Commonwealth of Puerto Rico
Office of Energy
Office of the Governor

3958

REGULATION FOR THE CERTIFICATION OF SOLAR EQUIPMENT

San Juan, Puerto Rico
August 1989

3958

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No. 3958
Date: March 2, 1990 4:17 p.m.
Approved: Antonio J. Colorado
Secretary of State
By: [signature]
Assistant Secretary of State

COMMONWEALTH OF PUERTO RICO
OFFICE OF ENERGY
OFFICE OF THE GOVERNOR OF PUERTO RICO

REGULATION FOR THE CERTIFICATION OF SOLAR EQUIPMENT

PART ONE: GENERAL CONDITIONS

ARTICLE 1 - TITLE

This Regulation shall be known as "Regulation for the Certification of Solar Equipment."

ARTICLE 2 - LEGAL AUTHORIZATION

This regulation has been adopted under powers conferred upon the Office of Energy of Puerto Rico by Law No. 133 of July 26, 1979; Law No. 128 of June 29, 1977, as amended; and Law Number 170 of August 12, 1988.

ARTICLE 3 - PURPOSE

The purpose is to establish minimum efficiency requirements for all solar equipment manufactured and sold commercially in Puerto Rico. In addition, guidelines, requirements and procedures for certifying solar equipment in Puerto Rico are established.

ARTICLE 4 - RULES OF INTERPRETATION

a) Tense, Gender and Number

The words and phrases used in this Regulation shall be interpreted according to their meanings in ordinary usage and their context. Words in the present tense include the future also; those in the masculine gender include the feminine and the neuter, except for cases in which this interpretation is absurd. The singular includes the plural, and the plural the singular.

b) Abbreviations and Definitions

1. Solar Equipment

Solar equipment is all machinery which converts the energy of the sun into usable energy, whether by thermal systems, oceanic thermal energy, photovoltaic, or wind energy. This term also includes separate equipment components.

2. Solar Collector

A solar collector is a device or apparatus for absorbing available solar energy, converting it to thermal energy, and transferring the thermal energy to a fluid or other medium in contact with the collector.

3. Model

A unit of solar equipment which can be identified by specific size, materials, construction and efficiency characteristics. A change in any characteristic comprises a new model.

4. Distributor or Manufacturer

Any natural or judicial person which manufactures or distributes solar equipment as described above.

5. Seller

A person who exhibits or offers to the public or consumer solar equipment for purchase.

6. Installer

A person which puts solar equipment in its place.

7. OEPR

Office of Energy of Puerto Rico

8. Innovative Equipment

   Equipment incorporating novel structure or composition into its design or elements, which introduces a new form of solar energy utilization.

9. Integrated Equipment Construction

   The combined physical and mechanical properties of solar equipment and components which comprise the collector and which contribute, collectively, to its satisfactory performance.

10. Nominal Efficiency

    Efficiency characteristics of a solar collector as determined by the tests delineated in this Regulation.

11. Location-Specific Collector

    A collector which is assembled in the specific location where it is to be used. For example, part of a building (insulation, structural framework) may form part of the collector. Or, it may be impractical to move a collector from one site to another due to size.

12. Auxiliary Energy System

    Equipment which uses an alternative source of energy to supplement a solar system, or which serves as an auxiliary source at times when the system needs to maintain its design temperature to continue operating.

13. Component

    A device or assembly, in particular one forming part of a more complex system.

14. Control Sub-System

    A group of devices and electrical, pneumatic or hydraulic accessories which are used to

regulate energy collection, transport, storage and utilization in order for a collector to meet health and safety requirements for occupants of a building.

15. Distribution System

The part of a solar system which transfers heat, circulating energy by conduits, pipes, or other means.

16. Heat Interchange Medium

A liquid or gas utilized to transfer heat from one medium to another, or to transfer thermal energy from one component to another.

17. Maximum Operating Temperature

Temperature of heat interchanger fluid in the outlet pipe of the solar collector when it is operating outdoors in hot weather, under maximum solar radiation conditions.

18. Solar Energy Thermal System

The group of components, equipment, controls, connectors and terminal elements which converts thermal energy to energy for space heating or cooling, water heating or processing systems.

