

FLORIDA SOLAR



ENERGY CENTER[®]

FSEC STANDARD

Operation of the Solar Thermal Collector Certification Program

FSEC Standard 101-09

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Introduction

The 1976 Florida Legislature enacted the Solar Energy Standards Act of 1976, now Section 377.705 of the Florida Statutes. This law, effective October 1, 1976, directs the Florida Solar Energy Center (FSEC) to develop standards for solar energy equipment sold or manufactured in the state, establish criteria for determining the performance of solar energy equipment and maintain a testing facility for evaluating solar energy equipment performance. It provides for the Center to charge a fee to cover costs of testing and certification, and allows for the acceptance of test results from other testing organizations. The Solar Energy Standards Act was amended in 1978 to require that, after January 1, 1980, all solar energy systems manufactured or sold in Florida must meet the standards of FSEC and must display results in a manner prescribed by FSEC.

1.0 Purpose

This document presents details of the operation of that part of the testing and standards program whereby solar collectors may be rated for performance, examined for compliance to minimum standards, and approved to bear a label of certification from the Florida Solar Energy Center.

2.0 Scope

This document provides:

- Operating guidelines for certifying solar collectors.
- Description of the standard method for thermal performance rating.
- Manufacturer's agreement for labeling certified collectors.
- Information on the application for requesting collector certification.

3.0 Definitions and Nomenclature

3.1 Definitions

Accreditation - Formal evaluation and notification by the FSEC that a laboratory is qualified to perform the specific tests listed in the accreditation for the purpose of providing test data to support requests for solar equipment certification.

Accredited Laboratory - A laboratory possessing FSEC accreditation.

Approved - Deemed acceptable in writing by authorized representative(s) of FSEC.

Certification: Designation that specific products are in compliance with FSEC standards.

FSEC - The Florida Solar Energy Center, the organization which is responsible for conducting the program, described herein, for certifying solar collectors.

Licensee - A person or business which provides a product or service under legal agreement with another person or business.

Manufacturer - any corporation or division, any firm or person which performs at least one of the following functions with respect to solar collectors: (1) principle design of the product; (2) producing in whole or part, including any substantial processing or assembling operation; (3) continuously selling, in the open market under its own trade name in reasonable volume, a solar collector. Manufacturer may also mean a company that assembles, fabricates, and/or sells a solar collector that has been certified by another company.

May - Action indicated is allowed.

Revoke - Certification withdrawn.

Seller – The solar equipment manufacturer, supplier or dealer who requests certification.

Shall - Indicates the criteria required to comply with the standard.

Solar Collector - A device designed to absorb incident solar radiation, to convert it to thermal energy, and to transfer the thermal energy to a fluid coming in contact with it.

Supplier - An entity which assumes responsibility for the solar equipment certified by FSEC, according to the procedures described herein.

Suspend - Certification temporarily placed in inactive status pending further action as specified by FSEC or the SRCC.

3.2 Nomenclature

a = computed constant [unitless]

b = computed constant [$W/(m^2\text{ }^\circ\text{C})$], [$Btu/(ft^2 \text{ hr } ^\circ\text{F})$]

b₁ = computed constant [$W/(m^2\text{ }^\circ\text{C})$], [$Btu/(ft^2 \text{ hr } ^\circ\text{F})$]

b₂ = computed constant [$W\text{-sec}/m^3 \text{ }^\circ\text{C}$], [$Btu/ft^2 \text{ }^\circ\text{F mile}$]

c = computed constant [$W/(m^2\text{ }^\circ\text{C})$], [$Btu/(ft^2 \text{ hr } ^\circ\text{F})$]

I = total solar irradiance measured in the plane of the collector [W/m^2], [$Btu/(ft^2\text{hr})$]

I'' = net irradiance [W/m^2], [$Btu/(ft^2 \text{ hr})$]

