

FLORIDA SOLAR



ENERGY CENTER[®]

FSEC STANDARD

Operation of the Solar Thermal Systems Certification Program

FSEC Standard 103-10

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1679 Clearlake Road, Cocoa, FL 32922-5703 • Phone: 321-638-1000 • Fax: 321-638-1010
www.fsec.ucf.edu



A Research Institute of the University of Central Florida

Table of Contents

1.0	[Reserved]
2.0	[Reserved]
3.0	Definitions and Nomenclature
3.1	Definitions
3.2	Nomenclature
4.0	[Reserved]
5.0	Implementation
6.0	Requirements for Approval
6.1	Active System Components
6.2	Passive System Components
6.3	System Manual
7.0	Classification of Systems
7.1	Basic System
7.2	Similar System
7.3	System Changes
8.0	Standards Administration
8.1	Award of Certification
8.2	Display of System Certification
8.3	Denial of Certification
8.4	Systems Sold by Licensee
8.5	Revocation of Certification
8.5.1	Seller Initiated
8.5.2	FSEC Initiated
9.0	System Performance Rating for Domestic Hot Water Systems
9.1	Rating Conditions
9.2	Energy Factor Ratings
9.2.1	Energy Factor Rating Methodology
9.3	Energy Output Rating
9.3.1	Energy Output Rating Methodology
9.4	Solar Fraction Rating
9.4.1	Solar Fraction Rating Methodology
10.0	Qualifying Previous Testing
11.0	Requirements for Inspection
11.1	System Inspection
12.0	Acceptance of Test Results from Other Organizations
12.1	Laboratory Certification

3.0 Definitions and Nomenclature

3.1 Definitions

The terms defined below have the given meaning in this document.

Approved - Evaluated on the basis of suppliers' data and application information and considered by FSEC to be suitable for use in solar energy systems. Tests are required for some components and limitations on suitable uses may be stated.

Auxiliary System – That portion of a SWH system that utilizes energy other than solar to supplement the output provided by a solar energy system.

Building Official: The official authorized to act in behalf of the responsible government agency for the local enforcement of codes.

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

Conventional system – A water heater that does not utilize solar energy.

Energy Output: The Energy Output (EO) rating is the estimated annual amount of energy (in kilowatt-hours) that did not have to be produced by electricity or gas.

Equivalent - Those alternatives which have been officially approved by FSEC.

Energy Factor: The Energy Factor represents the ratio of the solar hot water energy made available by each approved system divided by the auxiliary energy used by the system. The annual Energy Factor (EF) reported for each system is used to determine hot water credit multipliers for residential solar water heating systems in Chapter 13 of the Florida Building Code.

FSEC: The Florida Solar Energy Center, 1679 Clearlake Road, Cocoa, Florida 32922-5703.

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

Manual: The total documentation package to be provided by the seller to the purchaser which describes the general operation and maintenance procedures for the system. The manual will include a parts list, a system diagram, a description of major components, and other features required by the standards document.

Major Component: Collector, storage tank, controller, pump, heat exchanger or their functional equivalent.

May - Action indicated is allowed.

Owner: The person, group or organization who contracts to lease or buy the solar energy system.

Revoke - Certification withdrawn.

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

Shall - The criterion is required to comply with the standard.

Solar Fraction: The Solar Fraction is the percentage of hot water load produced solely by the solar system.

Supplier - An entity which assumes responsibility for the solar water heating system approved by FSEC, according to the procedures described herein.

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

SWH System: Domestic hot water system deriving at least part of its thermal energy output from incident solar energy. This definition includes active and passive systems.

System (Also referred to as SWH System) - A unit or package of components designed to provide solar heated water to residential-type loads.

TRNSYS - A particular system simulation software program.

3.2 Nomenclature

$Q_{auxconv}$	=	Electric or gas energy consumed by a conventional water heater without solar
$Q_{auxsolar}$	=	Electric or gas energy input to the auxiliary portion of the solar system
$Q_{insolar}$	=	Energy (electric or gas) consumed by the solar system to provide the same hot water load as a conventional water heater
$Q_{loadconv}$	=	Hot water load delivered by a conventional water heater without a solar system
$Q_{loadsolar}$	=	Hot water delivered by the solar system
Q_{outadj}	=	A calculated adjustment for the difference between the load delivered by the solar system versus that delivered by a conventional stand alone water heater

Q_{par} = Parasitic energy used by the solar system pump, controller, and other power consuming devices used for system operation excluding the auxiliary water heater

0_{hr} = Efficiency of the auxiliary water heater. The auxiliary water heater is the water heater incorporated in the solar system and used to supplement the solar system.