19. Thermal Storage Subsystem

A group of elements for storing thermal energy to be utilized as necessary.

20. Sub-system

A separable, functional part of a system, such as a collector or a tank.

21. Toxic Substance

Any substance which, without being radioactive, can produce sickness or injury to a person who ingests, inhales, or absorbs it through the skin.

22. Client

A person for whom solar equipment is made or to whom it is transferred.

ARTICLE 5 - COVERAGE

The requirements of this Regulation shall apply to all solar equipment herein described, to all persons, natural or judicial, and to all groups of the same, whether they be manufacturers, distributors, or any other person involved in solar equipment commerce.

ARTICLE 6 - EQUIPMENT COVERED BY THIS REGULATION

The requirements of this regulation will apply to all solar equipment sold or fabricated on a commercial scale in Puerto Rico, as described herein.

ARTICLE 7 - CERTIFICATION LABEL

A label certifying basic product information will be affixed to every unit of solar equipment complying with OEPR requirements. Under no circumstance shall this label be removed.

ARTICLE 8 - PROPRIETARY INFORMATION

All distributors and manufacturers of solar equipment who provide information to OEPR may request that this information remain confidential. Nevertheless, information necessary to certify solar equipment will be public domain, in the event that certification is granted.

ARTICLE 9 - SOLAR EQUIPMENT MANUFACTURED OR DISTRIBUTED UNDER LICENSE

Each solar equipment model certified for a manufacturer or distributor, which is also manufactured or distributed by another manufacturer under license, shall be certified if (1) OEPR verifies that this solar equipment is identical in its materials and construction to the certified model; and (2) the original applicant has authorized the licensee in writing to distribute or manufacture the equipment.

ARTICLE 10 - APPROVAL OF CERTIFICATION

The Office of Energy of Puerto of Puerto Rico will be able to issue certifications valid for a period of five (5) years for all solar equipment manufactured and distributed in Puerto Rico. Certifications will be renewed at the request of individual companies, if and when the firms continue to comply with the requirements of the Regulation for Certification of Solar Equipment.

ARTICLE 11 - VOLUNTARY TERMINATION OF CERTIFICATION

The distributor or manufacturer of a product certified by OEPR may voluntarily terminate the certification, by notifying OEPR in writing.

The notification will specify the date of termination of the certification, and reasons for the same.

ARTICLE 12 - REVOCATION OF CERTIFICATION

OEPR will be permitted to revoke certification of a solar equipment model for the following reasons:

a) Submission of false materials or documentation for certification.

b) Using or attaching the certification label to a model which has not been certified.

c) Violation of one of the requirements of this Regulation.

OEPR will provide written notice of reasons for revocation. Affected parties may appeal revocation by notifying OEPR in writing of their reasons for contesting revocation.

OEPR will reconsider its decision to revoke and make a final determination in the matter.

A distributor or manufacturer harmed by an OEPR decision may appeal the decision under the Adjudication Procedure established by Regulation No. 3769 of February 7, 1989.

ARTICLE 13 - SANCTIONS

a) After this Regulation goes into effect, all solar equipment manufactured and sold on a commercial scale in Puerto Rico must be certified as complying with OEPR minimum efficiency specifications and standards. OEPR will publish a list of authorized laboratories which can certify compliance with its specifications and standards for solar equipment manufactured and sold on a commercial scale in Puerto Rico.

b) The Director of OEPR may impose administrative fines for non-compliance with the directives of this Regulation. These fines shall not be less than one hundred (100) dollars, or more than one thousand dollars (1,000). Each day of non-compliance shall be considered a separate violation.

c) Every persons who manufactures or sells in violation of what is herein established will be guilty of a misdemeanor. If convicted, he will be punished by a minimum fine of not less than two hundred (200) dollars and not more than five hundred (500) dollars, or incarceration for not less than two (2) months and not more than six (6) months, or both penalties, at the discretion of the Court.

d) All solar equipment sold or manufactured commercially in Puerto Rico must have a label affixed in a clearly visible place which states that the equipment complies with established specifications and standards. All persons who manufacture solar equipment on a commercial scale in Puerto Rico who fail to affix this label shall incur misdemeanor charges and, if convicted, will be punished by a fine of not less than one hundred (100) dollars and not more than five hundred (500) dollars, or incarceration for not less than one (1) month and not more than six (6) months, or both penalties, at the discretion of the Court.

e) OEPR may at any time refer any violation of this Regulation to the Department of Justice of Puerto Rico for

processing, as stipulated in Article 3 of Law Number 133 of July 26, 1979.

f) All impositions of administrative fines may be reviewed at the request of the affected party, under the terms and procedures established by Regulation Number 3769 of February 7, 1989.

