Mean ΔT (°F)	36.6
Mean Wind Speed (MPH)	2
Mean Solar Flux (BTU/Hr·Ft^2), I	288.4
Mean Mass Flow (SCFM)	48

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I\,(BTU/Hr \cdot Ft^2)$ = 25.82 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.394

$(T_{in} - T_{amb}) \div I$ = 0.33

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +50 Data I.D. Number 4-12-77-6

Record at Start and Finish of Test

	Start	Finish
Local Time	1310	1315
Barometric Pressure (inches of Mercury)	29.70	29.70
Ambient Temperature (°F)	85	85
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	141	135
ΔP Across Collector ("H_2O)	.08	.08
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	49.4	49.4
Upper Plate Temperature (°F)	212	211
Lower Plate Temperature (°F)	168	168

Record every one minute during test.

Inlet Temperature (°F) 135.2

Mean Inlet Temperature (T_{in} °F) = 135.2

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Reduce from Strip Chart after Test

Mean ΔT (°F)	59.2
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	271
Mean Mass Flow (SCFM)	48

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423* \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2)$ = 44.37 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.29

$(T_{in} - T_{amb}) \div I$ = 0.18

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} + 25 Data I.D. Number 4-12-77-7

Record at Start and Finish of Test

	Start	Finish
Local Time	13:30	13:35
Barometric Pressure (inches of Mercury)	29.69	29.69
Ambient Temperature (°F)	86	86
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	114	114
ΔP Across Collector ("H_2O)	.07	.07
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	49.1	48.5
Upper Plate Temperature (°F)	195	195
Lower Plate Temperature (°F)	144	144

Record every one minute during test.

Inlet Temperature (°F) 111.2

Mean Inlet Temperature (T_{in} °F) = 111.2

Reduce from Strip Chart after Test

Mean ΔT (°F) 65.2
Mean Wind Speed (MPH) 3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I 258
Mean Mass Flow (SCFM) 48

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I\,(BTU/Hr \cdot Ft^2)$ = 51.39 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.224

$(T_{in} - T_{amb}) \div I$ = 0.097

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48. SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-12-77-8

Record at Start and Finish of Test

	Start	Finish
Local Time	14:05	14:10
Barometric Pressure (inches of Mercury)	29.67	29.67
Ambient Temperature (°F)	86	86
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	101	101
ΔP Across Collector ("H_2O)	.07	.07
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	46.1	45.5
Upper Plate Temperature (°F)	129	129
Lower Plate Temperature (°F)	101	101

Record every one minute during test.

Inlet Temperature (°F) 97.8 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 97.8

Reduce from Strip Chart after Test

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Mean ΔT (°F) 58.5
Mean Wind Speed (MPH) 3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I 232.3
Mean Mass Flow (SCFM) 48

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 51.15 %

$[\ (\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.176

$(T_{in} - T_{amb}) \div I =$ 0.05

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/12/77 Test Identification Incident Angle Modifier Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-12-77-9

Record at Start and Finish of Test

	Start	Finish
Local Time	14:17	14:22
Barometric Pressure (inches of Mercury)	29.67	29.67
Ambient Temperature (°F)	86	86
Mass Flow (SCFM)	47.1	47.1
Gauge Temperature (°F)	101	101
ΔP Across Collector ("H_2O)	.07	.07
Diffuse Solar Flux (BTU/Hr·Ft^2)	45.2	44.3
Upper Plate Temperature (°F)	129	129
Lower Plate Temperature (°F)	101	101

Record every one minute during test.

Inlet Temperature (°F) 97.0 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 97.0

Reduce from Strip Chart after Test

Mean ΔT (°F) 59.5
Mean Wind Speed (MPH) 3
Mean Solar Flux (BTU/Hr·Ft^2), I 226
Mean Mass Flow (SCFM) 47.1

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I(BTU/Hr\cdot Ft^2)$ = 52.47 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.18

$(T_{in} - T_{amb}) \div I$ = 0.048

TEST RESULTS

Collector Identification: SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-14-77-1

Record at Start and Finish of Test

	Start	Finish
Local Time	09:45	09:50
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	80.5	80.5
Mass Flow (SCFM)	48.9	48.9
Gauge Temperature (°F)	90.	90.
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	73.5	73.5
Upper Plate Temperature (°F)	174	176
Lower Plate Temperature (°F)	123	125

Record every one minute during test.

