

## **Solar Collector Test Report**

A Report to: **EnerWorks Inc.**  
P.O. Box 9  
252 Hamilton Crescent  
Dorchester, ON  
N0L 1G0

Attention: **Mr. Florin Plavosin**

Telephone: 519-268-6500 Ext. 116  
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Report No.: 06-08-9133-1  
7 Pages, 2 Appendices

Date: July 5, 2006

## **1.0 INTRODUCTION**

This report documents testing performed by Bodycote Materials Testing Canada Inc. on a glazed flat-plate liquid collector for **EnerWorks Inc.**

Testing was performed in accordance with SRCC OG-100 Standard “*Test Methods and Minimum Standards for Certifying Solar Collectors*”. The full series of tests were done at the National Solar Test Facility (NSTF), which included:

- 4.1 Receiving and Inspection
- 4.2 Static Pressure Test
- 4.3 Thirty-Day Outdoor Exposure Test
- 4.4 Thermal Shock/Water Spray Test
- 4.5 Thermal Shock/Cold Fill Test
- 4.6 Second Static Pressure Test
- 4.7 Time Constant Determination
- 4.8 Thermal Performance Test
- 4.9 Collector Incident Angle Modifier Determination
- 4.10 Disassembly and Final Inspection

The National Solar Test Facility is operated by Bodycote Materials Testing Canada Inc. for Natural Resources Canada.

## **2.0 SAMPLE DESCRIPTION**

Bodycote Sample No.:	06-08-9133-1
Manufacturer Name:	EnerWorks Inc.
Collector Model:	COL-4x8-TL-SGI-SD10 US
SRCC Identification:	SRCC 100-2005-014A
Serial Number(s):	0512006
Collector Type:	Liquid, flat plate, with temperature limiting damper
General Construction*:	Frame is steel w/ Galvalume coating, serpentine flow pattern
Connections*:	22 mm copper pipe
Cover Plate*:	Low iron glass, 1/8” (3.2mm) thick
Absorber Material*:	0.5-mm thick aluminum sheet
Absorber Coating*:	Miro-therm coated front surface, corrosion resistant nickel based coating on back
Insulation*:	1.17” thick rock-wool back insulation, protected by 0.016” thick aluminum sheet on the outside. 1” thick isocyanurate foam edge insulation.
Gross Dimensions:	2.446 m x 1.175 m; Area: 2.874 m <sup>2</sup>

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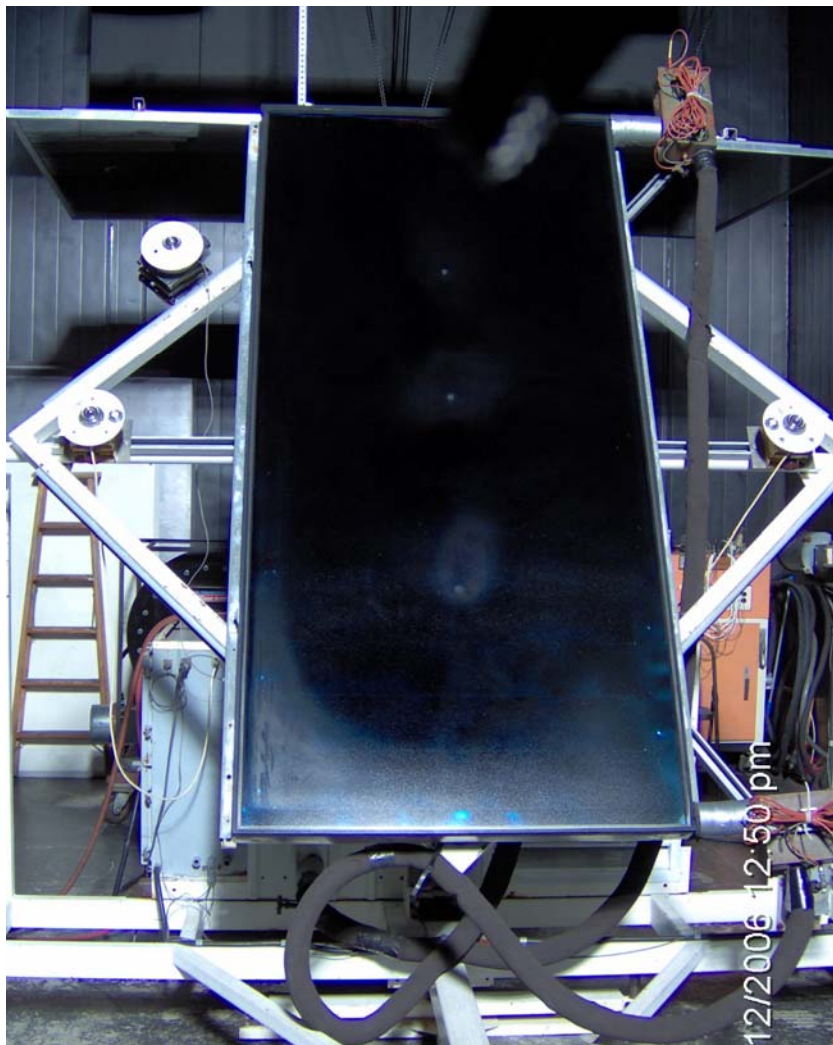
\* From product information supplied by Enerworks Inc.

