



Solar Rating & Certification Corporation™
The Industry Standard Since 1980.

SRCC™ STANDARD 600 2014-07

MINIMUM STANDARD FOR SOLAR THERMAL CONCENTRATING COLLECTORS

July 15, 2014

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SRCC Standard 600

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Foreword

The intent of this standard is to provide minimum criteria for the efficiency, longevity and design of Solar Collectors. The focus of this standard is to provide minimum testing requirements, consistent methods and procedures to ensure that products covered by the standard operate in a safe, reliable, and effective manner. Consistent test methods ensure that the performance of various solar collector designs and configurations can be compared and evaluated.

The standard serves as the basis for insuring to the consumer and industry that reliability and safety standards are met. Providing unbiased performance and rating data based on this standard will help the consumer make informed purchase decisions.

The standard is intended to ensure the quality of the product can be assessed through a review process without imposing unreasonable costs and difficulty on the manufacturer to comply with this standard.

Background

SRCC is recognized by the Solar Industry as the Standards Development Body for Solar Collectors and Solar Water Heating Systems. SRCC™ Standard 600 has been adopted by federal and state authorities and recognized as a requirement for product certification in the tax code.

This Standard has been developed in a regimented process consistent with ANSI requirements for “voluntary consensus standards” which requires participation from a range of representation of manufactures, technical experts, incentive program administrators, public sector agencies, utilities and consumers.

The draft as a result of the Standard Development Effort was first adopted in 2010 and has undergone several revisions since. Advocates who made major contributions to this national Solar Water Heating System Standard - SRCC™ Standard 600 were DOE, NREL, and concentrating collector manufacturers.

References to Solar Rating & Certification Corporation appear in requirements in the Energy Policy Act of 2005; commonly referred to as the “2005 Energy Bill” for determining eligibility of certified Solar Collectors for federal tax incentives.

Foreword and Background: The Foreword and Background sections are included with this document for information purposes only, and are not part of the “SRCC™ Standard 600 - MINIMUM STANDARD FOR SOLAR CONCENTRATING COLLECTORS.

1. PURPOSE

This document sets forth the procedure for determining thermal performance and assessing the durability of solar concentrating collectors.

2. SCOPE

This standard applies to the thermal output performance of solar concentrating collectors utilizing a fluid for heat transfer from the collector, and establishes a procedure for evaluating concentrating collector durability, in addition this Standard applies to measuring the thermal performance characteristics of technologies which simultaneously produce usable thermal and non-thermal energy as a solar concentrating collector output.

3. DEFINITIONS

A solar concentrating collector is defined as a solar collector that uses reflectors, lenses or other optical elements to redirect and concentrate solar radiation passing through the aperture onto an absorber. A flat plate collector provided with a mirror, or an evacuated tubular collector having a reflector behind the tubes, are examples of concentrating collectors.

For the purposes of the SRCC Standard 600, Terms and Definitions used in this document appear in Annex A attached hereto.

4. REFERENCED STANDARDS

The following standards contain provisions which, through reference in this text, constitute provisions of SRCC Standard 600.

ISO 9806:2013, Solar energy – Solar thermal collectors – Test methods,
International Organization for Standardization, Geneva, Switzerland.

<http://www.iso.org>

5. PROCESSES FOR SOLAR CONCENTRATING COLLECTOR TESTING

5.1 Required Durability Tests

All concentrating collectors tested within this standard shall be expected to satisfy requirements intended to demonstrate durability while operating in typical operating conditions.

Mechanical devices, or controls, to manage operation and protect the collector from conditions where material limits can be exceeded shall be required. For the purposes of this standard, these devices are classified as a) active or b) passive controls. Active controls are generally characterized by the use of mechanisms that require an external power source. Passive control action is generally accomplished by thermal mechanical means, such as a bimetallic material reacting to heat;

The use of controls requires additional steps in the testing sequence, thus primary and alternate testing paths are described in this standard. The testing path shall be based on: a) active controls used for protection and positioning; b) passive controls where collector protection and/or positioning is accomplished by thermal mechanical means such as a bimetallic material reacting to heat. A combination of active and passive controls are possible, therefore the testing path shall be chosen based on the individual balance-of-system based protection or positioning subsystem relevant to the individual test.