104-10

5.0 Implementation

System certification and thermal performance ratings shall only be awarded to those solar system suppliers who explicitly follow the process established in this document. All components shall be installed in accordance with the manufacturer's instructions unless an alternate method of installation is approved by FSEC. Installed certified solar energy systems shall also comply with all codes in force at the installation site.

In order to be awarded certification, the design and analytical evaluation of components which comprise the SWH system, i.e., collectors, controls, sensors, fluids, heat exchangers, pumps, plumbing, piping and tanks, etc., shall meet or exceed the minimum standards established in FSEC Standard 104-10, "Florida Standards for Design and Installation of Solar Thermal Systems."

All systems must comply with FSEC standards whether they are leased, sold, assembled, or in a kit. Requirements for approval of components and manuals may be waived for an owner designed and constructed system. Such systems must still meet safety and health requirements of applicable local codes.

6.0 Requirements for Approval

The supplier will initiate the certification process by submitting the documentation in the FSEC System Certification Application and paying the applicable fee. A separate application shall be submitted for each different system configuration and each different system size.

Installation and owner's operation manuals, system diagrams, and component data submitted for approval will be evaluated per the criteria listed in FSEC Standard 104-10. Such information shall comply with FSEC Standard 104-10 if supplied in rigorous conformance to any FSEC – supplied template for the type system submitted.

In addition to the documentation required in the FSEC System Certification Application, the following information must also be submitted.

6.1 Active System Components

1. Collectors

Collectors must be certified per FSEC Standard 101-10, "Operation of the Solar Thermal Collector Certification Program."

2. Controllers

Manufacturer's name and address.

Model number.

Descriptive brochure, including specifications information providing the following:

- Reports on safety or other certification tests, if available.
- Operating temperature differences and tolerances, and environmental temperature limitations.
- Evidence of independent laboratory test in accordance with appropriate UL standard.
- Evidence of compliance with criteria listed in FSEC Standard 104-10

3. Storage tanks

Manufacturer's name and address.

Model number.

Descriptive brochure, including specifications information providing the following:

- Dimensions and construction of integral heat exchanger if one is used.
- Evidence of compliance with criteria listed in FSEC Standard 104-10.

4. Pumps

Manufacturer's name and address.

Model number.

Descriptive brochure, including specifications information providing the following:

- Materials of pump body and impeller in contact with the pumped fluid.
- Evidence of compliance with criteria listed in FSEC Standard 104-10.
- Maintenance requirements.
- Description of overload protection (must be protected by overcurrent or overtemperature device or by impedance of windings according to the National Electrical Code).
- Limitations on fluids used.

5. Heat exchanger

Manufacturer's name and address.

Model number.

Descriptive brochure including applications information and specifications of at least the following:

- Materials in contact with heat transfer fluids on both sides of the heat exchanger.

6. Other components

Manufacturer's name and address.

Model number

Descriptive brochure, including specifications information providing the following:

- Appropriate approvals from recognized third party listing agencies.
- Performance information

6.2 Passive System Components

Applicants must provide a report on a test conducted on the solar collecting portion of the system in accordance with FSEC Protocol 105-05, Solar Thermal System and Component Test Protocols. Testing organizations must meet the requirements outlined in Section 12.0 below.

Collector, storage tank, and heat exchanger requirements as outlined above must also be met.

6.3 System Manual

Two copies of the system manual must be submitted to FSEC for approval. The manual must comply with the criteria listed in FSEC Standard 104-10. A system manual shall comply with FSEC Standard 104-10 if supplied in rigorous conformance to any FSEC – supplied template for the type system submitted. In such cases, printed copies of the manual are not required in addition to the electronic submission.

7.0 Classification of Systems

A system will be approved on the basis of:

- a. Collector specified by manufacturer's name and model number and the number of units used in the system. As many as two additional alternate collector combinations may be specified, but the lowest-rated collector or collector combination must have a rating that is at least 75 percent of the rating for the highest-rated collector or collector combination. In addition, the total number of installed collectors per individual system must be similar.
- b. Specified tank and no more than three alternates of the same type and having the same volumetric capacity.
- c. Specified pump and no more than three alternates.
- d. Specific controller and no more than three alternates. All controllers must be of the same operational type.

e. System diagram showing and labeling the components and their arrangement and interconnection in a plumbed system.