Mounting Details:	Attached directly to test frame
Heat Transfer Fluid:	50/50 % (by vol.) propylene glycol USP / deionized water
Fluid Volume:	1.9 L

Comments:

1. Average wind speed during testing was measured with a calibrated TSI Velocicalc anemometer (MII # B07886);
2. Requested fluid flow rate was 0.02 kg/s/m<sup>2</sup>;
3. Inlet and outlet connections were insulated and not included in the gross area.

Figure 1: EnerWorks Inc. collector 06-08-9133-1 in solar simulator chamber.



### **3.0 RECEIVING AND INSPECTION**

Section 4.1 of SRCC 100 requires an inspection and documentation of the condition of the collector when received. The collector was undamaged when received with the exception of slight scratches on the frame.

### **4.0 STATIC PRESSURE TEST**

Section 4.2 of SRCC 100 requires that static pressure leakage tests be performed before and after outdoor exposure testing. The static pressure leakage test consists of hydraulically or pneumatically testing all collectors for leaks. Test results are included in Appendix B.

### **5.0 EXPOSURE TEST**

Section 4.3 of SRCC 100 requires solar collectors to undergo an outdoor no-flow exposure test. This test includes 30 days exposure (not necessarily consecutive) with a minimum of 17 megajoules of incident energy per square metre of collector surface area. A written description of changes observed during the test is given in Appendix B. Insolation and ambient temperature data are recorded at half-hour intervals for the duration of the exposure period.

The dates of the days on which the total incident energy in the plane of the collector exceeded 17 MJ/m<sup>2</sup> are also reported. The collector described in this report received its exposure between the months of March and April, 2006.

### **6.0 THERMAL SHOCK / WATER SPRAY TEST**

Section 4.4 of SRCC 100 requires that for a five minute period on three different days of the exposure test the collector be subjected to heavy water spray after at least one hour exposure to direct sunlight (minimum 850 W/m<sup>2</sup> intensity). The water spray tests are done with a water flow rate of >0.02 L/s/m<sup>2</sup> of collector aperture area. Water temperature during the water spray tests is maintained at 24°C ± 5°C. A report of observations made during the test is included in Appendix B.

### **7.0 THERMAL SHOCK / COLD FILL TEST**

Section 5.6 of SRCC 100-05 requires that at one time during the test sequence, the unfilled collector is to be exposed to full sunlight (950 W/m<sup>2</sup>) at an ambient air

temperature  $>15\text{ }^{\circ}\text{C}$  for a one-hour period. Liquid is then circulated through the collector at a rate of at least  $0.02\text{ L/s/m}^2$  of collector aperture area. The heat transfer fluid temperature during the cold fill test is supplied at a temperature less than  $25\text{ }^{\circ}\text{C}$ . A report of the observations made during the test is included in Appendix B.

## **8.0 TIME CONSTANT**

Before a collector may be properly tested, its time constant must be known in order to determine stabilization and data integration periods.

The time constant for the collector sample was determined in the solar simulator and in accordance with ANSI / ASHRAE Standard 93 (Section 8.3.2). Simulated solar radiation was applied at  $800\text{ W/m}^2$ . The solar simulator was turned off when the collector inlet temperature stabilized near ambient temperature. The change in temperature rise across the collector was then recorded as a function of time. ANSI / ASHRAE Standard 93 defines the time constant as the time taken for the collector temperature rise to decrease to 0.368 of its initial value. The time constant for the collector described in this report was 1 minute, 40 seconds at a flow rate of  $0.054\text{ kg/s}$  50/50 USP/DI water. The collector fluid inlet temperature was  $19.9\text{ }^{\circ}\text{C}$  during the time constant test, with an ambient air temperature of  $20.2\text{ }^{\circ}\text{C}$ .