PART TWO: SOLAR EQUIPMENT POWERED BY SOLAR COLLECTORS

This second part of the Regulation will apply exclusively to solar equipment powered by solar collectors.

SECTION A: SOLAR COLLECTOR REQUIREMENTS

ARTICLE 14 - SCOPE OF SECTION A

This section establishes the following:

a) Procedures and guidelines for solar collector certification.

b) Application for certification of solar collectors.

ARTICLE 15 - OTHER RELATED DOCUMENTS

Appendix B of this Regulation, entitled "Description of Testing Methods and Minimum Requirements for Certification of Solar Collectors," describes testing methods and criteria to be utilized in evaluation of solar collector thermal efficiency and durability.

Testing methods utilized to establish thermal efficiency have been obtained from Publication 93-77 of the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), entitled "Methods of Testing to Determine the Thermal Performance of Unglazed Flat Plate Liquid Type Solar Collectors." The publications "Standards 93-77" and "Standards 96-80" may be obtained by writing to the following address:

ASHRAE
Publication Sales Department
1791 Tullie Circle, N.E.
Atlanta, Georgia 30329

ARTICLE 16 - PROCEDURES AND GUIDELINES

a) Collector Certification Process

After this Regulation goes into effect, the certification process will be initiated, with the exception of stipulations of Articles 9 and 16(f). Distributors or manufacturers shall request OEPR to choose a unit of the collector at random from existing stock in the manufacturer's plant or distributor's facilities, or from a distribution site. Distributors or manufacturers are responsible for submitting collectors for testing and for paying costs. Upon completion of testing the distributor or manufacturer shall submit an application to OEPR. (See Appendix A for Application Form.) If the tests have been conducted by an OEPR-certified laboratory, results satisfy requirements, and the information in the application is complete, the collector will be certified. A label containing the basic product information, including the brand and model number, shall be affixed to the collector. The distributor or manufacturer will immediately notify OEPR of the other model numbers or brand names under which the solar collector is sold.

b) Conventional Solar Collectors

OEPR will evaluate applications for "conventional" collectors; that is, collectors which may be evaluated appropriately under the testing sequence described in Appendix B.

Once an application has been submitted in its entirety, OEPR will notify the distributor or manufacturer that the collector has been approved and certified. If not approved, the distributor or manufacturer will be advised of the specific

sections of the application which are incomplete, and steps necessary for revision will be explained. The distributor or manufacturer may submit the application anew after making requisite modifications, and certification will be issued.

c) Innovative Solar Collectors

Applications for innovative solar collectors--that is, collectors which cannot be evaluated appropriately by tests for conventional collectors--will be processed in the following manner: The distributor or manufacturer may submit proposed collector evaluation criteria to OEPR. OEPR will notify the distributor or manufacturer of acceptance or rejection of the criteria. In the event of rejection, notification will be accompanied by a detailed explanation of reasons for denial. Then, OEPR will determine evaluation criteria to be utilized and explain them in detail.

d) Location-Specific Collectors

Procedures to evaluate location-specific collectors will be carried out by testing a sample area of no less than two (2) square meters (twenty-two (22) square feet). The sample will be identical to the installed collector.

e) Certification of Similar Models

Test results for one model may, at the discretion of OEPR, be applied to a similar model if and when construction materials and techniques are identical, and only the surface area of the collector is changed. Any other change which a distributor or manufacturer considers not to impede application of tests for one model to a similar model may be submitted to OEPR. OEPR will

determine whether or not the same test may be utilized.

OEPR will issue certification for a similar model if and when the performance and durability of the collector, and consumer confidence, are not jeopardized. A separate application for each model shall be submitted.

f) Acceptance of Prior Testing

Test results for a model that has been approved in a state of the United States with the same requirements as OEPR's may be accepted by OEPR if and when:

1. The tests have been carried out on the same model submitted to OEPR for certification.
2. A laboratory approved by OEPR has carried out the tests.

g) Periodic Inspections and Investigations.