5.2 Testing Program

The testing program is comprised of sequences that test collector durability, and thermal performance. In addition, the controls are tested for those collector designs that employ them. All collectors shall be subjected to durability testing, including at least 30 days of exposure testing.

Thermal performance testing shall commence upon completion of durability testing in cases where controls are not used for thermal protection and tracking.

When controls are required for tracking and protection of the collector from exceeding material limits, and require the flow of a heat transfer fluid, thermal performance testing shall commence as specified in Paragraph 8. This exposure test configuration is characterized as "wet" testing. In these cases, collector durability can only be established when controls allow full on-sun and un-stowed exposure of material surfaces, and maximum temperatures to be reached, but not exceeded.

For collectors where controls are used, controls must be tested and verified. The function of tracking and other operating controls shall be verified in the course of the thermal performance test. Failure of tracking and/or operating controls shall be deemed a failure of the test. Controls for material protection shall be verified in the course of durability testing and a control test phase following thermal performance testing.

5.2.1 Optional Tests & Reports

Optional tests are described within this standard that can be requested by the manufacturer or regulating body that may be of importance for special conditions. While there are various methods and still more theories as to the best execution of such tests, it is the intent of this standard to provide a uniform framework and context for such tests and eliminate variations.

Reports are described in Annex B of this standard and are normative. It is believed that the performance information collected, analyzed, and calculated for certification is useful beyond the scope of the test for the configuration and engineering of complete solar energy systems that require the use of small time steps and high resolution climate and thermal response data for modeling of thermal performance and design of controls. Test data beyond the minimum required by the standard may be privileged information subject to client (manufacturer) discretion and relevant agreements. In such cases the additional information may be considered confidential and may require explicit client consent to be used and published.

5.3 Processes and Collectors Tests

The following processes and collector tests shall be performed as appropriate:

- SELECTION AND INSPECTION
 - Random Selection Methodology
 - Alternative Selection Methodology
 - Alternative Selection Methodology For Solar Concentrating Collectors Where Collector Subcomponents are Physically Separate From One Another
 - Receiving Inspection
- DURABILITY TESTING
 - Thirty-day Exposure Test
 - Method of Conducting Exposure Testing
 - Thermal Shock /External Water Spray Test
 - Thermal Shock / Internal Cold Fill Test
 - Collector Protection System Test
 - Static Pressure Test
 - Pressure Drop Test
 - Mechanical Load Test
 - Impact Resistance Tests
- THERMAL PERFORMANCE TESTING
- ACTIVE AND PASSIVE CONTROLS TESTING
- DISASSEMBLY AND FINAL INSPECTION
- REPORTING

6. SELECTION AND INSPECTION

For purposes of this standard and the selection and inspection process, solar concentrating collectors are classified generally as "complete", "combined" or "distributed" assemblies. See Annex A for definitions.

6.1 Random Selection Methodology

Solar concentrating collectors classified as "complete" assemblies and submitted for testing shall be randomly selected by an evaluation authority, their designated representative, or selected based on a photography-based selection methodology.

The manufacturer shall make available, from existing stock at the manufacturing facility or at the manufacturer's distribution location, two (2) production units of the solar collector model to be tested. All selected units shall be affixed with non-removable serial numbered labels. The manufacturer shall then ship one (1) labeled collector, as selected by an evaluation authority, to a laboratory offering a SRCC approved laboratory at the manufacturer's expense. The remaining selected and labeled collector shall be held in storage by the manufacturer to be available as a replacement if the collector originally selected is damaged in shipment.

6.2 Alternative Selection Methodology

Alternative selection methodologies have been provided for "combined" and "distributed" assemblies where subcomponents of a module may be shared, or

require field assembly, and may be shipped from more than one manufacturer and location.