## **9.0 THERMAL EFFICIENCY**

The sample was mounted directly to the liquid collector test frame. Insulated inlet and outlet connections that incorporate fluid temperature sensors were attached. In this way the collector becomes part of a circulation system that is provided with accurate temperature measurement at inlet and outlet.

The mass flow rate times specific heat product ( $m\cdot c_p$ ) is measured directly using a calorimetric method for thermal performance testing. This product, expressed in units of  $\text{W}/^{\circ}\text{C}$ , is determined by measuring the fluid temperature rise for a given electrical power input in an insulated container. The value of this product is not significantly changed as the fluid passes through the collector, therefore the product of  $m\cdot c_p$  and collector temperature rise ( $\Delta T$ ) is the rate at which energy is collected. Values obtained in this way were used to calculate the efficiency of the collector described in this report.

Efficiency testing was done in the solar simulator and in accordance with SRCC Standard 100-05 “*Test Methods and Minimum Standards for Certifying Solar Collectors*”, which references ISO Standard 9806-1, Section 9. At the request of the client, testing was

performed at the ANSI / ASHRAE Standard 93-2003 standard flow rate of 0.054 kg/s (0.02 kg/s per m<sup>2</sup> of aperture area). The collector plane was maintained at 30° from vertical, and normal to the direction of irradiation during thermal efficiency testing. Average wind speed was measured to be 3.5 m/s, using a calibrated TSI Velocicalc anemometer (MII # B07886).

Collector efficiency was calculated using selected average data acquired by the frame computer. Test data accompanied by appropriate graphs are included in Appendix A.

The following curve fits in SI units based on the collector gross area of 2.874 m<sup>2</sup> were derived from the averaged test frame data:

$$\text{1st order fit: } \eta = 0.726 - 5.115(\text{Ti}-\text{Ta})/G$$

$$\text{2nd order fit: } \eta = 0.717 - 4.033(\text{Ti}-\text{Ta})/G - 0.0184(\text{Ti}-\text{Ta})^2/G$$

## **10.0 INCIDENT ANGLE MODIFIER TEST**

The Incident Angle Modifier (IAM) is a measure of the deviation of the collector from cosine response. Horizontal incident angle modifier testing was done in accordance with ISO Standard 9806-1, Section 11.

During the IAM testing the collector was set successively at 0°, 30°, 45°, and 60° angles from normal incidence, while the solar simulator lamp beam was tilted 30 degrees down from horizontal.

Collector inlet temperature was set equal to ambient temperature, and the thermal efficiency was determined at the various angles of incidence. Since the solar collector and its associated pyranometer were tracked off axis, the value of incident solar radiation reported is actually the solar radiation in the plane of the collector. Thermal efficiency relative to that at normal incidence was plotted against incident angle. The plots and average data are included in Appendix A.

## **11.0 PRESSURE DROP**

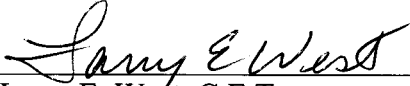
The collector pressure drop was determined in accordance with ISO Standard 9806-1, Section 12. Results are included in Appendix B.


## 12.0 FINAL INSPECTION

The purpose of this test is to determine the extent of any damage or degradation of the collector that occurred as a result of the previous test sequence. The collector was disassembled for this inspection. A report of the observations made during the final inspection is included in Appendix B.

Reported by:

Reviewed by:

  
\_\_\_\_\_  
Larry E. West, C.E.T.  
Technologist  
National Solar Test Facility

  
\_\_\_\_\_  
*for* Dr. Alfred P. Brunger, Ph.D., P.Eng.  
Manager  
National Solar Test Facility

*This report refers only to the particular samples, units, material, instrument, or other subject used and referred to in it, and is limited by the tests and/or analyses performed. Similar articles may not be of like quality, and other testing and/or analysis programs might be desirable and might give different results.*

## **APPENDIX A**

Detailed Efficiency Data

(3 Pages)

### **Detailed Efficiency Data**

The following data contain calculated values of efficiency together with associated variables as follows:

Time:	Eastern standard time
Len:	Integration period (minutes)
G:	Total insolation on plane of collector (W/m <sup>2</sup> )
Gdn:	Direct beam solar radiation as measured by the normal incidence pyrheliometer (W/m <sup>2</sup> )
Ta:	Ambient air temperature (°C)
Ti:	Inlet fluid temperature (°C)
ΔT:	Temperature rise across collector (°C)
$\dot{m}$ :	Mass flow rate (kg/s)
Ws:	Wind speed (m/s)
Wd:	Wind direction (degrees from North)
Output:	Net power delivered by collector (W/m <sup>2</sup> )
$\eta$ :	Collector efficiency
ΔP:	Pressure drop across the collector (kPa)
K:	Incident angle modifier
θ:	Incident angle between solar radiation and collector normal

Apparent Solar Time = Time - 18.64 min + Equation of time

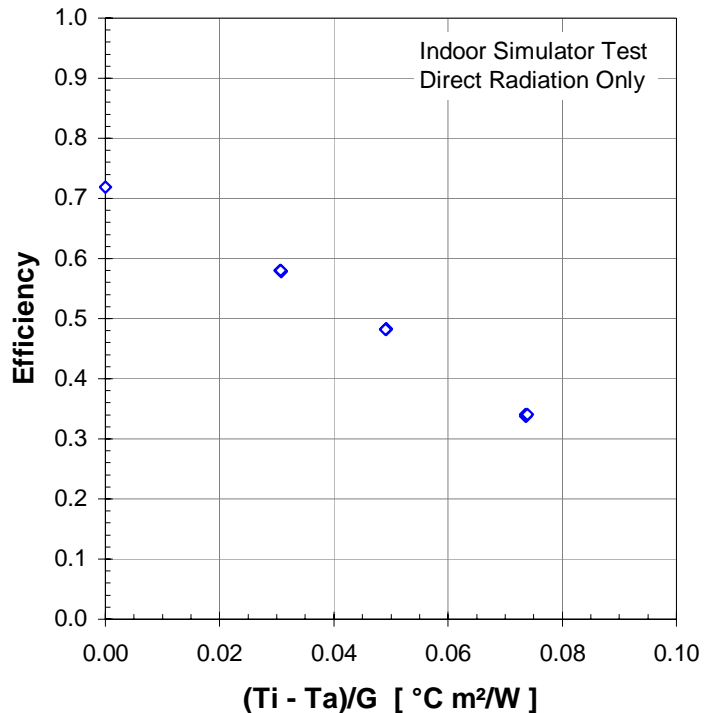
**Thermal Efficiency Test Data  
Enerworks**

Date/Time	Len <i>min.</i>	G <i>W/m<sup>2</sup></i>	G <sub>dn</sub> <i>W/m<sup>2</sup></i>	T <sub>a</sub> <i>°C</i>	T <sub>i</sub> <i>°C</i>	ΔT <i>°C</i>	W <sub>s</sub> <i>m/s</i>	ṁ•Cp <i>W/°C</i>	ṁ* <i>kg/s</i>	T <sub>i</sub> -T <sub>a</sub> <i>°C</i>	(T <sub>i</sub> -T <sub>a</sub> )/G <i>°C m<sup>2</sup>/ W</i>	η	ΔP <i>kPa</i>
2006-05-11 10:58	5	808	n/a	20.1	20.0	8.54	3.5	194.9	0.0543	-0.1	-0.0001	0.717	n/a
2006-05-11 11:03	5	808		20.1	20.0	8.54	3.5	194.7	0.0543	-0.1	-0.0001	0.716	
2006-05-11 11:08	5	810		20.0	20.0	8.57	3.5	195.2	0.0544	0.0	0.0000	0.718	
2006-05-11 11:13	5	809		20.1	20.0	8.56	3.5	194.9	0.0543	-0.1	-0.0001	0.717	
2006-05-11 12:00	5	811		20.2	45.0	6.94	3.5	194.9	0.0532	24.8	0.0306	0.580	n/a
2006-05-11 12:06	5	806		20.2	45.0	6.89	3.5	194.8	0.0531	24.8	0.0307	0.579	
2006-05-11 12:11	5	807		20.2	45.0	6.88	3.5	194.7	0.0531	24.8	0.0307	0.578	
2006-05-11 12:16	5	807		20.2	45.0	6.90	3.5	194.9	0.0532	24.8	0.0307	0.580	
2006-05-11 13:10	5	807		20.3	60.0	5.73	3.5	195.3	0.0526	39.6	0.0491	0.483	n/a
2006-05-11 13:26	5	807		20.3	60.0	5.74	3.5	195.0	0.0525	39.7	0.0491	0.483	
2006-05-11 13:31	5	807		20.3	60.0	5.75	3.5	194.9	0.0525	39.7	0.0492	0.483	
2006-05-11 13:36	5	808		20.4	60.0	5.74	3.5	194.9	0.0525	39.7	0.0491	0.482	
2006-05-11 14:37	5	809		20.4	80.0	4.03	3.5	194.9	0.0516	59.6	0.0737	0.338	n/a
2006-05-11 14:42	5	811		20.4	80.0	4.04	3.5	194.7	0.0516	59.6	0.0735	0.338	
2006-05-11 14:47	5	811		20.4	80.0	4.07	3.5	194.8	0.0516	59.6	0.0736	0.340	
2006-05-11 14:52	5	807		20.4	80.0	4.05	3.5	194.8	0.0516	59.6	0.0739	0.340	

