SOLAR RATING & CERTIFICATION CORPORATION™

An ICC Evaluation Service Program

OG-100 Solar Thermal Collector Certification No./10002146

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www.solar-rating.org | **(800) 423-6587** | **(562) 699-0543**

CERTIFICATION HOLDER:	**EVALUATION SUBJECT**	
SunEarth, Inc. 8425 Almeira Avenue Fontana, CA 92335 USA www.sunearthinc.com	**BRAND:**	ThermoRay
	MODEL:	TRB-20
	TYPE:	Glazed Flat Plate Liquid Heating Collector

PRODUCT CERTIFICATION SYSTEM:

The ICC-SRCC OG-100 certification program includes evaluation and performance ratings for solar thermal collectors as established in the *ICC-SRCC Rules for Solar Heating & Cooling Product Listing Reports.* The program also includes periodic factory inspections and surveillance of the manufacturer's quality management system.

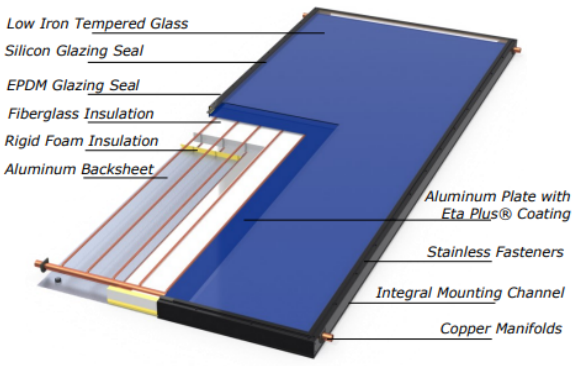
COMPLIANCE WITH THE FOLLOWING STANDARD(S): *ICC 901/SRCC 100 - 2015, Solar Thermal Collectors Standard*

OG-100 THERMAL PERFORMANCE RATINGS:

ICC-SRCC OG-100 thermal performance ratings provided for the collector are calculated for a 24-hour period using OG-100 standard conditions using collector parameters measured through laboratory testing. Actual performance will vary with local conditions, installation details and usage.

OG-100 STANDARD DAILY PRODUCTION

Kilowatt-hours (thermal) per Collector per Day				**Thousands of BTU per Collector per Day**			
Climate → **Category (T_i-T_a)**	High Radiation (6.3 kWh/m²•day)	Medium Radiation (4.7 kWh/m²•day)	Low Radiation (3.1 kWh/m²•day)	**Climate →** **Category (T_i-T_a)**	High Radiation (2 kBTU/ft²•day)	Medium Radiation (1.5 kBTU/ft²•day)	Low Radiation (1 kBTU/ft²•day)
A (-5°C)	8.69	6.64	4.60	**A (-9°F)**	29.66	22.67	15.68
B (5°C)	7.74	5.69	3.65	**B (9°F)**	26.40	19.43	12.46
C (20°C)	6.46	4.46	2.46	**C (36°F)**	22.05	15.22	8.39
D (60°C)	4.31	2.42	0.75	**D (90°F)**	14.72	8.27	2.57
E (80°C)	2.55	0.95	0.00	**E (144°F)**	8.69	3.25	0.00



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THERMAL EFFICIENCY:

The efficiency of solar thermal collectors is determined using test methods set in ICC 901/SRCC 100, based on ISO 9806 procedures. Results are processed to provide unique coefficients ($\eta_{0,hem}$, a1, a2…) for collection efficiency equations, provided in several forms below. For the simplified equations, instantaneous power at normal incidence is given by $\dot{Q} = \eta_{hem} A_G G$. Incident Angle Modifiers (IAMs) are provided to indicate the change in output as the angle of solar irradiance changes in the transverse and longitudinal planes of the collector. The inputs to the equations are defined as:

T_i: Temperature of the fluid entering the collector

T_m: Average temperature of the fluid in the collector (between the inlet and outlet)

T_a: Temperature of the ambient air around the collector

G: Hemispherical solar irradiance. Sub-types include beam (b) and diffuse (d) irradiance.

E_L: Longwave (infrared) irradiance

A_G: Gross collector area

u: Wind speed parallel to the plane of the collector and where u' is reduced by 3 m/s.