IR	=	net longwave irradiance [W/m^2], [$\text{Btu}/(\text{ft}^2\text{hr})$]
q	=	collector output during one hour [kWh/m^2], [Btu/ft^2]
Q	=	output of the collector on the standard day (for second order efficiency curve) [kWh] or [kWh/day], [Btu] or [Btu/day]
t_{in}	=	collector inlet fluid temperature [$^{\circ}\text{C}$], [$^{\circ}\text{F}$]
t_{amb}	=	ambient air temperature [$^{\circ}\text{C}$], [$^{\circ}\text{F}$]
u	=	wind speed [m/s], [miles/hr] or [mph]
W	=	Watts
x	=	reduced temperature difference [$^{\circ}\text{C} / \text{W}/\text{m}^2$], [$^{\circ}\text{F} / \text{Btu}/\text{hr}\text{-ft}^2$]
η	=	collector efficiency

4.0 Referenced Standards and Organizations

Test Methods and Minimum Standards for Certifying Solar Thermal Collectors, FSEC Standard 102-05, Florida Solar Energy Center, 1679 Clearlake Road, Cocoa, FL 32922-5703. <<http://www.fsec.ucf.edu/>>

Test Methods for solar collectors – Part 2: Qualification test procedure, ISO 9806-2:1995, International Organization for Standardization, Geneva, Switzerland. <<http://www.iso.ch/iso/en/ISOOnline.frontpage>>

General requirements for the competence of testing and calibration laboratories, ISO/IEC 17025:1999, International Organization for Standardization, Geneva, Switzerland. <<http://www.iso.ch/iso/en/ISOOnline.frontpage>>

5.0 Operating Guidelines

5.1 Certification Process

The certification process is initiated by the manufacturer who contacts FSEC for certification application documents and asks that an FSEC representative select a production unit solar collector at random from the manufacturer's plant or at the manufacturer's distribution point.

The manufacturer is responsible for submitting the application documentation, shipping the designated collector to the accredited laboratory, and paying the required testing fees. Standard fees for solar collector certification by the Florida Solar Energy Center are shown in the Solar Thermal Testing, Certification and Rating Fee Schedule.

If the product passes the prescribed series of tests conducted by FSEC or an FSEC accredited laboratory and the application information is complete, the equipment will be certified.

A label containing basic product information will then be required by FSEC to be affixed to each collector manufactured or distributed under the brand name and model number. This label shall be affixed to the collector and not to another component of the solar system. The manufacturer is obligated to notify FSEC immediately of other model numbers and brand names under which the solar equipment is to be marketed.

5.1.1 Standard Solar Equipment

FSEC will evaluate applications for "standard" equipment (i.e., equipment that can be fairly and adequately evaluated under the test sequence identified in this document) as follows.

After the manufacturer submits a complete Collector Certification Application, and any required testing has been completed, the application is reviewed. , FSEC will notify the manufacturer that the solar equipment has been approved and certified or, if disapproved, notify the manufacturer specifically of what elements of the application are incomplete and identify the corrective action that should take place. If all identified revisions or corrections are made, resubmitted to, and approved by FSEC, the equipment will be approved and certified.

The test sequence for standard equipment shall be that described in FSEC Standard 102-05, Test Methods and Minimum Standards for Certifying Solar Thermal Collectors. The qualification test procedures described in ISO 9808-2, "Test methods for solar collectors – Part 2: Qualification procedures," may be followed in lieu of those in FSEC Standard 102-05. Certification documents will identify the qualification procedures used.

The same serial-numbered collector must go through the above test sequence in the exact order specified. Any unauthorized variations to the test sequence and specifications will void the test results acceptability for purposes of FSEC certification and rating.

5.1.2 Interim Collector Ratings

This section of the standard sets forth the requirements for qualifying solar collectors to be assigned a time-limited, Interim Collector Rating in the interim period between successful completion of qualification and exposure tests and completion of thermal performance tests by FSEC or an FSEC accredited laboratory.

5.1.2.1 An applicant for an Interim Collector Rating shall comply with all other sections of this standard, including payment of all required fees.