\* mass flow rate is calculated from measured values of ṁ•Cp.

Bodycote Sample No.: 06-08-9133-1  
 Collector Model: COL-4x8-TL-SGI-SD10  
 Test Date(s): 2006-May-11  
 Test Fluid: 50/50 USP/DI water  
 Mass Flow Rate: **0.053 kg/s**  
 Wind Speed (average): 3.5 m/s  
 Gross Area: 2.874 m<sup>2</sup>  
 Aperture Area: 2.712 m<sup>2</sup>  
 Mean Ambient Temp.: 20.2 °C  
 Irradiance Intensity: 808 W/m<sup>2</sup>

**Curve Fits:**  
 1st Order (SI units):  
 $\eta = 0.726 - 5.115(T_i - T_a)/G$   
 2nd Order (SI units):  
 $\eta = 0.717 - 4.033(T_i - T_a)/G - 0.0184(T_i - T_a)^2/G$

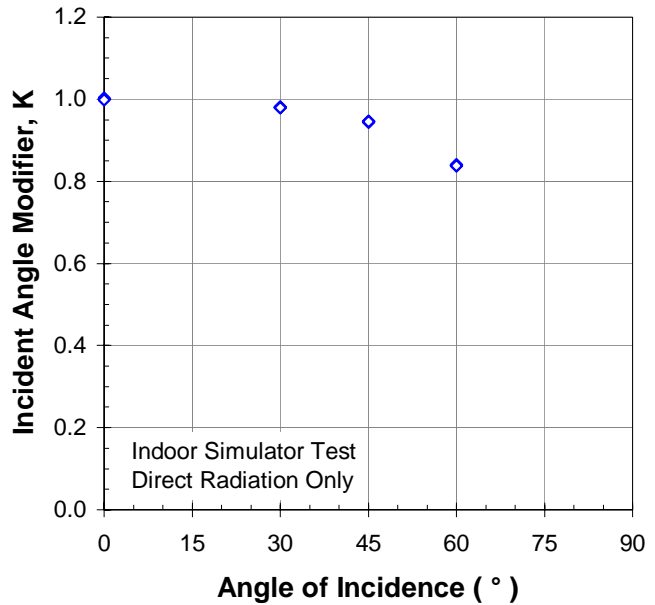


**Horizontal Incident Angle Modifier Test Data  
Enerworks**

Date/Time	Len <i>min.</i>	G <i>W/m<sup>2</sup></i>	Gdn <i>W/m<sup>2</sup></i>	Ta <i>°C</i>	Ti <i>°C</i>	ΔT <i>°C</i>	m•Cp <i>(W/°C)</i>	m * <i>kg/s</i>	Ti-Ta <i>°C</i>	(Ti-Ta)/G <i>°C m<sup>2</sup>/ W</i>	η	K
<b>θ = 0°</b>												
2006-05-12 9:57	5	787	n/a	20.1	20.0	8.52	196.4	0.056	-0.1	-0.00015	0.740	1.002
2006-05-12 10:02	5	787		20.1	20.0	8.53	195.8	0.056	-0.1	-0.00013	0.739	1.000
2006-05-12 10:07	5	787		20.1	20.0	8.54	195.7	0.056	-0.2	-0.00023	0.739	1.000
2006-05-12 10:12	5	787		20.1	20.0	8.53	195.4	0.056	-0.1	-0.00013	0.737	0.998
<b>θ = 30°</b>												
2006-05-12 10:44	5	676		20.3	20.0	7.22	195.4	0.056	-0.3	-0.00047	0.727	0.981
2006-05-12 10:49	5	675		20.3	20.0	7.22	195.2	0.056	-0.3	-0.00050	0.726	0.980
2006-05-12 10:54	5	677		20.3	20.0	7.23	195.2	0.056	-0.3	-0.00050	0.726	0.980
2006-05-12 10:59	5	679		20.3	20.0	7.24	195.4	0.056	-0.4	-0.00053	0.726	0.980
<b>θ = 45°</b>												
2006-05-12 11:29	5	546		20.6	20.0	5.65	195.3	0.056	-0.6	-0.00110	0.703	0.944
2006-05-12 11:34	5	546		20.6	19.9	5.66	195.2	0.056	-0.6	-0.00113	0.704	0.946
2006-05-12 11:39	5	545		20.6	20.0	5.65	195.2	0.056	-0.5	-0.00099	0.704	0.947
2006-05-12 11:44	5	545		20.6	20.0	5.64	195.6	0.056	-0.6	-0.00110	0.704	0.946
<b>θ = 60°</b>												
2006-05-12 12:19	5	373		20.5	20.0	3.45	195.0	0.056	-0.5	-0.00139	0.627	0.840
2006-05-12 12:24	5	373		20.5	20.0	3.44	195.0	0.056	-0.5	-0.00145	0.626	0.839