Inlet Temperature (°F) 88.0

Mean Inlet Temperature (T_{in} °F) = 88.0

Reduce from Strip Chart after Test

Mean ΔT (°F) 72.35
Mean Wind Speed (MPH) 3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I 250
Mean Mass Flow (SCFM) 48.9

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Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I\,(BTU/Hr \cdot Ft^2) =$ 57.88 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.175

$(T_{in} - T_{amb}) \div I =$ 0.03

TEST RESULTS

Collector Identification: SEPCO, "Soloron" Model EF-212, SN-002

Date: 4/14/77 Test Identification: Efficiency Test

Observers: J. Chiou, J. Dysart

Collector Tilt Angle: 27° Collector Azimuth Angle: 0°

Collector Aperture Area: 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate: 48 SCFM

Inlet Temperature: T_{amb} + 25 Data I.D. Number: 4-14-77-2

Record at Start and Finish of Test

	Start	Finish
Local Time	11.17	11:22
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	84	84
Mass Flow (SCFM)	47.5	47.5
Gauge Temperature (°F)	111	111
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	61.4	61.4
Upper Plate Temperature (°F)	186	186
Lower Plate Temperature (°F)	149	148

Record every one minute during test.

Inlet Temperature (°F) 107.3 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 107.3

Reduce from Strip Chart after Test

Mean ΔT (°F)	74.9
Mean Wind Speed (MPH)	2
Mean Solar Flux (BTU/Hr·Ft^2), I	288
Mean Mass Flow (SCFM)	47.5

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I\ (BTU/Hr{\cdot}Ft^2)$ = 52.27 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.211

$(T_{in} - T_{amb}) \div I$ = 0.081

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +50 Data I.D. Number 4-14-77-3

Record at Start and Finish of Test

	Start	Finish
Local Time	11:50	11:55
Barometric Pressure (inches of Mercury)	29.39	29.39
Ambient Temperature (°F)	82.5	82.5
Mass Flow (SCFM)	49	49.2
Gauge Temperature (°F)	135	135
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	67.4	67.4
Upper Plate Temperature (°F)	201	200
Lower Plate Temperature (°F)	167	167

Record every one minute during test.

Inlet Temperature (°F) 130.0

Mean Inlet Temperature (T_{in} °F) = 130.0

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Reduce from Strip Chart after Test

Mean ΔT (°F) 59.45
Mean Wind Speed (MPH) 3
Mean Solar Flux (BTU/Hr·Ft^2), I 288
Mean Mass Flow (SCFM) 49.1

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2)$ = 42.89 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.268

$(T_{in} - T_{amb}) \div I$ = 0.165

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area $25.52\ ft^2$ Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} + 100 Data I.D. Number 4-14-77-4

Record at Start and Finish of Test

	Start	Finish
Local Time	12:45	12:50
Barometric Pressure (inches of Mercury)	29.41	29.41
Ambient Temperature (°F)	84.5	84.5
Mass Flow (SCFM)	51	51
Gauge Temperature (°F)	191	191
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	73.5	73.5
Upper Plate Temperature (°F)	228.4	228.4
Lower Plate Temperature (°F)	201.2	201.2

Record every one minute during test.

Inlet Temperature (°F) 178.8

Mean Inlet Temperature (T_{in} °F) = 178.8

Reduce from Strip Chart after Test

Mean ΔT (°F)	30.93
Mean Wind Speed (MPH)	2
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	278
Mean Mass Flow (SCFM)	51

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2) =$ 24.01 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.398

$(T_{in} - T_{amb}) \div I =$ 0.343

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area $25.52\ ft^2$ Height of Collector (Inlet) 61"

(Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} + 100 Data I.D. Number 4-14-77-5

Record at Start and Finish of Test

	Start	Finish
Local Time	12:55	13:00
Barometric Pressure (inches of Mercury)	29.42	29.42
Ambient Temperature (°F)	84.5	84.5
Mass Flow (SCFM)	57.6	57.6
Gauge Temperature (°F)	190	190.
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	73.5	73.5
Upper Plate Temperature (°F)	223.4	223.4
Lower Plate Temperature (°F)	201.2	201.2

Record every one minute during test.

Inlet Temperature (°F) 180.25

Mean Inlet Temperature (T_{in} °F) = 180.25

Reduce from Strip Chart after Test

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Mean ΔT (°F) 30.26

Mean Wind Speed (MPH) 3

Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I 280.

Mean Mass Flow (SCFM) 57.6

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2)$ = 23.6 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.396

$(T_{in} - T_{amb}) \div I$ = 0.342

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area $25.52\ ft^2$ Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature $T_{amb} + 50$ Data I.D. Number 4-14-77-6

Record at Start and Finish of Test

	Start	Finish
Local Time	13:30	13:35
Barometric Pressure (inches of Mercury)	29.43	29.43
Ambient Temperature (°F)	85.5	85.5
Mass Flow (SCFM)	48.7	48.7
Gauge Temperature (°F)	141	141
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	64.4	64.4
Upper Plate Temperature (°F)	201	199
Lower Plate Temperature (°F)	165	165

Record every one minute during test.