SIMPLIFIED THERMAL PERFORMANCE COEFFICIENTS (ISO 9806-2013, T_i, A_G)

Second Order Thermal Efficiency Equation*

$$\eta_{hem} = \eta_{0,hem} - a_1 \frac{T_i - T_a}{G} - a_2 G \left(\frac{T_i - T_a}{G}\right)^2$$

Linearized Thermal Efficiency Equation*

$$\eta_{hem} = \eta_{0,hem} - a_1 \frac{T_i - T_a}{G}$$

UNITS	$\eta_{0,hem}$	a_1	a_2	$\eta_{0,hem}$ ("Intercept")	a_1 ("Slope")
SI	0.738	4.19 W/(m²K)	0.000 W/(m²K²)	0.738	4.19 W/(m²K)
IP	0.738	0.74 BTU/(h ft²°F)	0.000 BTU/(h ft²°F²)	0.738	0.74 BTU/(hr ft²°F)

* Thermal efficiency equations per ISO 9806-2013 using inlet (T_i) fluid temperature, provided in second and first order (linearized) forms for normal incidence. The second order efficiency equation is a more accurate representation of the collector performance. The linearized efficiency equation is provided for use with incentive programs, regulations and software that require the simplified "slope" and "intercept" coefficients to describe collector performance.

GENERAL THERMAL PERFORMANCE COEFFICIENTS (ISO 9806-2017, T_m, A_G)

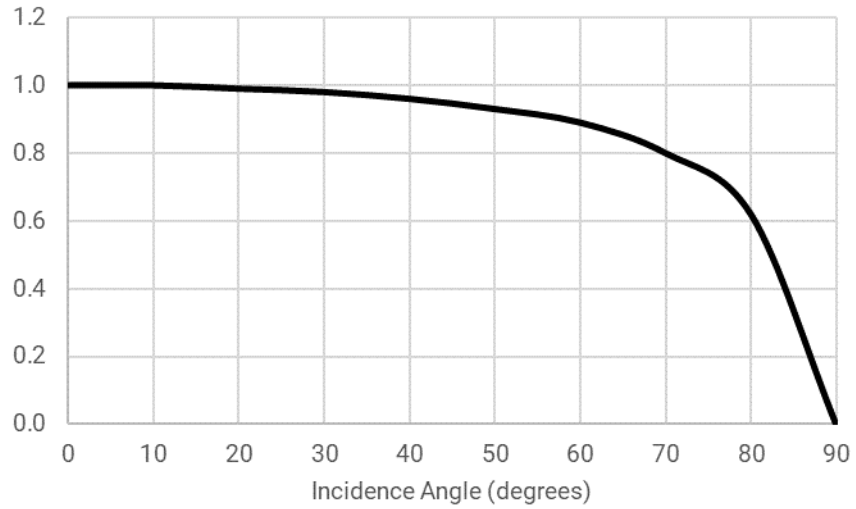
Extended Thermal Efficiency Equation**

$$\dot{Q} = A_G(\eta_{0,b} K_b(\theta_L, \theta_T) G_b + \eta_{0,b} K_d G_d - a_1(T_m - T_a) - a_2(T_m - T_a)^2 - a_3 u'(T_m - T_a) + a_4(E_L - \sigma T_a^4) - a_5\left(\frac{dT_m}{dt}\right) - a_6 u' G - a_7 u'(E_L - \sigma T_a^4) - a_8(T_m - T_a)^4$$

	$\eta_{0,hem}$	$\eta_{0,b}$	K_d	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	$\dot{m}$
VALUE	0.746	0.756	0.91	4.00	0.003	0.000	0.000	3390	0.000	0.00	0.000	0.020
UNITS	-	-	-	W/(m²K)	W/(m²K²)	J/(m³K)	-	J/(m²K)	s/m	W/(m²K⁴)	W/(m²K⁴)	kg/(m²s)

** General thermal efficiency equation based on mean (T_m) fluid temperature provided in accordance with ISO 9806-2017. See ISO 9806-2017 for definition of all coefficients.

DIRECT INCIDENT ANGLE MODIFIERS (IAM)



Angle (θ)	Longitudinal ($K_b(\theta_L,0)$)	Transverse ($K_b(0,\theta_T)$)
0°	1.00	1.00
10°	1.00	1.00
20°	0.99	0.99
30°	0.98	0.98
40°	0.96	0.96
50°	0.93	0.93
60°	0.89	0.89
70°	0.80	0.80
80°	0.62	0.62
90°	0.00	0.00