2006-05-12 12:29	5	374		20.5	20.0	3.45	195.0	0.056	-0.5	-0.00139	0.626	0.838
2006-05-12 12:34	5	372		20.5	20.0	3.44	195.1	0.056	-0.6	-0.00156	0.626	0.838

\* mass flow rate is calculated from measured values of m•Cp.

Bodycote Sample No.: 06-08-9133-1  
 Collector Model: COL-4x8-TL-SGI-SD10  
 Test Date: 2006-May-12  
 Test Fluid: 50/50 USP/DI water  
 Mass Flow Rate: 0.056 kg/s  
 Wind Speed (nominal): 3.5 m/s  
 Mean Ambient Temp.: 20.4 °C  
 Gross Area: 2.874 m<sup>2</sup>  
 Aperture Area: 2.712 m<sup>2</sup>



## **APPENDIX B**

Static Pressure Test

Outdoor No Flow Exposure Test, Exposure Days

Outdoor No Flow Exposure Test, Inspection Report

Thermal Shock / Water Spray Test

Thermal Shock / Cold Fill Test

Second Static Pressure Test

Pressure Drop Test

Final Inspection

(8 Pages)

**Liquid Collector Static Pressure Test**

(SRCC standard 100, section 4.2)

**General**

BODYCOTE sample no.: 06-08-9133-1  
Manufacturer: Enerworks  
Model No.: COL-4X8-TL-S61-SD10  
Tested by: Jany E. West Date: 2006-03-09

**Test Pressure**

Manufacturers' Recommended Working Pressure: 50 psi  
Street Pressure: N/A psi  
Test Pressure: 75 psi

**Pressure Test**

1) Before pressure applied: 0 psi  
2) Immediately after pressure applied: 75 psi  
3) 15 minutes after pressure applied: 75 psi  
4) Immediately after pressure released: 0 psi

dP = Pressure (2) - Pressure (3) = 0 psi

**Results**

Collector Accepted (dP = 0) []  
Rejected (dP > 0) []

Approved by: \_\_\_\_\_

Alfred Brugga

Date: 2006-05-24

**Outdoor No Flow Exposure Test**

<b>Month</b>	<b>Exposure Days - 2006</b>	<b>Totals</b>
January	6,15,26,27,28	5
February	18,19,20,21,22,23,24,26,28	9
March	1,3,4,5,6,7,11,15,16,17,18,20,21,26,27,28,29,30	18
April	2,6,8,9,10,11,13,15,16,17,18,19,20,25,26,27,28,29,30	19
May	1,2,3,5,6,7,8,9,10,12,14,15,17,20,23,24,27,28,29,30,31	21
June	5	1
July		
August		
September		
October		
November		
December		

NOTE: An exposure day is one on which the total recorded solar energy incident on the plane of the collector is at least 17 MJ/m<sup>2</sup>.