Inlet Temperature (°F) 134.7 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 134.7

Reduce from Strip Chart after Test

Mean ΔT (°F)	53.0
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	266.5
Mean Mass Flow (SCFM)	48.7

Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2) =$ 41.0 %

$[\ (\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.285

$(T_{in} - T_{amb}) \div I =$ 0.185

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +25 Data I.D. Number 4-14-77-7

Record at Start and Finish of Test

	Start	Finish
Local Time	13:55	14:00
Barometric Pressure (inches of Mercury)	29.42	28.42
Ambient Temperature (°F)	87.5	87.5
Mass Flow (SCFM)	47.78	47.78
Gauge Temperature (°F)	115	115
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	70.5	73.5
Upper Plate Temperature (°F)	186	186
Lower Plate Temperature (°F)	141	141

Record every one minute during test.

Inlet Temperature (°F) 111.6 ___ ___ ___ ___

Mean Inlet Temperature (T_{in} °F) = 111.6

Reduce from Strip Chart after Test

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Mean ΔT (°F)	59.8
Mean Wind Speed (MPH)	2
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	254
Mean Mass Flow (SCFM)	47.78

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 47.65 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.212

$(T_{in} - T_{amb}) \div I =$ 0.095

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area $25.52\ ft^2$ Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature $T_{amb}+10$ Data I.D. Number 4-14-77-8

Record at Start and Finish of Test

	Start	Finish
Local Time	14:25	14:30
Barometric Pressure (inches of Mercury)	29.36	29.36
Ambient Temperature (°F)	87.5	87.5
Mass Flow (SCFM)	50.1	50.1
Gauge Temperature (°F)	88	88
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr\cdot Ft^2$)	73.5	73.5
Upper Plate Temperature (°F)	168	168
Lower Plate Temperature (°F)	126	126

Record every one minute during test.

Inlet Temperature (°F) 88.2

Mean Inlet Temperature (T_{in} °F) = 88.2

Reduce from Strip Chart after Test

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Mean ΔT (°F)	53.7
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr\cdot Ft^2$), I	231
Mean Mass Flow (SCFM)	50.1

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I\,(BTU/Hr\cdot Ft^2) =$ 49.28%

$[\ (\Delta T\div 2) + T_{in} - T_{amb}]\ \div I =$ 0.162

$(T_{in} - T_{amb}) \div I =$ 0.046

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Time Constant Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 25° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-14-77-9

Record at Start and Finish of Test

	Start	Finish
Local Time	14:33	14:40
Barometric Pressure (inches of Mercury)	29.36	29.36
Ambient Temperature (°F)	87	87
Mass Flow (SCFM)	50	50
Gauge Temperature (°F)	99	99
ΔP Across Collector ("H_2O)	0.07	0.07
Diffuse Solar Flux (BTU/Hr·Ft^2)	66	0
Upper Plate Temperature (°F)	168	102
Lower Plate Temperature (°F)	125	100

Record every one minute during test.

Inlet Temperature (°F) 98.2 98.2

Mean Inlet Temperature (T_{in} °F) = 98.2

Reduce from Strip Chart after Test

	start	Finish
Mean ΔT (°F)	57	
Mean Wind Speed (MPH)	3	3
Mean Solar Flux (BTU/Hr·Ft^2)	230	0
Mean Mass Flow (SCFM)	49.5	49.5

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423*\dot{m}(SCFM)*\Delta T\,(°F) \div Q(BTU/Hr\cdot Ft^2)$ = —

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div Q$ = —

$(T_{in} - T_{amb}) \div Q$ = —

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Incident Angle Modifier Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-14-77-10

Record at Start and Finish of Test

	Start	Finish
Local Time	14:50	14:55
Barometric Pressure (inches of Mercury)	29.35	29.35
Ambient Temperature (°F)	86.5	86.5
Mass Flow (SCFM)	48	48
Gauge Temperature (°F)	99	99
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	52.4	52.4
Upper Plate Temperature (°F)	157	156
Lower Plate Temperature (°F)	122	120

Record every one minute during test.

Inlet Temperature (°F) 98.2

Mean Inlet Temperature (T_{in} °F) = 98.2

Reduce from Strip Chart after Test

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Mean ΔT (°F)	43.85
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	180
Mean Mass Flow (SCFM)	48

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 49.48 %

$[\ (\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.187

$(T_{in} - T_{amb}) \div I =$ 0.065

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Incident Angle Modifier Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-14-77-11

Record at Start and Finish of Test

	Start	Finish
Local Time	15:15	15:20
Barometric Pressure (inches of Mercury)	29.35	29.35
Ambient Temperature (°F)	86	86
Mass Flow (SCFM)	48.8	48.8
Gauge Temperature (°F)	99	99
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	46.4	46.4
Upper Plate Temperature (°F)	150	149
Lower Plate Temperature (°F)	117	116

Record every one minute during test.