6.2.1 Combined assemblies

The subcomponents of solar concentrating collectors classified as "combined" assemblies shall be randomly selected provided all subcomponents are shipped from their respective manufacturers and each subcomponent has affixed labels. It is required that the collector geometry cannot change from its design specification upon final assembly. For "combined" assembly type solar concentrating collectors, the manufacturer shall provide for the assembly and test readiness of the product, at their own expense, at a testing laboratory facility or at an end-user location suitable for testing. Circumstances where end-use location assembly may take place include cases where: a) transport in a fully-constructed condition is impractical; b) collectors are not inventoried in a fully-constructed condition; or c) collectors are not pre-fabricated in whole at an assembly facility. Combined assembly solar collectors using alternative selection methodology must be designed such that variations in geometry due to field assembly are not possible.

6.2.2 Distributed Assemblies

For "distributed" assembly solar concentrating collectors where the subcomponents are not physically connected to each other, the manufacturer shall specify the geometric parameters and configuration of all subcomponents and the total system. Such parameters shall include orientation, distance, height, and angle of all solar collector subcomponents in relation to one another and the installation site, including the quantity of each. The manufacturer specifications shall include minimum and maximum values for each geometric parameter defining the configuration's final assembly with minimum and maximum operating specifications. Selected configuration(s) shall fall within a specified range, representing operating conditions closest to the minimum and maximum allowed. The most rigorous test conditions applicable shall be chosen for the test. Performance ratings shall only extend to configurations equal to or larger than the smallest configuration under test.

6.3 Receiving Inspection

Upon receiving a collector or its constituent parts for tests, the test laboratory shall inspect and document the condition of the product. Documentation shall include photographs of the collector or its constituent parts, as received, showing all surfaces if possible. Any abnormalities shall be noted and photographed in detail.

7. DURABILITY TESTING

The durability testing program shall be selected by the manufacturer on the basis of controls. When controls are used for material protection, durability tests shall be carried out during normal operation of the collector system. All solar collectors shall demonstrate resistance to failure modes associated with normal solar exposure in the course of normal operation. A testing program and individual operational points shall be established in accordance with Annex C - Test Program and Control Verification Guidelines.

7.1 Thirty Day Exposure Test

The purpose of this test is to verify integrity of collector construction after at least 30 days of outdoor exposure to environmental conditions. Any collector which exhibits compromised integrity either during the course of the exposure test or at its conclusion, such that it will no longer function as designed, the solar collector will be deemed to have failed the test. If the collector manufacturer elects to utilize active systems for collector protection purposes including, but not limited to, controls, motors, drives, actuators, or other equipment, those systems shall be active and operational during the exposure test. A test cycle that demonstrates the different functions of the active system shall be in operation during the exposure period. The collector, and all associated component parts and subsystems designated by the manufacturer as necessary for the operation of the collector as designed, shall be validated to be functional in accordance with the manufacturers description of intended operating characteristics.

Exposure conditions shall be as defined in ISO 9806 for Class B.

7.1.1 Method of Conducting Exposure Testing

The collector shall be tested over the full range of heat transfer loop and outdoor exposure conditions.

If the manufacturer elects to test the system “dry” and no controls are used for both high temperature and no-flow conditions, then stagnation temperatures must be reached in the course of exposure testing. Collector designs which incorporate a factory sealed container used in the collection of heat are treated as “dry” unless controls are used for over temperature protection, then control operation must be verified.

If the collector assembly has active mechanism(s) which are intended to be functional during normal operation, those mechanism(s) shall be operational during testing.

Data recorded and reported during exposure testing shall include integrated daily solar radiation and ambient air temperature. A regularly scheduled weekly visual inspection shall be made, and a record of changes in the physical appearance of the collector shall be maintained.

7.2 External Thermal Shock / Water Spray Test

Factory-sealed container(s) charged with a refrigerant, other fluid, or phase-change material shall not be removed for this test. If the collector assembly has active mechanism(s) which are intended to be functional during normal operation, those mechanism(s) shall be operational during testing.