**Outdoor Exposure Tests:**

<b>Client</b>	<b>Standard</b>	<b>Start Date</b>	<b>End Date</b>	<b>Sample no.</b>	<b>Exposure Days</b>
Enerworks	SRCC 100	2006-Mar-09	2006-Apr-29	06-08-9133-1	<b>30</b>
Enerworks	SRCC 100	2006-Mar-17	2006-May-03	06-08-9133-2	<b>30</b>

**Outdoor No Flow Exposure Test**

(SRCC standard 100, section 4.3)

**General**

BODYCOTE sample no.: 06-08-9133-1  
Manufacturer: Enerworks  
Model Number: COL-4X8-TL-SGI-SD10  
Exposure commencement: 2:50 PM Date: 2006-03-09

**Inspections** (weekly)

Date	Initials	Observations of Changes
2006-03-13	FEW	no change
2006-03-20	FEW	no change
2006-03-27	FEW	no change
2006-04-03	FEW	no change
2006-04-10	FEW	no change
2006-04-17	FEW	no change
2006-04-24	FEW	" "

Exposure test termination: 2006-04-29

Reason:  exposure completed  
 structural damage

Approved by: Alfred Brunger Date: 2006-05-24

**Liquid Collector Thermal Shock / Water Spray Test**

(SRCC standard 100, section 4.4)

**General**

BODYCOTE sample no.: 06-08-9133-1  
Manufacturer: Enerworks  
Model No.: COL-4x8-TL-SGI-3D10  
Recommended Working Fluid: 50/50 USP glycol/water  
Tested by: Fary Ewest Test Duration: 5 min.  
Solar Irradiance: 850 W/m<sup>2</sup> for at least 1 hour previous to test

**Test 1:**

Test start time: 13:50 Date: 2006-04-17  
Flow rate 0.020 L/s/m<sup>2</sup> of collector area: ~4 Lpm  
Water temperature (24 ± 5 °C): 25°C

**Test 2:**

Test start time: 13:40 Date: 2006-04-18  
Flow rate 0.020 L/s/m<sup>2</sup> of collector area: ~4 Lpm  
Water temperature (24 ± 5 °C): 24°C

**Test 3:**

Test start time: 13:54 Date: 2006-04-20  
Flow rate 0.020 L/s/m<sup>2</sup> of collector area: ~4 Lpm  
Water temperature (24 ± 5 °C): 26°C

Visible signs of leakage:

YES

NO

Description of leakage (if any):  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Approved by:

Alfred Brung

Date:

2006-05-24

**Liquid Collector Thermal Shock / Cold Fill Test**

(SRCC standard 100, section 5.6)

BODYCOTE sample no.: 06-08-9133-1  
Manufacturer: Enerworks  
Model number: COL-4x8-TL-SGI-SD10  
Recommended working fluid: 50/50 usp glycol/water

Test duration: >5 minutes

Solar irradiance level must be >950 W/m<sup>2</sup> for at least 1 hour previous to test.

Fill rate (>0.02 L/s/m<sup>2</sup> of collector aperture): 0.03 L/s/m<sup>2</sup>  
Fluid temperature (<25 °C): 18 °C  
Air temperature (>15 °C): 15.0 °C  
Solar irradiance (W/m<sup>2</sup>): 1024 W/m<sup>2</sup>  
Absorber temperature before fill: 114 °C  
Test start time: 14:30  
Test completion time: 14:36

Visible signs of damage: YES  NO

Description of damage (if any):

\_\_\_\_\_  
\_\_\_\_\_

Equipment used:

Thermometer location:

- as per ISO 9806-2, section 9.2  
 Other: \_\_\_\_\_

Tested by: Samy E West

Date: 2006-04-26

Approved by: Alfred Brunger

Date: 2006-04-27

**Liquid Collector Static Pressure Test**

(SRCC standard 100, section 5.3)

**General**

BODYCOTE sample no.: 06-08-9133-1  
Manufacturer: Enerworks  
Model No.: COL-4X8-TL-SGI-SD10  
Tested by: Larry E West Date: 2006-05-04

**Test Pressure**

Manufacturers' Recommended Working Pressure: 50 psi  
Street Pressure: N/A psi  
Test Pressure: 75 psi

**Pressure Test**

1) Before pressure applied: 0 psi  
2) Immediately after pressure applied: 75 psi  
3) ~~15~~ <sup>10</sup> minutes after pressure applied: 75 psi  
4) Immediately after pressure released: 0 psi

dP = Pressure (2) - Pressure (3) = 0 psi

**Results**

Collector Accepted (dP = 0) []  
Rejected (dP > 0) []