Inlet Temperature (°F) 97.8 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 97.8

Reduce from Strip Chart after Test

Mean ΔT (°F)	37.8
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	170
Mean Mass Flow (SCFM)	48.8

Calculate from Reduced Data

$\eta = \dot{m} C_p \Delta T / Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 45.92 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.181

$(T_{in} - T_{amb}) \div I =$ 0.069

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/14/77 Test Identification Incident Angle Modifier Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} + 10 Data I.D. Number 4-14-77-12

Record at Start and Finish of Test

	Start	Finish
Local Time	15:45	15:50
Barometric Pressure (inches of Mercury)	29.33	29.33
Ambient Temperature (°F)	86.5	86.5
Mass Flow (SCFM)	49.2	49.2
Gauge Temperature (°F)	88	89
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	40.4	46.4
Upper Plate Temperature (°F)	143	140
Lower Plate Temperature (°F)	113	112

Record every one minute during test.

Inlet Temperature (°F) 98.2

Mean Inlet Temperature (T_{in} °F) = 98.2

Reduce from Strip Chart after Test

Mean ΔT (°F) 29.4
Mean Wind Speed (MPH) 3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I 140.5
Mean Mass Flow (SCFM) 49.2

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM)\ {*}\ \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 43.5

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.188

$(T_{in} - T_{amb}) \div I =$ 0.083

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Incident Angle Modifier Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} Data I.D. Number 4-15-77-1

Record at Start and Finish of Test

	Start	Finish
Local Time	07:45	07:50
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	66	66
Mass Flow (SCFM)	49.5	49.5
Gauge Temperature (°F)	67	67
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	43.5	43.5
Upper Plate Temperature (°F)	107	113
Lower Plate Temperature (°F)	90	91

Record every one minute during test.

Inlet Temperature (°F) 66

Mean Inlet Temperature (T_{in} °F) = 66

Reduce from Strip Chart after Test

Mean ΔT (°F)	28.97
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	128.3
Mean Mass Flow (SCFM)	49.5

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Calculate from Reduced Data

$\eta = \dot{m}C_p \Delta T / Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 47.3 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.226

$(T_{in} - T_{amb}) \div I =$ 0.

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Incident Angle Modifier Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-15-77-2

Record at Start and Finish of Test

	Start	Finish
Local Time	08:15	08.20
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	70	70
Mass Flow (SCFM)	47	47
Gauge Temperature (°F)	81	81
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	47	47
Upper Plate Temperature (°F)	124	128
Lower Plate Temperature (°F)	98	100

Record every one minute during test.

Inlet Temperature (°F) 81.2 ____ ____ ____ ____

Mean Inlet Temperature (T_{in} °F) = 81.2

Reduce from Strip Chart after Test

Mean ΔT (°F)	39.8
Mean Wind Speed (MPH)	4
Mean Solar Flux (BTU/Hr·Ft^2), I	163.2
Mean Mass Flow (SCFM)	47

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423*\ \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr\cdot Ft^2) =$ 48.5 %

$[\ (\Delta T \div 2) + T_{in} - T_{amb}]\ \div I =$ 0.19

$(T_{in} - T_{amb}) \div I =$ 0.068

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Incident Angle Modifier Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-15-77-3

Record at Start and Finish of Test

	Start	Finish
Local Time	08:45	08.50
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	75	75
Mass Flow (SCFM)	46.8	47
Gauge Temperature (°F)	83	83
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	51.7	51.7
Upper Plate Temperature (°F)	143	148
Lower Plate Temperature (°F)	106	107

Record every one minute during test.

Inlet Temperature (°F) 82.5

Mean Inlet Temperature (T_{in} °F) = 82.5

Reduce from Strip Chart after Test

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Mean ΔT (°F)	50.07
Mean Wind Speed (MPH)	3
Mean Solar Flux (BTU/Hr·Ft^2), I	193.6
Mean Mass Flow (SCFM)	46.9

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423*\dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr \cdot Ft^2) =$ 51.35 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.168

$(T_{in} - T_{amb}) \div I =$ 0.038

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Incident Angle test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 25° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 48 SCFM

Inlet Temperature T_{amb} + 10 Data I.D. Number 4-15-77-4

Record at Start and Finish of Test

	Start	Finish
Local Time	09:15	09:20
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	74	74
Mass Flow (SCFM)	46.70	46.66
Gauge Temperature (°F)	86	86
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	55.7	55.7
Upper Plate Temperature (°F)	153	155
Lower Plate Temperature (°F)	112	113

Record every one minute during test.