The external thermal shock test shall be performed as specified in ISO 9806, Section 12 under the conditions required for climate class B. One external shock shall be performed on each of two (2) different days of the exposure test.

7.3 Internal Thermal Shock / Cold Fill Test

Any part of the concentrating solar collector assembly that is not factory sealed shall be subjected to this test. If the collector assembly has active or passive mechanism(s) which are intended to be functional during normal operation, those mechanism(s) shall be operational during testing.

This test is not applicable to collectors in which heat transfer fluid is continuously flowing for protection purposes. In such cases, control(s) used to manage a no-flow condition shall be validated to be functional in such a way that any failure can be detected. Control functions which have been verified shall be described and reported with the test results.

The internal thermal shock tests (if required) shall be conducted as specified in ISO 9806, Section 13 under the conditions required for climate class B . One external shock shall be performed on each of two (2) different days of the exposure test.

7.4 Collector Protection System Test

The Collector Protection System Test shall be conducted in accordance with section 10.0.

7.5 Static Pressure Test

A static pressure test shall be conducted as specified in ISO 9806, Section 6.

7.6 Pressure Drop Test

At the manufacturer's option, the pressure drop across the collector shall be determined in accordance with ISO 9806, Section 28. .

7.7 Mechanical Load Test

A mechanical load test shall be conducted on glazed collectors in accordance with Section 16 of ISO 9806.

7.8 Impact Resistance Test

Solar concentrating collectors may experience a variety of mechanical impacts during manufacture, transportation, installation and operation. A test shall be conducted to determine the solar concentrating collector's resistance to impacts on the physical area of the solar concentrating collector which will be exposed to atmospheric conditions. The collector, especially the optical elements associated with the concentrator and receiver, shall withstand such impacts without adverse effect on operation or performance. The tests shall be conducted in accordance ISO 9807, Section 17.

8. THERMAL PERFORMANCE TEST

The thermal performance test shall be conducted in accordance with ISO 9806, Section 24.

8.1 Concentrating Photovoltaic – Thermal (CPVT) Collectors

Thermal performance testing of CPVT shall be comprised of both open electrical circuit and combined electrical and thermal output modes with the use of a maximum power point (MPP) controller. In testing and reporting of performance, both electrical and thermal energy shall be accounted for. CPVT collectors shall be tested open electrical circuit for at least one complete testing day under clear sky conditions focused on determining the optical intercept and IAM.

Electrical output (V) voltage and (I) current shall be measured in accordance with IEC 61925 at a point between the source and the MPP device. If the manufacturer provides the MPP tracking device, the details of this device shall be included in the report, otherwise a laboratory MPP may be used. If the laboratory MPP is used, the parameters of its operation shall be included in the test report.

8.2 Incident Angle Modifiers (IAM)

Concentrating solar collector testing shall include all operational conditions in which the collector is designed to operate. Incident Angle Modifiers (IAM) shall be found for the maximum acceptance angle and all intermediate angles as needed to properly characterize the optical behavior of the collector. Unless manufacturer stipulates otherwise, the maximum acceptance angle to be tested shall be 60°. All testing shall comply with practices referenced by this standard in EN12975-2.

Biaxial IAM testing and reporting are required on all non-tracking concentrating collectors as covered by this standard and any single axis tracking collector where reflectors and/or receivers move independently of each other.

The manufacturer shall submit a drawing showing the optical normal, transverse plane and longitudinal plane. Drawings showing these three items will be published with the certificate.

9. ACTIVE AND PASSIVE CONTROLS TESTING

The manufacturer shall identify all components and systems which are designed to protect the operational integrity of the collector during normal operating conditions. A test cycle demonstrating all functions of all active collector protection mechanism(s), including, but not limited to, overheating protection, wind protection, or other collector protection mechanisms which are necessary for the continued operation of the collector as designed, shall be observed at least once during the exposure period. All of the collector's components shall operate in accordance with the manufacturer's specifications.