Change in any of items a. through e. above constitutes a change in the system, which must be approved by FSEC.

7.1 Basic System

A system with a unique plumbing arrangement, controller type and with a similar number of installed collectors is a basic system.

a. Examples of changes that produce a different basic system:

- Piping is changed from a direct solar loop to an indirect loop.
- Control method is changed from differential temperature control to photovoltaic control.

7.2 Similar System

A DHW system which differs from another only in component size, capacity rating, etc., is a similar system.

a. Examples of changes that create a similar system:

- Using two installed collectors instead of one. Using three installed collectors instead of two, etc.
- Substituting an 82-gallon tank for a 66-gallon tank.
- Changing collector options if the maximum ratio requirement is not met. The ratio of the lowest-rated collector to the highest rated collector must be at least 0.75.

7.3 System Changes

Changes in a certified system that require approval of FSEC are:

1. Changes in the manufacturer's model number of the collector, tank, pump, heat exchanger or controller to one not listed on the system certification document.
2. A change in the number of collectors used in a SWH system.
3. A change in the schematic diagram; that is, a change in the arrangement and interconnection of parts in the system.

8.0 Standards Administration

8.1 Award of Certification

An agreement between FSEC and a seller is required for certification of a solar water heating system meeting the requirements of this Standard.

When the certification is completed, the seller will receive a system certification document and conditions for maintaining the certification.

8.2 Display of System Certification

On each approved manual there shall be pasted or printed a label stating:

"The solar energy system described by this manual, when properly installed and maintained, meets the minimum standards established by the Florida Solar Energy Center in accordance with Section 377.705, Florida Statutes. This certification does not imply endorsement or warranty of this product by the Florida Solar Energy Center or the state of Florida."

A listing of approved systems will be maintained by FSEC. Updates will be made on an on-going basis. To verify the certification of a system, an interested party or building official can access the FSEC web site to obtain a listing of certified solar systems at <http://www.fsec.ucf.edu/solar/>.

FSEC may correspond with manufacturers annually to determine if each system manual and the description of each listed component remains accurate and if the manufacturer wishes to maintain the certification listing for the next year.

8.3 Denial of Certification

If FSEC determines that the applicant does not satisfy all the criteria for certification, FSEC shall give the applicant written notice containing a statement of all reasons for denying certification. An applicant aggrieved by the FSEC decision may file a written request for review with FSEC. The FSEC Director shall appoint a Certification Review Committee which will reconsider the information on file. Based upon the recommendation of the Certification Review Committee, FSEC shall affirm, modify or reverse the initial decision and shall so inform the applicant of the Certification Review Committee's recommendations.

8.4 Systems Sold by Licensee

A SWH system certified by FSEC that is also fabricated and sold by another manufacturer who is a Licensee of the first will be certified upon (1) application by the Licensee (2) verification by FSEC that the system is identical in components and configuration to the system already certified and (3) receipt of written authorization from the Licensor allowing issuance of certification to the Licensee.

System certification issued to the Licensee will be consistent with system certification issued to the Licensor. Changes made to the Licensor system will automatically be made to the Licensee system. Revision fees will be paid by both Licensor and Licensee. The Licensee system cannot be changed without identical changes also being made to the Licensor system.

FSEC will also correspond with the Licensee on an annual basis to determine if each system manual and the description of each listed component remains accurate and if the Licensee wants to maintain the listing for the next year. If the original Licensor of that system does not choose to maintain the system listing, the Licensee system will also be removed from the approved system listing.

The Licensee must meet the same conditions and program requirements for certification as are required of other FSEC system certification participants.

8.5 Revocation of Certification

8.5.1 Seller Initiated

A manufacturer who has been issued certification for a SWH system may voluntarily terminate that certification by giving written notice to FSEC and shall state the effective termination date and reason for termination.