Inlet Temperature (°F) 86 86

Mean Inlet Temperature (T_{in} °F) = 86

Reduce from Strip Chart after Test

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Mean ΔT (°F)	59.2
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$)	223.7
Mean Mass Flow (SCFM)	46.68

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423*\dot{m}(SCFM) * \Delta T\ (°F) \div Q(BTU/Hr \cdot Ft^2)$ = 52.28%

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div Q$ = 0.186

$(T_{in} - T_{amb}) \div Q$ = 0.053

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area $25.52\ ft^2$ Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-15-77-5

Record at Start and Finish of Test

	Start	Finish
Local Time	09:47	09:53
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	79	79
Mass Flow (SCFM)	120.3	120.3
Gauge Temperature (°F)	89	89
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	57.9	57.9
Upper Plate Temperature (°F)	135	136
Lower Plate Temperature (°F)	106	106

Record every one minute during test.

Inlet Temperature (°F) 90.1

Mean Inlet Temperature (T_{in} °F) = 90.1

Reduce from Strip Chart after Test

Mean ΔT (°F) 38.64
Mean Wind Speed (MPH) 3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I 252
Mean Mass Flow (SCFM) 120.3

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423*\dot{m}(SCFM) * \Delta T\ (°F) \div I\,(BTU/Hr \cdot Ft^2)$ = 78.06 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.120

$(T_{in} - T_{amb}) \div I$ = 0.044

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +25 Data I.D. Number 4-15-77-6

Record at Start and Finish of Test

	Start	Finish
Local Time	10:12	10:17
Barometric Pressure (inches of Mercury)	29.44	29.44
Ambient Temperature (°F)	79	79
Mass Flow (SCFM)	119.8	119.8
Gauge Temperature (°F)	104	104
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	59	59
Upper Plate Temperature (°F)	150	151
Lower Plate Temperature (°F)	120	120

Record every one minute during test.

Inlet Temperature (°F) 103.

Mean Inlet Temperature (T_{in} °F) = 103.

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Reduce from Strip Chart after Test

Mean ΔT (°F) 38.8

Mean Wind Speed (MPH) 3

Mean Solar Flux (BTU/Hr·Ft^2), I 266.7

Mean Mass Flow (SCFM) 119.8

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I(BTU/Hr{\cdot}Ft^2)$ = 73.7

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.163

$(T_{in} - T_{amb}) \div I$ = 0.09

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature $T_{amb} + 50$ Data I.D. Number 4-15-77-7

Record at Start and Finish of Test

	Start	Finish
Local Time	10:37	10:42
Barometric Pressure (inches of Mercury)	29.40	29.40
Ambient Temperature (°F)	81.	81
Mass Flow (SCFM)	121.8	121.8
Gauge Temperature (°F)	128.	128.
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux ($BTU/Hr \cdot Ft^2$)	59.9	59.9
Upper Plate Temperature (°F)	173.	173.
Lower Plate Temperature (°F)	144.	144.

Record every one minute during test.

Inlet Temperature (°F) 127.6

Mean Inlet Temperature (T_{in} °F) = 127.6

Reduce from Strip Chart after Test

Mean ΔT (°F)	36.06
Mean Wind Speed (MPH)	3
Mean Solar Flux ($BTU/Hr \cdot Ft^2$), I	277.5
Mean Mass Flow (SCFM)	121.8

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423*\dot{m}(SCFM)*\Delta T\,(°F) \div I\,(BTU/Hr \cdot Ft^2) =$ 66.99 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.233

$(T_{in} - T_{amb}) \div I =$ 0.168

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

Observers J. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +100 Data I.D. Number 4-15-77-8

Record at Start and Finish of Test

	Start	Finish
Local Time	11:17	11:22
Barometric Pressure (inches of Mercury)	29.40	29.40
Ambient Temperature (°F)	84	84
Mass Flow (SCFM)	120.2	120.2
Gauge Temperature (°F)	185	185
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	60.2	60.2
Upper Plate Temperature (°F)	201	201
Lower Plate Temperature (°F)	195	195

Record every one minute during test.

Inlet Temperature (°F) 180.25

Mean Inlet Temperature (T_{in} °F) = 180.25

Reduce from Strip Chart after Test

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Mean ΔT (°F)	23.5
Mean Wind Speed (MPH)	2
Mean Solar Flux (BTU/Hr·Ft^2), I	291
Mean Mass Flow (SCFM)	120.2

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t*A = 0.0423*\dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr\cdot Ft^2) =$ 41.13 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.371

$(T_{in} - T_{amb}) \div I =$ 0.331

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

Testers C. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +100 Data I.D. Number 4-15-77-9

Record at Start and Finish of Test

	Start	Finish
Local Time	11:48	11:53
Barometric Pressure (inches of Mercury)	29.38	29.38
Ambient Temperature (°F)	84	84
Mass Flow (SCFM)	120.5	120.5
Gauge Temperature (°F)	184	184
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	59.9	59.9
Upper Plate Temperature (°F)	201.	201.
Lower Plate Temperature (°F)	194.	194.