Where system operation is dependent on associated collector tracking and/or safety control function(s), such control(s) shall be tested for normal operation and shall demonstrate operational capability in the event of loss of grid electrical supply. If collector tracking and/or safety systems do not rely on active controls but employ other passive means of managing over-limit conditions, such system operations shall be demonstrated during the thermal performance procedures set forth in Section 8.0. Visual observation of the collector tracking system and associated safety controls shall be made, and any non-conformity of operation with intended

system function shall be noted. Hydraulic loop temperature measurements shall be used to verify intended operation of the controls, and to confirm that operation within design limits has been maintained.

Testing of the control over-temperature protection will be satisfactorily proven with local heating of the temperature sensing element and observation of the active control responding appropriately. If fluid thermal sensors are used for over temperature sensing, they shall be operable when the receiver is dry unless a flow sensor is used as an interlock.

If the collector is defocused for over-temperature control by passive mechanical means, the collector shall be operated normally then heat exchange fluid flow stopped. It is required that the over- temperature mechanism is independent of any flow controls. If active control is mixed with passive elements, an interlock functionality shall be demonstrated.

During tracking or safety control(s) testing, any migration of collector temperature, pressure or other factors intended to be limited by collector or control(s) design, into operating conditions outside of design limits shall be considered a failure of the test.

Any failure of controls, which shall be reported as such based on manufacturer's operational parameters, that causes a halt in system testing and that prevents the publishing of a thermal performance report shall result in a collector failing the test.

The manufacturer shall establish control set points and parameters and submit these to the lab for verification of proper control operation.

10. DISASSEMBLY AND FINAL INSPECTION

After exposure testing, the collector shall be disassembled to determine its final condition and actual or potential points of failure which may lead to impairment of function or abnormally short collector life. Final inspection shall be conducted in accordance with ISO 9806, Section 18 The format specified in ISO 9806, Annex A shall be used to document the disassembly and final inspection findings.

11. REPORTING

The report shall document the various test results in accordance with the requirements of ISO 9806, Annex A.

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ANNEX A - Terms and Definitions

The SRCC uses the following Terms and Definitions in reference to Standard 600. Where a definition does not appear herein, informative reference is made to Document ISO 9488:1999-10-01; Solar energy - Vocabulary

Absorber: The absorber is that part of the solar collector that receives the incident solar radiation and transforms it into thermal energy. It may consist of a solid surface through which energy is transmitted to a heat transfer fluid; however some designs employ the transfer fluid as the absorptive surface.

Active Controls: Control and actuator systems where external power and a computational device is used for operation and safety control purposes.

Ambient Air: Ambient air is the outdoor air in the vicinity of the solar collector being tested.

Certification: The act of attesting officially as being true and as meeting a standard.

Collector Absorber Area: The maximum area in which concentrated or un-concentrated solar radiation is admitted and converted to heat or power. Absorber Area does not include portions of the receiver where light is permanently screened and thermal barriers are in place.

Collector Aperture Area: The maximum area projected on a plane perpendicular to the optical normal through which the un-concentrated solar radiant energy is captured, excluding any area of the reflector or refractor permanently shaded by collector elements that are opaque such as a secondary reflector or receiver, and structural elements such as supports. Gaps between reflector segments within collector module are also excluded.

Collector Enclosure: The structural frame which supports the components of the collector and protects internal components from the environment.

Combined Assembly: A solar collector with one or more subcomponents that are not physically attached within a common structure or assembly at the point of manufacture, but are assembled in the field. Once assembled, collector modules should not vary in geometry and performance from design specification. A combined assembly would generally be comprised of subcomponents, each with individual nameplates and serial numbers, and may be shipped from separate facilities and manufacturers to a common location for final assembly. A building integrated collector system that requires specific shared external components for normal operation may be an example of a combined assembly.

Complete Assembly: A solar collector designed and constructed as a permanent, single unit. Complete assemblies cannot be physically separated for normal operation

and would generally carry a single nameplate and serial number. A single parabolic trough with mounted receiver and tracking frame is an example of a complete assembly.

Concentrating Solar Collector: a solar collector that uses reflectors, lenses, or other optical elements to redirect and concentrate the solar irradiance at the collector aperture area onto an absorber of which the surface area is smaller than or equal to the collector aperture area.