1. An official of OEPR may periodically inspect the plant or facilities of a distributor or manufacturer to verify product quality.
2. OEPR may investigate, at the request of interested parties or motu propio, whether or not a distributor or manufacturer of a certified item is complying with all requirements of this Regulation. Any person may request OEPR to investigate distributor or manufacturer and, to this end, present evidence to support the request. On the basis of information provided, OEPR will decide whether or not to carry out an investigation. Investigation may include, but is not limited to, periodic inspections and new laboratory testing.

3. If new laboratory tests are necessary, procedures described in Article 16(a) of this Regulation will be utilized.

4. If OEPR decides to revoke the certification of a solar equipment item, procedures described in Article 12 of this Regulation shall be utilized.

ARTICLE 17 - CERTIFICATION LABEL

a) When a collector is certified, OEPR will notify the applicant in writing and will describe the information required for the certification label. The label will be supplied by the applicant. See Annex 1, Appendix A, for required label information.

b) The distributor or manufacturer may utilize its own label design or a design provided by OEPR. If its own design is used, a sample will submitted to OEPR for prior approval. The certification label will be affixed permanently to all production units of the certified collector.

c) The certification label may be used in advertisements, catalogs or other promotional material, as long as the models to which certification applies are clearly specified.

SECTION B - COLLECTOR POWERED SOLAR EQUIPMENT COMPONENTS

ARTICLE 18 - THERMAL STORAGE REQUIREMENTS

A. Liquid-Based Systems

1. Thermal storage tanks must be insulated according to the Energy Conservation Code for Buildings in Puerto Rico, Section 9.02, which states the following:

> "Loss of heat from hot water storage tanks must be limited to a maximum of 8.0 BTU/hr. per square foot of tank exterior. Atmospheric design temperature will be no greater than 75°F."

2. The liquid solar storage component will be designed so that it can be emptied when necessary.
3. Valves impeding backflow from the supply system and storage tanks shall be installed.
4. Tank capacity must comply with the requirements established by HUD's Minimum Property Standards.

ARTICLE 19 - CONTROL SUBSYSTEM REQUIREMENTS

a. Auxiliary Energy System

1. Auxiliary energy system capacity will comply with HUD's Minimum Property Standards.
2. When an electric auxiliary system is utilized, an identification plate will be affixed to the thermal storage component in a visible location stating capacity in watts, electricity consumption and operating voltage (See Appendix C).

b. Pressure Control

1. A safety valve maintaining pressure at or below the maximum permitted per manufacturer's specifications will be provided (See Appendix C).

c. Temperature Control

A safety valve for maintaining fluid at or below the maximum temperature permitted per manufacturer's specifications will be provided (See Appendix C).

d. Pumps

If used as a component of a solar system, pumps will be installed in such a way that they can be disconnected, automatically or manually, when the hot water system is not functioning as described in

Section 9.03 of the Energy Conservation Code for Buildings in Puerto Rico:

> "Pump Functioning - Hot water circulating systems must be formulated in such a way that circulating pumps may be easily disconnected, either automatically or non-automatically, when the hot water system is not functioning."

e. Additional Controls

Any other solar system control subsystem, whether electric, mechanical or hydraulic, must be installed according to manufacturer's specifications.

f. Warnings

The functions of all switches and control subsystems must be identified. All warning lights must indicate defects or abnormal conditions. If manual adjustments are required during operation of a solar system, the control system will be designed to assure the safety of both the system and the structure where it is located when manual adjustments are not made.

ARTICLE 20 - DISTRIBUTION SYSTEM REQUIREMENTS

a. Conduit material shall be that specified by the manufacturer.

b. Conduit size shall limit fluid speeds to those recommended by the manufacturer of the conduit, bearing in mind the type of fluid to be utilized.

SECTION C - ADDITIONAL REQUIREMENTS

ARTICLE 21 - GUARANTEE

All manufacturers or distributors will offer consumers a minimum guarantee of five (5) years for all collector-powered solar equipment. Tanks are excluded; these will have a minimum guarantee of three (3) years.