8.5.2 FSEC Initiated

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

1. Material misrepresentation in the application for certification.
2. Misrepresentation that one SWH system's certification applies to another system which has not been certified.
3. Use of components not approved as part of the certified system.
3. Failure to comply with a condition of certification or labeling.
4. Failure to correct a discrepancy which is detected by FSEC after initial FSEC certification. Seller will be given 30 days in which to make corrections.
5. Misuse or misrepresentation of the FSEC rating.
6. Failure to pay required certification and listing fees.
7. Installations that do not follow the design and installation procedures specified in the FSEC approved system manual or FSEC Standard 104-10.
8. Failure to meet the requirements of Section 10.1, System Inspection.

The procedure for revoking certification shall conform to the process for denial of certification as specified in Section 8.3 above.

9.0 System Performance Rating for Domestic Hot Water Systems

Ratings for solar domestic water heating systems have been developed by FSEC to provide the solar industry and consumers a reasonable method of comparing solar water heating systems. The ratings provided are intended for use in comparing solar systems and may not accurately predict the performance of a system installed at a specific site. Specified system ratings are an estimate only and are not guaranteed. They are based on specific collector or system test results, typical water usage, and typical Florida climatic conditions. The actual solar contribution can vary and is dependent on the weather, the user, and proper system installation and maintenance. When multiple options are specified for a particular component, the ratings are based on the components that result in the lowest rating.

FSEC will provide three ratings for solar systems. These ratings will be posted on the FSEC web site. The ratings are based on the estimated annual performance of the system using the TRNSYS system simulation program and typical meteorological year (TMY2) weather data. Ratings for the three regions defined by the Florida Building Code are based on Jacksonville (North), Tampa (Central), and Miami (South). The following ratings will be provided.

9.1 Rating Conditions

In these ratings, the quantity of hot water drawn from each SWH system is equivalent to that produced by a conventional (electric or gas) water heater. The conventional water heater is a 52-gallon electric water heater with an Energy Factor of 0.9, or a gas water heater with an Energy Factor of 0.6.

Table 1. Conditions upon which performance ratings are based

Conditions	Value
Hot water load	64.3 gallons (243 liters) per day drawn throughout the day with the maximum loads occurring at 8 a.m. and 8 p.m. ¹
Water mains temperature	Varied monthly using values for each city. ²
Collector orientation	Facing south at a tilt of 24 degrees ³
Distance from collector to tank	25 feet (7.6 meters) pipe length (each way), 16 feet (4.9 meters) of that is vertical rise. Total calculation is based on 50 feet.
Backup heater set points	120 ⁰ F (48.8 ⁰ C) ⁴
Weather conditions	TMY2 data for each city. ⁵
Air temperature around indoor tanks	$T_{air} + [(72 - T_{air})/3]$, this estimates the temperature in a garage.
<p>¹ This profile is from ANSI/ASHRAE Standard 90.2-2001, "Energy Efficient Design of Low-Rise Residential Buildings", Section 8.9.4, Hourly Domestic Hot Water Fractions" and Table 8-4, "Daily Domestic Hot Water Load Profile." See Figure 1 below.</p> <p>² Based on TMY2 data and the equation provided in "Building America Performance Analysis Procedures: Revision #1, Building Technologies Program, National Renewable Energy Laboratory, NREL/TP-550-35567, Golden, CO, June 2004. pp 15-16." See Figure 2 below.</p> <p>³ Christensen, Craig B. (National Renewable Energy Laboratory) and Barker, Greg M., (Mountain Energy Partnership) Effects of Tilt and Azimuth on Annual Incident Solar Radiation for United States Locations, Proceedings of Solar Forum 2001: Solar Energy: The Power to Choose, April 21-25, 2001, Washington, D.C.</p> <p>⁴ This set point was chosen to follow the International Plumbing Code 2000, International Code Council, Inc. 120⁰ F (48.9⁰ C) maximum allowable in showers and tubs.</p> <p>⁵ TMY2s, Typical Meteorological Years", National Renewable Energy Laboratory, June 1995.</p>	