Concentrating Photovoltaic (CPV): Concentrating photovoltaic systems use optical elements (such as lenses or mirrors) to concentrate sunlight onto high-efficiency solar cells to generate electrical energy.

Concentrator: The concentrator is that part of the concentrating collector which directs the incident solar radiation onto the absorber.

Concentration: The direction of a quantity of solar insolation greater than normal incident insolation onto a solar collector absorber surface.

Corrosion: The deterioration of a substance or its properties caused by a chemical or electrochemical reaction with its environment.

Cover Plate: The cover plate is the material or materials covering the absorber. These materials generally are used to reduce the heat loss from the absorber to the surroundings and to protect the absorber. In some collector designs, materials in the shape of a tube may serve as a cover plate by enclosing the absorber. (See Transparent Covers)

Crazing: Formation of minute surface cracks.

Delamination: Separation into constituent layers, as in one layer of material separating from another.

Distributed Assembly: A solar collector using subcomponents which are not physically attached to one another or a common structure. When fully assembled, the geometry of the assembly may vary from module to module due to customization of design in or installation. Distributed assemblies have the potential to be scaled by subcomponent count and system geometry without changes to actual subcomponent specifications. An example of distributed assemblies would be a central receiver design where layout or count of heliostats can vary while the central receiver, and individual heliostat module designs and specifications remain fixed.

“Dry” Collectors: Collectors are collectors where heat transfer fluid is not shared with other external components as part of a heat transfer loop.

Fail-safe: An operating condition of a collector, where collector protection functions will continue under all collector and system failure modes.

Gross Collector Area: The maximum projected area of the complete module, including integral mounting means.

Hail: Precipitation in the form of small balls or lumps usually consisting of concentric layers of clear ice and compact snow.

Heat Transfer Fluid: Air, water, or other fluid which is used to transfer thermal energy between collectors and other components in a system.

Incident Angle Modifier (IAM): The measurement of changes in light transmittance by a collector cover plate as a function of the angle at which light enters the aperture. The IAM is measured based on the angle of incidence and the associated transmittance of light at that angle.

Innovative Equipment: Solar equipment which, due to its design, cannot be evaluated fairly and adequately by the test methods described in this document.

Instantaneous Efficiency: The instantaneous efficiency of a solar collector is defined as the amount of energy removed by the heat transfer fluid over a given measuring period divided by the total incident solar radiation onto the collector aperture area during the measuring period.

Integrity of Construction: Those physical and mechanical properties of the solar collector which collectively are responsible for the overall thermal performance and physical structure of the solar collector.

Irradiance. Power density of solar energy incident on a surface, usually expressed in W/m^2 , but can also be expressed in British Thermal Units (BTUs) per $foot^2$. For purposes of the standard, solar irradiance can fall on the collector as beam or diffuse light.

Irradiance, Beam: Beam solar irradiance (also Direct Irradiance) falls on a surface without being scattered and from a narrow angle comparable to the size of the solar disc.

Irradiance, Diffuse: Diffuse radiation is by definition scattered light and can fall on a surface from any point above the horizontal plane. For the purposes of this standard, diffuse irradiance is not assumed to be isotropic and considers the energy and directionality of the circumsolar radiation. Diffuse irradiance is a result of the scattering processes in the atmosphere. It depends also on the surface albedo and increases with increasing aerosol loading in clear skies. Clouds increase the diffuse radiation even more, whereby the degree of multiple scattering depends on the cloud properties.

Irradiance, Global: The global irradiance G is the sum of the direct I plus diffuse D irradiance. The direct beam must be multiplied by the cosine of the solar zenith angle to obtain the radiation for a horizontal surface.

$$G = I \cos\theta + D$$

Latitude: The location north or south of the equator, expressed as an angular measurement in degrees ranging from zero (0) at the equator to ninety (90) at the poles, or the angle between the zenith at the surface and the sun at an equinox.