5.1.2.2 An applicant for an Interim Collector Rating shall provide for two randomly selected collectors that shall both be required to successfully complete qualification and

exposure tests. Following successful completion of qualification and exposure testing, one of the collectors shall undergo disassembly and comprehensive inspection of the interior and exterior of the collector prior to issuance of the Interim Collector Rating. The second collector shall be used for the follow-on thermal performance testing.

5.1.2.3 FSEC shall list Interim Collector Ratings in a separate section of its collector certification listings.

5.1.2.4 Interim Collector Ratings shall be valid for a period of not more than twelve (12) months from the date of original certification. This Interim collector rating time period may be extended at the sole discretion of FSEC.

5.1.2.5 If, after twelve months from the date of Interim Collector Rating, FSEC has not completed valid thermal performance tests or received valid thermal performance test results from an FSEC accredited test laboratory, either the Interim Collector Rating will be withdrawn or the Interim Collector Rating will be extended in accordance with section 5.1.2.4. If the Interim Collector Rating is withdrawn, all system certifications using this collector or collectors certified as “similar models” based on this collector shall be withdrawn.

5.1.2.6 The Interim Collector Ratings shall be determined based on the following criteria:

5.1.2.6.1 Typical glazed, flat-plate, hot water collectors without a selective surface shall have an efficiency equation of $0.6 - 6.3 \cdot (T_i - T_a) / I$.

5.1.2.6.2 Typical glazed, flat-plate, hot water collectors with a selective surface shall have an efficiency equation of $0.6 - 4.5 \cdot (T_i - T_a) / I$.

5.1.2.6.3 Typical evacuated-tube, hot water collectors shall have an efficiency equation of $0.3 - 1.6 \cdot (T_i - T_a) / I$.

5.1.2.6.4 Typical unglazed hot water collectors shall have an efficiency equation of $0.7 - 18.3 \cdot (T_i - T_a) / I$.

5.1.2.6.5 Typical glazed flat-plate hot air collectors shall have an efficiency equation of $0.4 - 6 \cdot (T_i - T_a) / I$.

5.1.2.6.6 Concentrating and non-typical flat plate collectors shall be assigned an efficiency equation based on collectors of similar design. The equation will be established based on the most conservative intercept and average slope of all similarly designed collectors for which data is available.

5.1.2.6.7 Integral collector storage (ICS), thermosiphon, and non-conventional solar collectors shall be assigned energy production values conservative for their design, based on previously completed testing for similar designs where available.

5.1.3 Innovative Solar Equipment

FSEC shall process applications for "innovative" solar equipment (i.e., equipment that cannot be fairly and adequately evaluated under the test standards identified for standard equipment) as follows:

The manufacturer may submit proposed evaluation criteria to FSEC. FSEC shall notify the manufacturer of acceptance or rejection of the proposed evaluation criteria with a specific and detailed explanation of the reasons for rejection. FSEC will then specify, with an explanation to the manufacturer, the FSEC designated evaluation method. Once an evaluation method has been agreed upon by FSEC and the manufacturer, and after the manufacturer submits the complete application, the FSEC review process will follow that for standard equipment.

5.1.4 Certifying Similar Models

Test results from one model may be used to certify a similar model if all materials, part designs and construction techniques are identical and only the collector size has been changed. Other model changes, even those that the manufacturer may deem insignificant shall be submitted to be considered for certification with the test data from similar models. FSEC will review the application to determine if recalculated performance is accurate enough to not require new testing, and issue certification provided that performance, durability and consumer confidence are not jeopardized. Separate applications for certification must be submitted for separate models.

The thermal performance of similar models that have different glazing thickness may be calculated using the difference in transmissivity of the glazing materials. This procedure will be used only if both cover materials are in the same material category.

5.1.5 Qualifying Previous Testing

No certification shall be based on test data older than 20 years. Test data submitted to FSEC in support of an application for collector certification may be acceptable if the tests were performed within the last 20 years on the same model as the one submitted to FSEC for certification and the laboratory that performed the testing was accredited by FSEC at the time of the test.