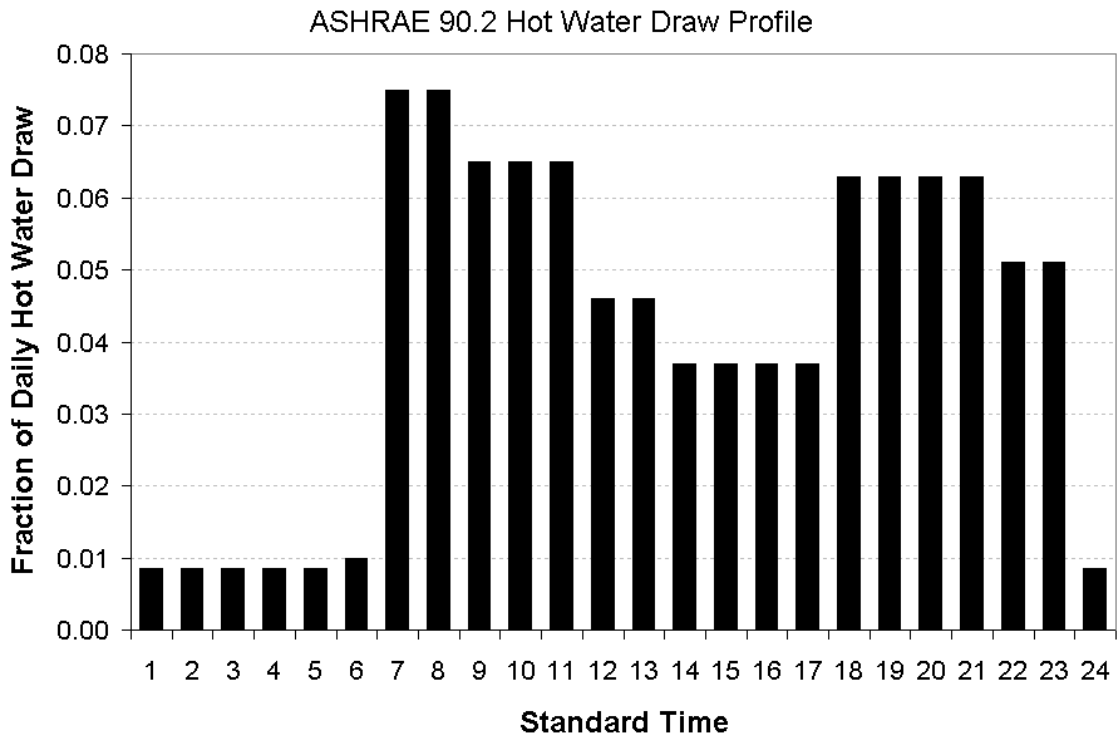


Figure 1. ASHRAE 90.2 Hot Water Draw Profile

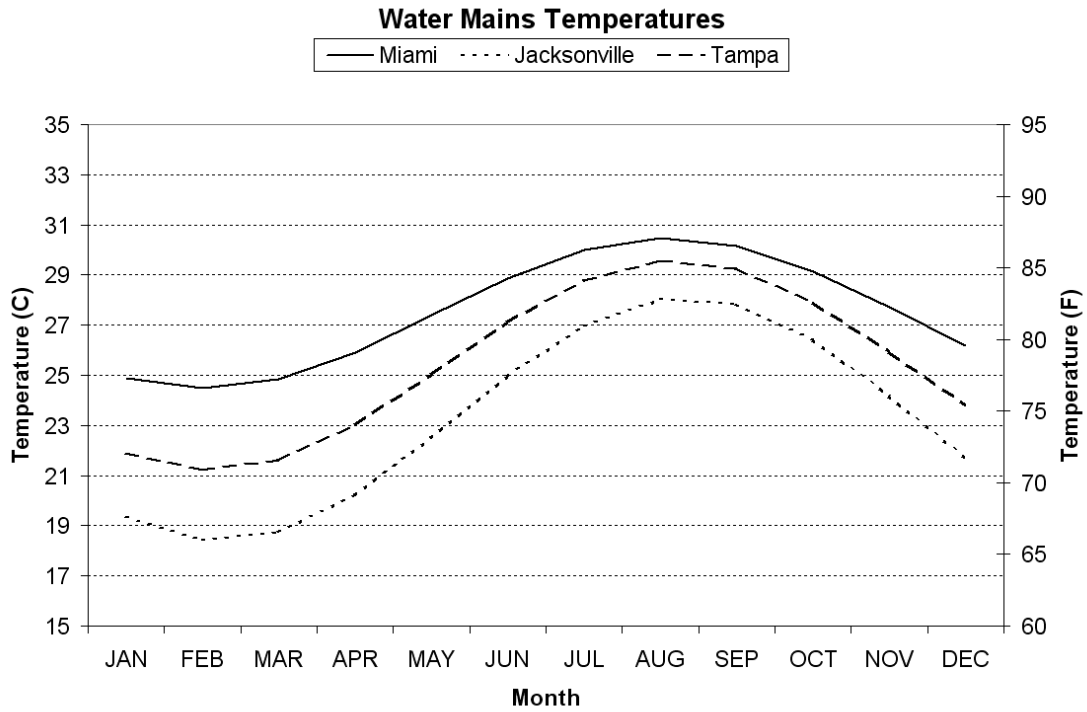


Figure 2. Water Mains Temperatures

9.2 Energy Factor (EF) Rating

FSEC will calculate annual Energy Factors for solar water heating systems (SWH) for use in the State of Florida. The annual Energy Factor is designed for use in determining the hot water credit multipliers for residential solar water heating systems in Chapter 13 of the Florida Building Code. These Energy Factors represent the ratio of the solar hot water energy delivered to the load by each approved SWH system divided by the electrical energy used by the total water heating system.

9.2.1 Energy Factor Rating Methodology

An annual Energy Factor (EF) will be defined as:

$$EF = \frac{Q_{loadconv}}{Q_{insolar}}$$

where:

$Q_{loadconv}$ = Hot water load delivered by a conventional water heater without a solar system.

$Q_{insolar}$ = Energy (electric or gas) consumed by the solar system to provide the same hot water load as a conventional water heater.

$$Q_{insolar} = \frac{Q_{auxsolar}}{\eta_{htr}} + Q_{par} - Q_{outadj}$$

where:

$Q_{auxsolar}$ = Electric or gas energy input to the auxiliary portion of the solar system.

η_{htr} = Efficiency of the auxiliary water heater. The auxiliary water heater is the water heater incorporated in the solar system and used to supplement the solar system.

Q_{par} = Parasitic energy used by the solar system pump, controller, and other power consuming devices used for system operation, excluding the auxiliary water heater.

Q_{outadj} = A calculated adjustment for the difference between the load delivered by the solar system versus that delivered by a conventional stand alone water heater.

$$Q_{outadj} = \frac{Q_{loadsolar} - Q_{loadconv}}{\eta_{htr}}$$

where:

$Q_{loadsolar}$ = Hot water delivered by the solar system.

9.3 Energy Output Rating

FSEC will calculate the Annual Energy Output of SWH systems. The Energy Output (EO) is the estimated annual amount of energy (in kilowatt-hours) that did not have to be produced by electricity or gas.

9.3.1 Energy Output Rating Methodology