Model: A unit of solar equipment that is identifiable by a specified size, set of materials, and performance. A change in any of these basic characteristics constitutes a new model.

Net Collector Area: “See Collector Aperture Area”

"No-Flow" Condition: The condition where heat transfer fluid is not flowing through the solar collector while collector is exposed to solar radiation the collector would receive under normal operating conditions. For purposes of the standard, a no flow condition can extend to closed loop designs where heat is not removed from the collector while being exposed to solar radiation.

Normal Solar Angle, Geometric: The normal is an imaginary line perpendicular to the surface of an optical medium. The word normal is used here in the mathematical sense, meaning perpendicular.

Optical Normal Solar Angle: The angle at which the sun is perpendicular to each axis of the solar collector optical plane. The aperture optical plane can be characterized as an invisible datum plane that may or may not be orthogonal to or have any symmetrical relationship to the aperture, reflecting elements, heat collecting apparatus, or the solar collector systems frame. An optical based definition of the normal solar angle is required when the collector is geometrically asymmetrical or has a tailored and non-symmetrical solar response. The manufacturer will define the normal solar angle and must provide a points of reference for proper mounting of the product. The normal solar angle as referenced and applied in this standard will be use the manufactures stated angle whether it be geometric or optical.

Outgassing: The generation of vapors by solar collector components or construction materials, usually occurring during periods of solar collector exposure to elevated temperatures and/or reduced pressure.

Passive: An operating condition of a solar concentrating collector where no human or mechanical intervention is required for operation as intended.

Passive Controls: Control and actuation systems where no external energy source is required and no computational device is used,

Pitting: The process by which localized material loss is caused in materials or components by erosion, corrosion, or chemical decomposition.

Power: Herein, the amount of energy produced over time, expressed as watts per square meter of collector area per hour, or the thermal equivalent of 3,413 BTU/kilowatt-hour.

Pyranometer: A radiometer used to measure the total solar radiation (direct, diffuse, and reflected) incident on a surface per unit time per unit area.

Rated Performance: The thermal output characteristics of solar equipment as determined by tests specified in this document.

Receiver: The part of the solar collector to which the solar irradiance is finally directed or redirected, including the absorber and any associated glazing through which the redirected energy must pass.

Reflector or Reflective Surface: A surface intended for the primary function of reflecting radiant energy.

Site Dependent Collectors: A collector intended to be assembled only at the site of its application. This may be because the size or construction characteristics of the fully assembled collector makes intact delivery in final form or operational construction impractical.

Solar Collector: A device designed to absorb incident solar radiation, to convert it to thermal energy, and to transfer the thermal energy to a heat transfer media which comes in contact with it.

Solar Energy: The energy originating from the sun's radiation.

Standard: A document which specifies the performance, durability, or safety requirements of a product.

Time Constant: The time required for the heat transfer media leaving a solar collector to attain 63.2% of its steady state value following a step change in insolation or inlet heat transfer media temperature.

Tracking Solar Collector - A solar collector that moves so as to follow the apparent motion of the sun. Tracking may be accomplished by a single axis in the transverse for tracking the sun through the day or longitudinal adjustment generally for seasonal adjustment. Two axis tracking may be employed to precisely track the sun in both longitudinal motion as well as transverse.

Transparent Covers: Geometries of transparent covers used in solar concentrating collectors can be flat sheets used as a glazing, flat sheets used as first surfaces for reflectors, or non-flat shapes used as glazing for receivers, first surface substrates or protective layers for reflectors, or other purposes not yet conceived.

Transparent Frontal Area: The transparent frontal area is the area of that part of the collector designed to transmit incident solar energy to the interior of the collector, also referred to as the "cover plate."

"Wet" Collectors: Collectors where thermal subcomponents of the solar concentrating collector share a common heat transfer fluid with and are part of a fluid circuit with external components.

ANNEX B – Test Guidelines

System Types

System types for certification and types for purposes of control description and testing are comprised of two discrete groups.