5.1.6 Collectors Sold by Licensee

A collector which has been FSEC certified and rated as produced by one manufacturer that is also fabricated/assembled and sold by another manufacturer, who is a Licensee of the first, may be certified by FSEC upon (a) written authorization from the original applicant to issue certification to the Licensee, (b) submittal by the Licensee of an FSEC Solar Collector Labeling Agreement, (c) submittal by the Licensee of a completed Collector Certification Application, (d) submittal of a complete FSEC solar collector certification test conducted on a randomly selected collector which has been fabricated/assembled by the Licensee, and (e) payment of requisite fees.

A solar collector which has been FSEC certified and rated as produced by one manufacturer that also is sold by another company, who is a Licensee of the first but where no fabrication/assembly of the product is performed by the Licensee, may be certified by FSEC upon (a) written authorization from the original applicant to issue certification to the Licensee and verification that the model for which the application is made is identical in material, construction techniques, specifications, and parts design to the model originally certified and that the Licensee is not involved in any fabrication or assembly of the certified collector, (b) execution by the Licensee of an FSEC Solar Collector Labeling Agreement, (c) submittal by the Licensee of an FSEC Application for Solar Collector Certification form, and (d) payment of requisite fees.

Licencees must meet the same conditions and program requirements for certification as are required of other FSEC solar collector certification program participants.

5.1.7 Initiating the Process

Initiating the certification process is the manufacturer's responsibility. The applicant shall:

- a. Apply for certification using the forms incorporated in the Collector Certification Application.
- b. Request FSEC to initiate the random selection process of the model submitted for certification for testing at an ISO/IEC 17025 accredited laboratory approved by FSEC of the applicant's choice.

5.1.8 Periodic and Challenge Retests

Periodic Retests - To verify manufacturing quality control, an FSEC representative may conduct periodic inspections of manufacturing facilities or a manufacturers' distribution facilities. If deemed necessary, the FSEC representative will select a sample of the certified model from existing stock, submit it to an accredited laboratory for testing and evaluate the test results. The manufacturer will pay retesting fees if the model fails. FSEC will pay retesting fees if the model passes. Failure is defined as a decrease in the thermal output rating (the rating appropriate to the collector design) by more than 10 percent from the original rating, or significant change in design, material properties or model dimensions, as determined by FSEC.

If the sample fails to meet or exceed the product description or performance requirements, certification for that model and any size changes based on or related to that model will be revoked.

Challenge Retest - If a manufacturer's collector rating is challenged by another party and retesting verifies that the original performance has been maintained or increased, the challenging party shall pay the retesting fees. If the thermal output rating increases or decreases by greater than 10 percent and/or there is significant change in design, material

properties or model dimensions, as determined by FSEC, then the collector may be considered a new model and certified as such. This will also apply to all other collectors based on or related to that model. The manufacturer shall submit all documentation for the new model and any fees not covered under the challenge process. Certification of the original collector may be revoked per Section 5.1.10. Random selection provisions outlined in Section 5.1.6 shall apply to challenge retests.

5.1.9 Denying Certification

If FSEC determines that the applicant does not satisfy all criteria of certification, the applicant shall be given written notice containing a statement of all reasons for the denial.

The applicant may contest the reasons for the denial by giving FSEC a prompt notice of contention. The applicant may, at this point, present collateral evidence and materials. The application will be reconsidered for certification and a final decision made based solely on evidence in the application file.

An applicant aggrieved by the FSEC final decision may, within a reasonable time, file a written request for review. FSEC shall appoint a Certification Review Committee which will reconsider the evidence on file. FSEC shall, based upon the recommendation of the Certification Review Committee, affirm, modify or reverse the initial decision and shall so inform the applicant of the Certification Review Committee recommendations.

5.1.10 Terminating Certification

The manufacturer of a certified product may voluntarily terminate certification by giving written notice to FSEC. The notice shall state the effective termination date and reason for termination.