ARTICLE 22 - CONSUMER INFORMATION

All manufacturers or distributors will provide consumers with an instruction manual containing all information necessary to install collector-powered solar equipment. In addition, the manuals will inform consumers of preventive and corrective maintenance procedures for solar equipment, and of the availability of spare parts and accessories.

ARTICLE 23 - OBLIGATION TO PROVIDE INFORMATION

All manufacturers or distributors will notify OEPR of any change in materials or construction utilized in collector-powered solar equipment, and will accept the decision of OEPR with respect to the necessity of submitting the equipment for testing again, or evaluating it or its components anew.

SECTION D - CERTIFICATION OF COLLECTOR-POWERED SOLAR EQUIPMENT

ARTICLE 24 - CERTIFICATION

a) Certification of collector-powered solar equipment models and their components will be granted when the following requirements are met:

   1. OEPR receives an application for certification. This must comply with all the requirements described in Appendices A and C of this Regulation.
   2. OEPR has evaluated results of laboratory tests of a collector and found them acceptable.
   3. OEPR has evaluated all components as described in Section B of this Part Two, and found them acceptable.

b) Upon fulfillment of these requirements, OEPR will certify a collector-powered solar equipment model and notify the applicant.

ARTICLE 25 - APPEAL AND JUDICIAL REVIEW

Any party adversely affected by a decision, order or resolution of the Office of Energy may appeal and request review of the decision, order or resolution through the Procedure established in Office of Energy Adjudication Regulation No. 3769, of February 7, 1989.

ARTICLE 26 - SEPARABILITY

Declaration by a competent tribunal that a part of this Regulation is invalid, null or unconstitutional will not affect other parts of the same, which will remain in effect and valid.

ARTICLE 27 - REPEAL

Regulation No. 2829 of October 22, 1981, is hereby repealed.

ARTICLE 28 - EFFECTIVE DATE

This regulation will go into effect thirty (30) days after its approval.

San Juan, Puerto Rico, August 4, 1989

Date of Approval August 4, 1989

Lewis L. Smith
Director

APPROVAL

In keeping with the directives of Law Number 133 of July 26, 1979, and Law Number 128 of June 29, 1977, as amended, this Office of Energy of Puerto Rico APPROVES the Regulation for the Certification of Solar Equipment, which will go into effect

Regulation Number
Approved today, _____

Lewis L. Smith
Director

APPENDIX A

APPLICATION FOR CERTIFICATION OF SOLAR COLLECTORS

1. Label Information (See Annex 1 of Appendix A)
2. General Information Form (See Annex 2 of Appendix A)
3. Drawings of the Collector showing in detail:
   a. Dimensions of the cover opening and mounting details
   b. Dimensions of the collecting plate including thickness, location and space between fluid conduits; thickness of tube walls; and means for transferring heat between surface and tubes.
   c. Dimensions of exterior frame; location and size of fastener holes for the collecting plate.
   d. Collector mounting details, specifying type of fastener and general dimensions.
   e. For concentrators, cross section with dimensions and mounting details.
4. Description of materials, including list identifying materials by brand name:
   a. Cover
   b. Collecting plate
   c. Collecting plate facing
   d. Reflectors or lenses
   e. Exterior frame
   f. Insulation
   g. Seals
   h. Mechanical or thermal connections, including bonds for reflecting materials which are not similar to those used on the back of the reflector
   i. Finishes, borders, anchorings and other fittings
   j. Connection system
   k. Control system sensors
   l. Reflector mounting frame (if required, optical, thermal, flame spread, electrical corrosion, ultraviolet radiation or contamination

characteristics will be provided according to manufacturer's specifications).

m. Declaration of combustibility, component by component, including testing method, classification and method of classification.

5. Product guarantee

6. Fluid to be heated and/or flow recommendations or restrictions. If a heat interchanger fluid other than water is used, characteristics of specific heat, density, viscosity, thermal conductivity and toxicity of the fluid.