Record every one minute during test.

Inlet Temperature (°F) 181.4

Mean Inlet Temperature (T_{in} °F) = 181.4

Reduce from Strip Chart after Test

Mean ΔT (°F)	24.73
Mean Wind Speed (MPH)	2
Mean Solar Flux (BTU/Hr·Ft^2), I	293.4
Mean Mass Flow (SCFM)	120.5

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t{*}A = 0.0423{*}\ \dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr{\cdot}Ft^2) =$ 42.99 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I =$ 0.374

$(T_{in} - T_{amb}) \div I =$ 0.332

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

... F. Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61" (Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} + 50 Data I.D. Number 4-15-77-10

Record at Start and Finish of Test

	Start	Finish
Local Time	12:42	12:47
Barometric Pressure (inches of Mercury)	29.37	29.37
Ambient Temperature (°F)	85	85
Mass Flow (SCFM)	121.2	121.2
Gauge Temperature (°F)	132	132
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft^2)	59.1	59.2
Upper Plate Temperature (°F)	175	176
Lower Plate Temperature (°F)	129	129

Record every one minute during test.

Inlet Temperature (°F) 130.2

Mean Inlet Temperature (T_{in} °F) = 130.2

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Reduce from Strip Chart after Test

Mean ΔT (°F)	35.75
Mean Wind Speed (MPH)	3
Mean Solar Flux (BTU/Hr·Ft^2), I	286.7
Mean Mass Flow (SCFM)	121.2

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2)$ = 63.95 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = 0.220

$(T_{in} - T_{amb}) \div I$ = 0.157

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

[illegible] J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature $T_{amb} + 25$ Data I.D. Number 4-15-77-11

Record at Start and Finish of Test

	Start	Finish
Local Time	13:12	13:17
Barometric Pressure (inches of Mercury)	29.33	29.33
Ambient Temperature (°F)	86	86
Mass Flow (SCFM)	120.9	120.9
Gauge Temperature (°F)	111	111
ΔP Across Collector ("H_2O)	—	—
Diffuse Solar Flux (BTU/Hr·Ft²)	61.7	61.8
Upper Plate Temperature (°F)	163	162
Lower Plate Temperature (°F)	128	127

Record every one minute during test.

Inlet Temperature (°F) 110.3

Mean Inlet Temperature (T_{in} °F) = 110.3

Reduce from Strip Chart after Test

Mean ΔT (°F)	41.1
Mean Wind Speed (MPH)	4
Mean Solar Flux (BTU/Hr·Ft²), I	275
Mean Mass Flow (SCFM)	120.9

Calculate from Reduced Data

$\eta = \dot{m}c_p \Delta T/Q_t A$ = 0.0423* $\dot{m}$(SCFM) * ΔT (°F) ÷ I(BTU/Hr·Ft²) = 76.5%

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = .163

$(T_{in} - T_{amb}) \div I$ = [illegible]

TEST RESULTS

Collector Identification SEPCO, "Soloron" Model EF-212, SN-002

Date 4/15/77 Test Identification Efficiency Test

. . Chiou, J. Dysart

Collector Tilt Angle 27° Collector Azimuth Angle 0°

Collector Aperture Area 25.52 ft^2 Height of Collector (Inlet) 61"
(Outlet) 116"

Mass Flow Rate 120 SCFM

Inlet Temperature T_{amb} +10 Data I.D. Number 4-15-77-12

Record at Start and Finish of Test

	Start	Finish
Local Time	13:57	14:02
Barometric Pressure (inches of Mercury)	29.32	29.32
Ambient Temperature (°F)	86	86
Mass Flow (SCFM)	119.5	119.5
Gauge Temperature (°F)	96	96
ΔP Across Collector ("H_2O)		
Diffuse Solar Flux (BTU/Hr·Ft^2)	54.2	53.6
Upper Plate Temperature (°F)	145	143
Lower Plate Temperature (°F)	113	112

Record every one minute during test.

Inlet Temperature (°F) 97.4

Mean Inlet Temperature (T_{in} °F) = 97.4

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Reduce from Strip Chart after Test

Mean ΔT (°F)	36.4
Mean Wind Speed (MPH)	3
Mean Solar Flux (BTU/Hr·Ft^2), I	241
Mean Mass Flow (SCFM)	119.5

Calculate from Reduced Data

$\eta = \dot{m}C_p\Delta T/Q_t * A = 0.0423 * \dot{m}(SCFM) * \Delta T\ (°F) \div I\ (BTU/Hr \cdot Ft^2)$ = 76.4 %