5.1.11 Revoking Certification

FSEC may revoke or suspend certification of a product in the event of:

- a. Material misrepresentation in the application for certification.
- b. Misrepresentation that a specific collector's certification applies to other models which have not been certified.
- c. Failure to pay fees established by FSEC.
- d. Failure to comply with a condition of certification or labeling.
- e. Modifications of facts on the FSEC certification documents
- f. Failure to meet the requirements of Section 5.1.11, Collector Inspection.

The procedure for revoking certification will conform to the process for denying certification specified in Section 5.1.8

5.1.12 Collector Inspection

A representative sample of a collector that has been FSEC certified shall be subject to an announced manufacturer's facility inspection every two to four years to determine that the collector design and materials are as specified in the certification documentation. In some cases it may not be feasible to conduct a manufacturer's facility inspection. In those situations, arrangements will be made to conduct the inspection at a manufacturer's distributor facility or other acceptable location.

6.0 Certification Labeling

A label containing basic product information will then be required by FSEC to be affixed to each collector manufactured or distributed under the brand name and model number.

When a product is certified, FSEC will notify the applicant of certification in writing and identify the information required on the certification label. The manufacturer shall be responsible for printing all labels and shall only use the label approved by FSEC.

The manufacturer will have the option of including the required label information using a label design supplied by FSEC or the manufacturer's own label design. If the manufacturer chooses to design a label, a sample of the label must be submitted to FSEC for approval prior to labeling units. The approved certification label shall be permanently affixed to all production units of the certified model.

The certification symbol may be used in advertising, in catalogs and sales promotion material provided clear reference is made as to which models certification applies.

6.1 Agreement for Labeling Solar Collectors

The manufacturer, supplier or seller (hereinafter called the seller) shall be required to execute an FSEC Solar Collector Labeling Agreement.

6.1.1 Agreement by FSEC

For each certified solar collector FSEC will:

- a. Furnish the seller with one copy of the approved label information.
- b. Authorize the seller to use the FSEC name and symbol on the label of each certified model.

6.1.2 Agreement by the Seller

To maintain the collector certification under the FSEC program the seller must agree to:

- a. Represent a collector as certified only when it is manufactured of the same materials and specifications as the collector that was originally certified.
- b. Permanently affix an FSEC approved certification label to all production units of the certified model.
- c. Notify FSEC of changes in collector design, materials or construction and accept FSEC's judgment relative to whether these changes constitute a new model requiring retesting.

- d. Make copies of the FSEC certification information available to the consumer upon request.
- e. Permit FSEC to conduct a manufacturer's facility inspection every two to four years to determine that the collector design and materials are as specified in the certification documentation.
- f. Permit FSEC to select, at any time, a certified collector offered for evaluation and/or retest according to Section 5.1.7 of this document to demonstrate its compliance to specifications and performance given in the original certified test report. Payment of fees for retesting will be in accordance with the provisions of paragraph 5.1.7.
- g. Pay annual certification and listing fees.

7.0 Standard Method for Thermal Performance Rating

7.1 Purpose

A set of three thermal performance ratings will be assigned to collectors certified by FSEC. These ratings will provide a uniform basis for comparing solar collectors sold in Florida by applying results of the thermal performance test to a set of representative operating conditions.

7.2 Scope

This method is suitable only for rating collectors that utilize both direct and diffuse components of incident solar radiation and do not track or move during operation.

7.3 Conditions

7.3.1 Operating Temperature

A single set of environmental conditions will be used to provide an estimate of collector thermal output for the following three average fluid temperatures:

- a. Low temperature (LT); 25°C (77°F); representative of operating conditions for swimming pool heating.
- b. Intermediate temperature (IT); 50°C (122°F); representative of operating conditions for domestic water heating.
- c. High temperature (HT); 100°C (212°F); representative of operating conditions for suitably designed high temperature applications.

If there is no calculated output from a collector under a given operating temperature, the rating for that temperature will be given as "0" to signify that the collector is not applicable to operations at this temperature.