7. Details on Product Installation, Operation and Maintenance

8. Laboratory tests, including:

- o Thermal efficiency curve (ASHRAE 93-77)
- o Incidence angle modifier (ASHRAE 93-77)
- o Collector time constant (ASHRAE 93-77)
- o Explanation of collector performance validation (e.g. fluid ratio, fluid to be used)
- o Results of test under fluid flow impediment
- o Results of final inspection after disassembly

9. Structural Requirements

A written declaration certifying the equipment's structural integrity, including signature and seal of an accredited engineer or architect (See Appendix D for structural certification).

ANNEX 1 TO APPENDIX A

COLLECTOR

Manufactured by: Name_____

Address_____

_____

_____

Model Number _____ Serial Number _____

Collector Gross Area _____ m^2 (sq ft)

Maximum Operation Temperature _____ °C (°F)

Thermal Efficiency (ASHRAE 93-77 or 96-80)

Slope _____ w/m^2 °C (BTU/m/sq ft °F)

Y-Intercept _____

ANNEX 2 TO APPENDIX A

GENERAL INFORMATION FORM

I. Collector

A. Identification

Manufacturer_____

Distributor_____

Model_____

Type_____

Guarantee _____ years

Test Performed_____

B. Construction

Dimensions (gross)_____

Length _____ m _____ ft

Width _____ m _____ ft

Thickness _____ m _____ ft

Area _____ m^2 _____ sq ft

Frame

Material_____

Cover

Thickness _____ cm _____ in

Transmissibility_____

Number of Covers_____

Dimensions of Transparent Area

Length _____ m _____ ft

Width _____ m _____ ft

Area _____ m^2 _____ sq ft

Collecting Plate

Material _____ m _____ ft

Length _____ m _____ ft

Width _____ m _____ ft

Area _____ m^2 _____ sq ft

Facing_____

Absorption Capacity_____

Emission Capacity_____

Circulation Pattern_____

Insulation

Type_____

Dimensions _____ cm _____ in

K Factor _____ watts/m °C

_____ BTU/hr sq ft °F/in

Fluid to be Heated

Material_____

Density _____ kg/m^3 _____ lb/cu ft

Fluid Ratio _____ liters/min _____ gal/min

Specific Heat_____

Thermal Conductivity_____

Viscosity_____

Weight of the Collector _____ kg _____ lb

Capacity _____ liters _____gallons

Maximum Operating Temperature _____ °C _____ °F

Maximum Operating Pressure _____ kPa

_____ lb/sq in

Maximum Wind Load _____ pascals

_____ lb/sq ft

Restrictions_____

_____

II. Components

A. Thermal Storage

Type of Construction_____

Capacity _____ liters

_____ gallons

Insulation

Material_____

Thickness _____ cm_____ in

Internal Finish_____

Maximum Pressure _____ kPa

_____ lb/sq in

U Factor _____ watts/m^2 °C

_____ BTU/hour-sq ft °F

B. Controls

Auxiliary Electrical System

Capacity _____ watts

Electricity Consumption_____

Voltage_____

Temperature Valve_____

Pump_____

Other Controls_____

Restrictions_____

_____

APPENDIX B

DESCRIPTION OF TESTING METHODS AND MINIMUM REQUIREMENTS FOR CERTIFICATION OF SOLAR COLLECTORS.

1.0 PURPOSE

This appendix applies to innovative, liquid, air-filled, and location-specific collectors, and provides:

a. A description of how to evaluate durability and structural integrity of solar collectors

b. A description of data necessary to evaluate thermal efficiency of solar collectors.

2.0 DEFINITIONS

2.1 Collecting Plate

The part of the solar collector which receives solar radiation and transforms it into thermal energy. In general, this is a solid plate through which energy is transmitted to liquid to be heated; nevertheless, fluid may perform the function of the collecting plate in certain configurations.

2.2 Collector Framework

This is the structure or frame which holds the components and protects them from the environment.

2.3 Corrosion

Deterioration of a substance or its properties, occasioned by a chemical substance or a chemical reaction with the environment.

2.4 Cover

The material or materials which cover the collector opening.

This is the part of the collector which is most exposed to solar radiation.

These materials are generally used to reduce heat loss from the collecting plate to surrounding areas and to protect the collecting plate.

2.5 Cracking

Formation of small fissures in a surface

2.6 Delamination

Separation of layers

2.7 Fluid Flow Impediment

Condition which occurs when, upon heating, a fluid does not flow through conduits due to closed accesses, or because of functional failure, while the collector continues receiving the same amount of solar radiation as it would under normal operations.