Equipment used: Pressure gauge MII# B01324

Approved by: Alfred Brugga Date: 2006-05-24

Collector Pressure Drop Test Results

**SRCC standard 100-05, section 5.8**

Aperture Area = **2.712** m<sup>2</sup>

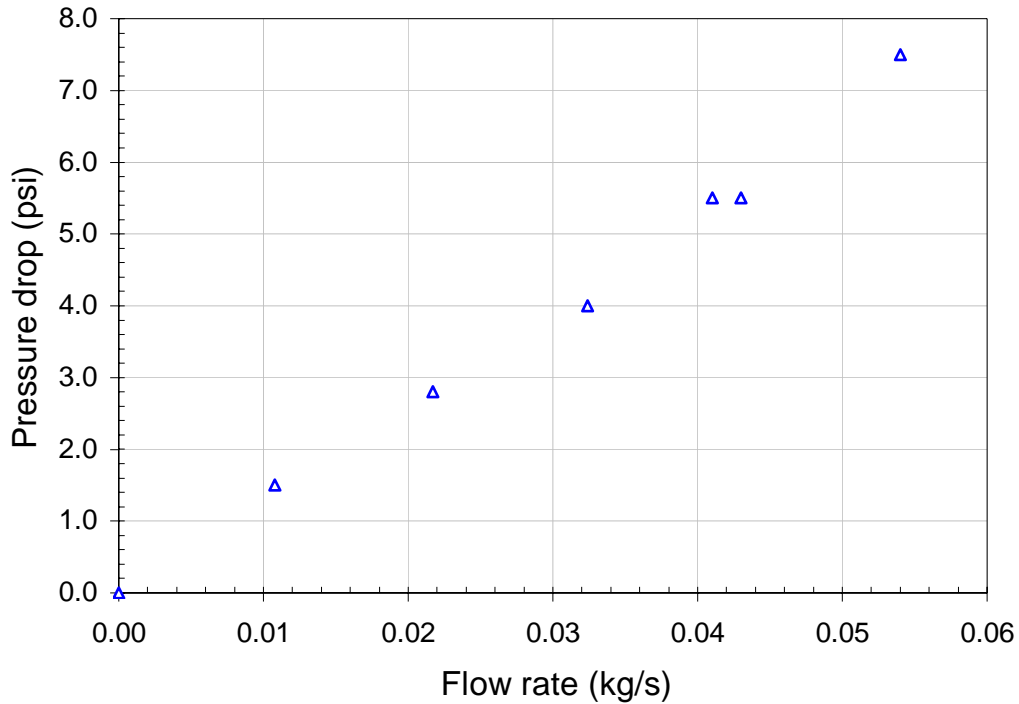
09-May-2006

**50/50 glycol mix**

Comments	Flow (F1) (kg/s per m <sup>2</sup> )	Flow (F1) (kg/s)	Flow rate <sup>2</sup> (kg/s) <sup>2</sup>	Pressure drop (psi)	T_in (°C)
	0.0	0.0000	0.0000	0.0	21.6
	0.004	0.0108	0.0001	1.5	20.3
	0.008	0.0217	0.0005	2.8	20.7
	0.012	0.0324	0.0010	4.0	20.8
	0.015	0.0410	0.0017	5.5	21.0
	0.016	0.0430	0.0018	5.5	21.1
ASHRAE 93 std.	0.020	0.0540	0.0029	7.5	21.9

D0 = **1.057** kg/L      N = kg·m/s<sup>2</sup>

Enerworks Inc. collector 06-08-9133-1



**Final Inspection Results**

(ISO 9806-2, App. A.14)

BODYCOTE sample no.: 06-08-9133-1 Model: COL-4x8-TL-SG1-SD10  
 Inspected by: Fanny Elwest Inspection Date: 2006-05-12

Evaluate each potential problem according to the following scale:

0 - No problem

1 - Minor problem

2 - Severe problem

\* - Inspection to establish the condition was not possible.

Collector Component	Potential Problem	Evaluation
a) Collector box / fasteners	Cracking / warping / corrosion / rain penetration	<u>0</u>
b) Mountings / structure	Strength / safety	<u>0</u>
c) Seals / gaskets	Cracking / adhesion / elasticity	<u>0</u>
d) Cover / reflector	Cracking / crazing / buckling / delamination / warping / outgassing	<u>0</u>
e) Absorber coating	Cracking / crazing / blistering	<u>0</u>
Absorber tubes & headers	Deformation / corrosion / leakage / loss of bonding	<u>0</u>
Absorber mountings	Deformation / corrosion	<u>0</u>
f) Insulation	Water Retention / outgassing / degradation	<u>0</u>

Approved by: Alfred Bringer

Date: 2006-05-24