Insolation (Watts/m ²)	Ambient Temperature (°C)	Insolation (Btu/ft ² hr)	Ambient Temperature (°F)
50	24	16	75
151	25	48	77
252	25	80	77
353	26	112	79
454	27	144	81
555	27	176	81
656	28	208	82
757	29	240	84
858	29	272	84
959	30	304	86
5045 W-hr/m ²	27 (Avg)	1,600 Btu/ft ²	81 (Avg)

Table 1 Insolation and Ambient Temperature for Standard Day

7.3.2 Standard Day

The following temperature and insolation conditions are used to represent one 10-hour period of collector operation called the "Standard Day."

- Ambient temperature will average 27°C (81°F) and be distributed as in Table 1.
- Solar insolation will total 5,045 W-hr/m² (1600 Btu/ft²) and be distributed as in Table 1.
- For unglazed collectors, a wind speed (u) of 2.5 m/s (5.6 mph) will be assumed.
- For unglazed collectors, a net longwave irradiance (IR) of 65 W/m² (20.6 Btu/ft²hr) will be assumed.

7.4 Equations and Definitions

7.4.1 Glazed Collectors

7.4.1.1 Equations

Measured collector efficiency for normal incidence may be expressed by a second-order equation of the form

$$\eta = a + bx + cIx^2 \quad (1)$$

where a, b and c are computed constants for a given collector, and

$$x = \frac{t_{in} - t_{amb}}{I} \quad (2)$$

in which t_{in} is the collector inlet fluid temperature, t_{amb} is the ambient air temperature, and I is the total solar irradiance measured in the plane of the collector. The value of b and c are normally negative. If the value of c is positive, the first-order equation shall be used to calculate the performance ratings.

7.4.1.2 Calculations

Collector output of one hour may be estimated by

$$q = \eta I \quad (3)$$

where η is expressed by equation (1) above, and I is the total solar irradiance during the hour.

The summation of hourly outputs gives the output for the Standard Day. For glazed collectors using the second-order efficiency curve, the following equation is used.

$$Q = \sum_{i=1}^{10} I_i (a - bx_i - cx_i^2) \quad (4)$$

7.4.1.3 Sample Calculation for Glazed Collectors

An example of a representative collector efficiency curve is

$$\eta = 0.70 - 3.0x - .010Ix^2 \quad (5)$$

For $t_{in} = 50^\circ\text{C}$ (intermediate temperature operation), $t_{amb} = 27^\circ\text{C}$, and $I = 555 \text{ W/m}^2$

$$x_6 = \frac{50 - 27}{555} = 0.0414 \frac{m^2 \text{ } ^\circ\text{C}}{W}$$

Then, for the 10-hour Standard Day, the rating for intermediate temperature (IT) operation is calculated as shown in Table 2.

Hour No.	I (W/m ²)	x _i (°C-m ² /W)	η	Output (W·hr/m ²)
1	50	0.5200	*	*
2	151	0.1656	0.162	24
3	252	0.0992	0.378	95
4	353	0.0680	0.480	169
5	454	0.0507	0.536	244
6	555	0.0414	0.566	314
7	656	0.0335	0.592	388
8	757	0.0277	0.611	462
9	858	0.0245	0.621	533
10	959	0.0209	0.633	607
DAILY	5,045 W-hr/m ²			2838 W·hr/m ²

Table 2 Intermediate Temperature Glazed Collector Output

For a collector area of 3.7 m² (40 ft²), the rating for intermediate temperature operation is

$$IT = 10.5 \text{ kWh (35,800 Btu)}$$

Similar computations for low and high temperature operation produce ratings for the same example collector

$$LT = 13.3 \text{ kWh (45,300 Btu)}$$

$$HT = 5.1 \text{ kWh (17,300 Btu)}$$

Note that the ratings are rounded to the nearest tenth kWh or to the nearest hundred Btu.