2.8 Gas Emission

Process through which materials generate vapor, generally upon exposure to high temperatures and/or a reduction of pressure.

2.9 Corrosion Spread

Process through which a material disintegrates as the result of erosion, corrosion or chemical decomposition.

2.10 Transparent Frontal Area

The projecting area of the collector which transmits solar energy to the interior.

3.0 Collector Testing Methods

Collector testing will be carried out in the following sequence:

a. Inspection of the collector upon arrival.

b. Static pressure test.

c. Test of exposure to atmosphere for 30 days.

d. Test of thermal impact of water sprinkling.

e. Test of thermal impact of filling with cold liquid.

f. Static pressure test

g. Time constant test

h. Thermal efficiency test

i. Incidence angle modifier test

j. Collector disassembly; final inspection

3.1 Inspection of the Collector Upon Arrival

Upon delivery, the laboratory will inspect the collector and state in writing the condition in which it is found.

3.2 Static Pressure Test

The static pressure test will be carried out before exposing the collector to the elements, depending on the type of collector.

3.2.1 Types of Collector

a. Collectors functioning under pressure, utilizing conduit system - collectors which, upon installation, will be submitted to variations in water pressure caused by conduits and by water from the hot water tank.

b. Collectors for low-pressure hot water service and for pools - Collectors which, by design, do not have a direct fluid interchange with an auxiliary heater or with a conduit system. Heat interchange from this type of collector to the water service system is achieved through an appropriate heat interchanger.

c. Hybrid or alternative fluid solar collectors- Collectors which are not be connected to a hot water service system. These units may or not be designed to tolerate pressure from the conduit system.

3.2.2 Testing Method

Hydrostatic or pneumatic pressure sources may be utilized to test liquid-based collectors. Air collectors shall be tested by pneumatic pressure.

3.3 Exposure Test

The purpose of this test is to verify the integrity of product construction after a minimum of 30 days of exposure to adverse conditions.

3.3.1 Testing Methods

a. Liquid-based collectors must be filled with clean liquid, and then be permitted to drain by gravity for 15 minutes with the collector

at a 45° angle. Inlet and outlet tubes shall be sealed, but not by pinching.

b. Exposure conditions will consist of 30 days of cumulative exposure.

c. Data gathered and noted during the exposure test shall include comprehensive daily solar radiation data. A visual inspection will be performed weekly, and changes in the appearance of the collector noted.

3.4 Thermal Impact Test - Spraying Cold Water on Collector

This test consists of spraying water under pressure upon the surface of the collector during the exposure test. This must be done for five minutes on three different days during the last 10 days of the test, after exposing the collector to at least an hour of direct solar radiation.

3.5 Thermal Impact Test - Filling Collector with Cold Liquid

At some point during the atmospheric exposure test, empty liquid-based collectors shall be exposed to solar radiation for one hour. While it is exposed to the sun, liquid will be circulated throughout the collector for five minutes. If the manufacturer specifies that collector design is such that it cannot be filled with cold liquid or be heated while empty, the collector may be certified without conducting this test. Manufacturer's specifications will comprise part of the certification documents.

3.6 Static Pressure Test

This test will be conducted after the exposure test and before the thermal efficiency test.

3.7 Time Constant Test

A time constant test will be performed to determine time necessary for fluid outlet temperature to reach 63.2 per cent stability after a sharp change at the inlet. This

figure will be utilized to measure time necessary for temperature and irradiation data to be compiled, and to obtain efficiency values from the thermal efficiency test. The testing method to be utilized shall be that described in "Methods of Testing to Determine the Thermal Performance of Solar Collectors," ASHRAE Standard 93-77.

3.8 Thermal Efficiency Test

Collectors which have met the requirements of Sections 5.1 and 5.6 of this Appendix, and those for which time constant has been determined, will be submitted to the thermal efficiency test.

This test establishes momentary efficiency of the collector on the basis of a global number encompassing operating temperatures. Efficiency is defined as the ratio of energy gathered to total energy received by the collector. Energy employed is calculated by multiplying fluid circulation by specific heat by the accumulation of integrated temperature throughout the collector. Available energy is calculated on the basis of integrated solar radiation.