$[(\Delta T \div 2) + T_{in} - T_{amb}] \div I$ = .123

$(T_{in} - T_{amb}) \div I$ = .047

APPENDIX II

Collector Identification SEPCO "Soloron" Model EF-212

Month December Test Identification Weathering Test

Weather data furnished:
Observers J. Wright, National Weather Service, Huntsville, Alabama

Collector Tilt Angle 45° Collector Azimuth Angle 0°

Collector Area Height of Collector (Inlet)
(Outlet)

Day	Solar Flux Btu/ft²	Temperature (°F) High	Temperature (°F) Low	Temperature (°F) Avg.	Precipitation (In.) Rain	Precipitation (In.) Snow	Precipitation (In.) Other	Additional Weather Conditions Fog	Additional Weather Conditions Wind m/hr.
[illegible]		45°	30°	38°	0				9.6
[illegible]		56°	29°	43°	.06				9.0
[illegible]		56°	35°	46°	.10			heavy fog	5.1
[illegible]		55°	34°	45°	0			heavy fog	7.6
[illegible]		63°	28°	46°	0				6.6
18		68°	35°	52°	0				5.5
19		66°	36°	51°	.05				8.6
20		57°	25°	41°	.67			light fog	16.2
21		29°	18°	24°	0				12.4
[illegible]		38°	15°	27°	0				7.2
[illegible]		50°	20°	35°	0				8.4
[illegible]		50°	20°	35°	0				6.2
25		43°	33°	38°	1.14			light fog	9.6
26		47°	29°	38°	0				11.7
27		63°	26°	45°	0				10.5
28		57°	28°	43°	0				11.9
29		41°	25°	33°	0				13.3
30		56°	26°	41°	.38	trace	sleet	fog	12.8
31		32°	9°	21°	.01		sleet		15.9

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[illegible] SFPCO "Soloron" Model EF-212

Month January Test Identification Weathering Test

Weather data furnished:

Observers J. Wright, National Weather Service, Huntsville, Alabama

[illegible] Tilt Angle 45° Collector Azimuth Angle 0°

[illegible] Area Height of Collector (Inlet)

(Outlet)

Day	Solar Flux BTU/Hr·Ft²	Temperature (°F) High	Low	Avg.	Precipitation (In.) Rain	Snow	Other	Additional Weather Conditions Wind M/hr.	Fog
1		26°	7°	17°	0			9.8	
2		31°	16°	24°	.11	trace	sleet	7.3	
3		38°	27°	33°	.08	trace	sleet	10.0	dense
4		43°	35°	39°	0			13.0	dense
5		44°	37°	41°	.60	trace		14.0	light
6		38°	36°	37°	trace	trace	sleet	13.0	light
7		38°	26°	32°	trace			17.0	light
8		42°	22°	32°	1.5			9.0	
9		45°	33°	39°	1.52			25.0	light
10		33°	11°	22°	trace	trace		21.9	
11		30°	8°	19°	0			5.4	
12		39°	17°	28°	0			6.2	
13		51°	21°	36°	.03		sleet	8.2	
14		48°	34°	41°	.57			11.2	light
15		43°	30°	37°	0			8.0	light
16		31°	4°	18°	trace	trace		30.0	
17		21°	-1°	10°	0			15.0	
18		21°	3°	12°	.05			23.0	
19		25°	2°	14°	.04			15.0	
20		38°	20°	29°	trace			28.0	
21		42°	13°	28°	0			12.0	
22		36°	17°	27°	0			13.0	
23		47°	19°	33°	.04		sleet	12.0	
24		40°	33°	37°	.63			14.0	dense
25		40°	26°	33°	0			10.9	
26		56°	21°	39°	.04			12.8	
27		55°	33°	44°	trace			5.8	
28		53°	9°	31°	trace			13.5	
29		23°	3°	13°				10.5	
30		40°	12°	26°				9.6	
31		33°	14°	24°				8.2	

Collector Identification SEPCO "Soloron" Model EF-212

Month February Test Identification Weathering Test

Weather data furnished:

Observers J. Wright, National Weather Service, Huntsville, Alabama

Collector Tilt Angle 45° Collector Azimuth Angle 0°

Collector Aperture Area ____ Height of Collector (Inlet) ____ (Outlet) ____

Day	Solar Flux Btu/Hr Ft^2	Temperature (°F) High	Low	Avg.	Precipitation (In.) Rain	Snow	Other	Additional Weather Conditions Wind m/hr	Fog
1		42°	13°	28°				5.0	
2		50°	19°	35°				4.8	
3		50°	33°	42°				4.4	
4		58°	34°	46°				11.0	haze
5		43°	24°	34°				16.1	
6		38°	15°	27°				9.0	
7		36°	16°	26°				10.0	
8		45°	17°	31°				3.8	
9		57°	22°	40°				5.0	
10		62°	28°	45°				5.0	
11		65°	31°	48°	trace	blowing		6.2	
12		61°	47°	54°	.40			11.2	light
13		53°	32°	43°				8.9	
14		68°	29°	49°			sleet	12.9	
15		42°	23°	33°	trace	hail &	sleet	12.4	
16		39°	20°	30°				9.2	light
17		49°	25°	37°	freezing			6.8	
18		64°	38°	51°				9.7	
19		58°	29°	44°				14.3	haze
20		43°	23°	33°	freezing			11.0	
21		54°	22°	38°				7.2	light
22		70°	40°	55°				16.4	light
23		62°	49°	56°	1.8		hail	19.0	light
24		66°	44°	55°				14.8	
25		77°	42°	60°			hail	9.9	
26		77°	54°	66°	1.08			16.4	
27		60°	34°	47°				15.2	
28		50°	29°	40°				8.7	

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Collector Identification SEPCO "Soloron" Model EF-212

Month March Test Identification Weathering Test

Observers J. Wright, Weather data furnished: National Weather Service, Huntsville, Alabama

Collector Tilt Angle 45° Collector Azimuth Angle 0°

Collector Aperture Area ____ Height of Collector (Inlet) ____ (Outlet) ____

Day	Solar Flux BTU/Hr·Ft^2	Temperature (°F) High	Low	Avg.	Precipitation (In.) Rain	Snow	Other	Additional Weather Conditions Wind m/hr.	Fog
1		55°	29°	42°	0			10.7	
2		60°	30°	45°	trace			10.2	
3		62°	48°	55°	1.46			17.1	
4		65°	45°	55°	1.44			11.7	light
5		58°	35°	47°	.37			6.3	
6		50°	35°	43°	.31			8.2	light
7		59°	31°	45°				8.4	
8		67°	32°	50°				6.6	
9		66°	37°	52°				8.4	
10		69°	47°	58°	trace			14.1	
11		67°	54°	61°	.84		thunder	18.0	fog
12		67°	51°	59°	3.41		thunder	13.5	fog
13		71°	47°	59°				12.7	
14		79°	43°	61°				5.8	
15		80°	45°	63°				7.1	
16		65°	48°	57°				12.9	
17		66°	46°	56°				10.2	
18		76°	55°	66°	trace			20.0	
19		62°	48°	55°	.28			9.4	
20		64°	41°	53°				7.0	fog
21		60°	49°	55°	.08			13.7	
22		52°	36°	44°				15.3	
23		65°	30°	48°				7.5	
24		66°	39°	53°				7.5	
25		74°	43°	59°				4.8	
26		75°	44°	60°				6.9	
27		76°	56°	66°	.11			15.8	
28		69°	56°	63°	.63		thunder	17.6	fog
29		73°	54°	64°	.57		thunder	8.7	fog
30		82°	60°	71°	trace		thunder	11.0	fog
31		67°	47°	57°				9.3	

Collector Identification SEPCO "Soloron" Model EF-212

Month April Test Identification Weathering Test

Observers J. Wright, Weather data furnished: National Weather Service, Huntsville, Alabama

Collector Tilt Angle 45° Collector Azimuth Angle 0°

Collector Aperture Area ____ Height of Collector (Inlet) ____ (Outlet) ____

Day	Solar Flux BTU/Hr·Ft^2	Temperature (°F) High	Low	Avg.	Precipitation (In.) Rain	Snow	Other	Additional Weather Conditions Winds M/hr	Fog
1		65°	46°	56°	.04			9.1	
2		76°	60°	68°	1.21		thunder	13.9	fog
3		63°	55°	59°	1.16		thunder	7.5	light
4		70°	50°	60°	1.52		thunder	13.0	
5		60°	38°	49°	.03			17.2	
6		62°	34°	48°				10.7	
7		78°	40°	59°				9.0	
8		74°	48°	61°				7.2	
9		75°	44°	60°				4.0	
10		80°	46°	63°				3.0	
11		82°	50°	66°				4.1	
12		82°	53°	68°				4.6	
13		85°	54°	70°				3.8	
14		83°	54°	69°			—	4.3	
15		84°	55°	70°				4.1	
16		85°	54°	70°				3.3	
17		87°	54°	71°				3.7	light
18		85°	58°	72°	.04			6.3	
19		85°	63°	74°				8.7	
20		85°	62°	74°				10.6	light
21		73°	66°	70°	1.35			9.5	light
22		71°	65°	68°	.97			9.2	light
23		77°	57°	67°	.17		thunder	7.0	
24		72°	56°	64°	.18			9.7	light
25		65°	44°	55°				11.1	
26		63°	40°	52°				4.3	
27		72°	41°	57°				7.5	
28		77°	47°	62°				10.4	
29		74°	58°	66°				7.4	
30		78°	56°	67°	.01	thunder & haze		5.4	fog

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