7.4.2 Unglazed Collectors

7.4.2.1 Equations

Measured collector efficiency for normal incidence may be expressed by a first-order equation of the form

$$\eta = a - (b_1 + b_2 u) \frac{t_{in} - t_{amb}}{I''} \quad (6)$$

where a, b₁, and b₂ are computed constants for a given collector, u is the wind speed, t_{in} is the collector inlet fluid temperature, t_{amb} is the ambient air temperature, and

$$I'' = I + IR \quad (7)$$

in which I'' is the net irradiance, I is the total solar irradiance measured in the plane of the collector, and IR is the net longwave irradiance in the plane of the collector.

7.4.2.2 Calculations

Collector output during one hour may be estimated by

$$q = \eta I'' \quad (8)$$

where η is expressed by equation (6) above, and I'' is the net irradiance during the hour.

The summation of hourly outputs gives the output for the Standard Day. For unglazed collectors, the following first-order efficiency curve is used.

$$Q = \sum_{i=1}^{10} I_i'' \left(a - (b_1 + b_2 u) \frac{t_{in} - t_{amb,i}}{I_i''} \right) \quad (9)$$

7.4.2.3 Sample Calculation for Unglazed Collectors

An example of a representative collector efficiency curve is

$$\eta = 0.86 - (25.5 + 2.82u) \frac{t_{in} - t_{amb}}{I''} \quad (10)$$

For $t_{in} = 25^\circ\text{C}$ (low temperature operation), $t_{amb} = 27^\circ\text{C}$, $I = 555 \text{ W/m}^2$, $u = 2.5 \text{ m/s}$ and $IR = 65 \text{ W/m}^2$

$$x_6 = \frac{25 - 27}{555 + 65} = -0.00323 \frac{\text{m}^2 \text{ } ^\circ\text{C}}{\text{W}}$$

Then, for the 10-hour Standard Day, the rating for low temperature (LT) operation is calculated as shown in Table 3.

Hour No.	I (W/m ²)	x _i (°C-m ² /W)	η	Output (W·hr/m ²)
1	50	0.00870	0.577	66
2	151	0.00000	0.860	186
3	252	0.00000	0.860	273
4	353	-0.00239	0.938	392
5	454	-0.00385	0.985	511
6	555	-0.00323	0.965	598
7	656	-0.00416	0.995	718
8	757	-0.00487	1.018	837
9	858	-0.00433	1.001	924
10	959	-0.00488	1.019	1043
DAILY	5,045 W-hr/m ²			5549 W-hr/m ²

Table 3 Low Temperature Unglazed Collector Output

For a collector area of 3.7 square meters (40 ft²) the rating for low temperature operation is

$$LT = 20.5 \text{ kWh (70,100 Btu)}$$

Similar computations for intermediate and high temperature operation produce ratings for the same example collector

$$IT = 1.3 \text{ kWh (4,600 Btu) and}$$

$$HT = 0 \text{ kWh (0 Btu).}$$

Note that the ratings are rounded to the nearest tenth kWh or to the nearest hundred Btu .

8.0 Acceptance of Test Results from Other Organizations

A collector tested by an organization other than the Florida Solar Energy Center will be certified as meeting FSEC standards subject to the following provisions.

8.1 Laboratory Certification

Testing organizations must meet the following conditions:

- a. Hold accreditation to ISO/IEC 17025 by a recognized accreditation organization.
- b. Have the appropriate ISO test standard included in the laboratory's ISO/IEC 17025 scope.
- c. Permit FSEC personnel to visit the organization's test facility and observe testing procedures.

8.2 Documentation on Collector and Test Results

The manufacturer/seller requesting collector certification shall:

- a. Furnish complete drawings and specifications for the collector tested as required by this document and the Collector Certification Application.
- b. Submit a copy of the complete test report.
- c. Sign the FSEC Solar Collector Labeling Agreement.

(This appendix is not part of this standard but is included for information only.)

Appendix A: Bibliography

Operation of the Solar Thermal Collector Certification Program, FSEC Standard 101-05, Florida Solar Energy Center, 1679 Clearlake Road, Cocoa, FL 32922-5703.
<<http://www.fsec.ucf.edu/>>

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