An Annual Energy Output Rating will be defined as:

$$\text{Annual Energy Output} = Q_{auxconv} - \frac{Q_{auxsolar}}{\eta_{hr}} - Q_{par} + Q_{outadj}$$

where:

$Q_{auxconv}$ = Electric or gas energy consumed by a conventional water heater without solar.

9.4 Solar Fraction Rating

FSEC will calculate an annual Solar Fraction (SF) for each approved SWH system. The solar Fraction is the percentage of the hot water load produced solely by the solar system. (If, for example, a system has a 70% solar fraction, this means that 70% of the hot water is produced by the solar system, while the other 30% is produced by the auxiliary system.)

9.4.1 Solar Fraction Rating Methodology

The annual Solar Fraction is defined as:

$$SF = 1 - \frac{Q_{insolar}}{Q_{auxconv}}$$

10.0 Qualifying Previous Testing

No certification data shall be based on test data older than 20 years. Test data submitted to FSEC in support of an application for system 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.

11.0 Requirements for Inspection

Compliance with many of the requirements of the system standards document can be verified only by an on-site inspection made after installation.

11.1 System Inspection

A representative sample of a system that has been FSEC certified shall be subject to an announced manufacturer's facility or on-site installation inspection every two to four

years to determine that the system design and installation are as specified in the certification documentation and installation manual.

12.0 Acceptance of Test Results from Other Organizations

A system with components tested by an organization other than the Florida Solar Energy Center may be certified as meeting FSEC standards subject to the following provisions.

12.1 Laboratory Testing Program Certification

Testing programs of the organizations must meet the following conditions:

1. Hold accreditation to ISO/IEC 17025 by a recognized accreditation organization
2. Have the appropriate FSEC test standards and protocols included in the laboratory's ISO/IEC 17025 scope.
3. Permit FSEC personnel to visit the test facility and observed testing procedures.