3.9 Calculation of Incidence Angle Modifier

The thermal efficiency curve of a collector is determined (Section 3.8) when solar exposure is between 30 degrees and perpendicular to the collector opening. To predict behavior of the collector under different conditions, tests to determine incidence angle modifier shall be performed. The resulting formula is used to modify the efficiency curve (calculated at 30 degrees to perpendicular incidence), appraising changes in collector efficiency as a function of the incidence angle of solar rays.

3.10 Collector Disassembly and Final Inspection

Following exposure and efficiency tests, the collector shall be disassembled to identify conditions which may hinder performance or shorten useful life. See Section 5.6.

4.0 Innovative Collectors and Location-Specific Collectors

4.1 Innovative Equipment

Any solar collector which cannot be tested by ASHRAE 93-77 or 96-80 sequences shall be evaluated utilizing specific procedures, providing results similar to those of the ASHRAE tests, as developed or adapted by the agency responsible for certification.

4.2 Location-Specific Collectors

Location-specific collectors will be tested by evaluating a sample area of no less than 2 square meters (22 square feet). The sample will be identical to the installed collector.

5.0 Minimum Collector Requirements

The following standards represent the minimum durability requirements with which a collector design must comply to obtain certification.

5.1 All collector surface coverings must be shock resistant.

5.2 Condensation

The collector will be designed to avoid accumulation of condensation. The use of a dehydrating agent is permitted to control condensation. Laboratory reports will mention any unusual degree of condensation.

5.3 Liquid Collector Test Results

Collectors will be approved which:

a. Do not suffer pressure losses

b. Do not show leakage

c. Do not show deterioration of fluid conduits.

5.3.1 Air Collector Test Results

Collectors will be approved which do not show deterioration in fluid conduits.

5.4 Results of Thermal Impact Test - Spraying Water On Collector

Collector structure and efficiency will not be affected by entry of moisture. Cracks must not appear; the collector cover must not bend or warp.

5.5 Results of Exposure Test

This test will be considered finished, even without disassembling the collector, when collector deterioration is apparent and it fails to comply with the requirements of Section 5.6.

5.6 Collector Disassembly and Final Inspection

The collector will be disassembled following exposure and efficiency tests. Certification will not be granted if any condition which might significantly shorten the useful life of the collector is apparent. These conditions are:

a. Severe deformation of the collecting plate
b. Severe deformation of fluid circulation conduits
c. Loss of adherence of the collecting plate and tubes
d. Leakage from circulation conduits and/or joints
e. Loss of mounting integrity
f. Severe corrosion or any other deterioration caused by chemical reaction
g. Cracking, formation of bubbles or scales on the coating of the collecting plate, or delamination of reflecting surfaces.
h. Water retention in insulation
i. Increase in insulation volume, severe gas emission or any other adverse change in insulation which affects collector efficiency
j. Cracking, loss of flexibility or adherence in seals

k. Leakage in interior conduits of the collector, or leakage at joints.

l. Cracking or warping of the cover.

m. Cracking or warping of frame materials.

APPENDIX C

APPLICATION FOR CERTIFICATION OF SOLAR EQUIPMENT COMPONENTS

Thermal Storage.

a. Liquid-Based Systems:

1. Drawings showing in detail:

a. Dimensions

b. Mounting Details

c. Connections to Other Components

2. Description of Materials

a. Type of Construction (Material)

b. Capacity

c. Insulating Material and Thickness

d. Interior Finish

3. Product Guarantee (Minimum of Five (5) Years)

4. Considerations of Installation, Operation and Maintenance

Controls

a. Auxiliary Electric Heating Element

1. Identification Plate

a. Capacity in Watts

b. Electricity Consumption

c. Operating Voltage

b. Additional Controls

a. Product Description and Specifications

APPENDIX D

STRUCTURAL ANALYSIS CERTIFICATION

The undersigned, by high standards of structural analysis, certifies that the following solar equipment:

_____

_____

_____

_____

_____

_____

Complies with the design capacities established by Building Regulations of Puerto Rico Planning Regulation Number 7).

Seal of Professional

Signature_____

Title_____

License Number_____