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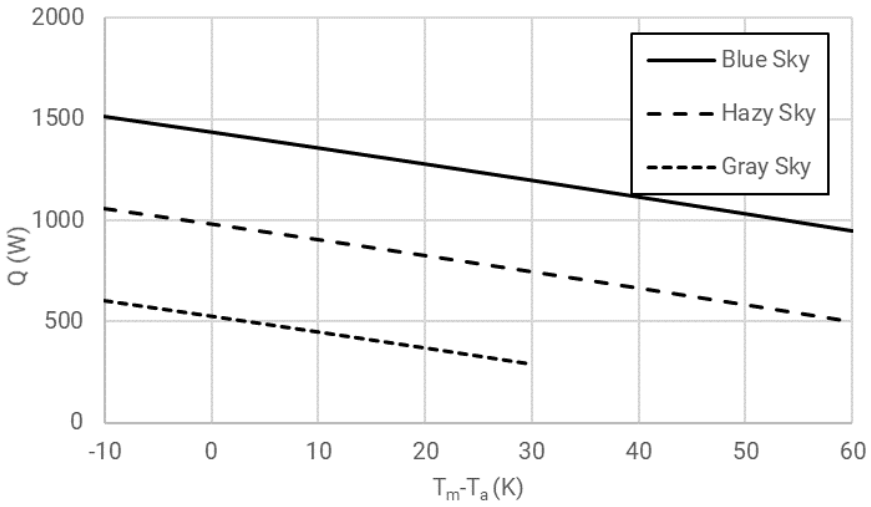
POWER OUTPUT:

The instantaneous power output of the collector under different conditions is calculated at the Standard Reporting Conditions (SRC) defined by ISO 9806-2017 using the measured performance coefficients above.



STANDARD COLLECTOR POWER OUTPUT (W)			
Based on Standard Rating Conditions (SRC) and mean temperature (T_m) in accordance with ISO 9806-2017			
T_m-T_a (°C)	**Blue sky** G_b = 850, G_d = 150 (W/m²)	**Hazy sky** G_b= 440, G_d= 260 (W/m²)	**Grey sky** G_b=0, G_d= 400 (W/m²)
-10	1510	1059	603
0	1433	982	527
10	1356	905	449
20	1277	826	371
30	1197	746	290
40	1115	664	209
50	1032	581	126
60	948	497	42
* Peak Power defined in ISO 9806 as Blue Sky irradiance condition at T_m-T_a =0 and normal incidence.			

TEST SAMPLE SPECIFICATIONS:

The specifications of the collector sample submitted for testing are provided below.

TEST & SAMPLE SPECIFICATIONS					
Gross Area:	1.91 m²	20.6 ft²	**Maximum Design Temperature:**	162 °C	325 ˚F
Gross Length:	1.57 m	5.2 ft	**Maximum Design Pressure:**	1103 kPa	160 psi
Gross Width:	1.22 m	4.0 ft	**Ave. Flowrate Efficiency Testing:**	0.020 kg/(m²s)	0.004 lb/(ft²s)
Gross Depth:	84.0 mm	3.31in	**Standard Stagnation Temperature:**	162 °C	325 ˚F
Empty Weight:	28.1 kg	62 lb	**Test Fluid:**	Water	
Fluid Capacity:	2.65 L	0.7 gal	Test Standard(s):	*ICC 901/SRCC 100 – 2020* *ISO 9806-2017*	
Notes:	Standard stagnation at 1000 W/m² and 30 °C				

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IDENTIFICATION:

Certified collectors must be labeled with the OG-100 certification mark in accordance with the *Rules for Certification Mark and Certificate Use*, containing information meeting the requirements of the standard specified above.

1. Manufacturer's name and model number.
2. OG-100 collector certification number
3. Maximum operating pressure
4. Dry weight
5. Fluid volume
6. Compatible heat transfer fluids
7. Standard stagnation temperature
8. Year of manufacture and/or serial number.

CONDITIONS:

1. Collector must be installed and operated in accordance with the manufacturer's published instructions and local codes and regulations.
2. OG-100 Standard Performance Ratings and Standard Collector Power Output have been calculated for the tested components using standardized conditions established by the OG-100 program and associated test standards. Actual performance will vary based on the specific usage, installation and local environmental conditions.
3. The collector listed in this ICC-SRCC OG-100 certification must be labeled in accordance with the *ICC-SRCC Rules for Mark and Certificate Use*.
4. OG-100 certifications do not include mounting hardware and fixtures.
5. Solar thermal collectors and mounting hardware and appurtenances must comply with all applicable local requirements for fire resistance. Solar thermal collectors must be mounted in accordance with the requirements of the collector and mounting hardware manufacturers to comply with local codes for structural loading for wind, seismic, snow and other loads.
6. Solar thermal collectors must be used with the heat transfer fluids listed in this document.
7. Solar thermal collector manufactured under a quality control program subject to periodic evaluation in accordance with the requirements of ICC-SRCC.
8. This document must be reproduced in its entirety.
9. Certification status should be confirmed on the ICC-SRCC Directory at www.solar-rating.org

Vincent Chui, S.E. VP of Evaluation Services

ACCREDITED
CERTIFICATE # 3299.01, 3299.03

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