1. Collector Assembly Type
2. Control

Figure C1 – Assembly Types

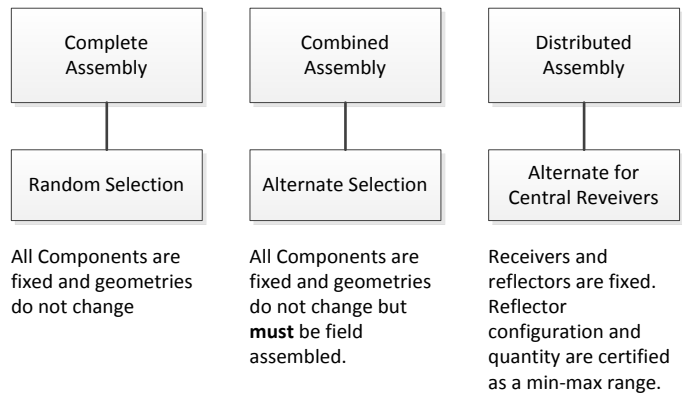
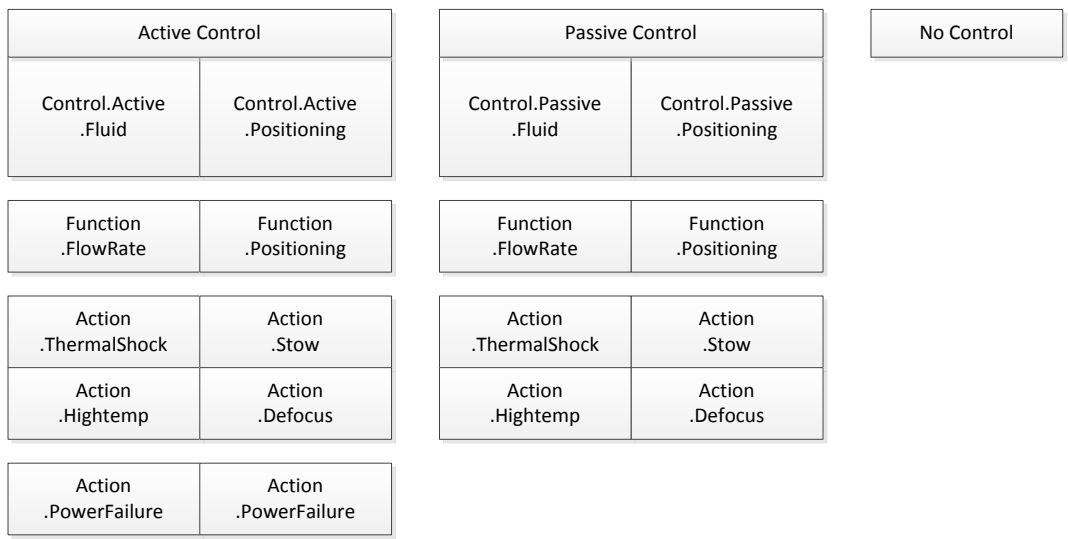


Figure C2 - Control Types



Tracks

The tracks indicate the ability to run test modules simultaneously. Dry exposure test removes this possibly from those collectors that do not track and do not use wet heat removal. Track 2 and 3 are indicative of tracks that can be followed with active and passive controls. Track 4 is indicative of a distributed assembly collector where a minimum configuration must be tested as well as a maximum.

Figure C3 - Track Examples (1)

Tracking: Tracking Type: Overtemperature Protection: Internal Thermalshock Protection: Mechanical Stress Protection?	None Active TOD Active.Positioning Active.Fluid Active.Positioning	None Active TOY Active.ThermalLimit Active.FlowControl None	None NA None Active.FlowControl None	None NA None None None			
7.1 Static Pressure Test	Required	Required	Required	Required			
7.2 Exposure Test	ALT2 Wet (Operation)	ALT2 Wet (Operational)	ALT2 Wet (Operational)	ALT1 Dry (No Operation)			
7.3 External Thermal Shock Test	Required	Required	Required	Required			
7.4 Internal Thermal Shock Test	Not Required	See 7.5.1	Not Required	See 7.5.1	Not Required	See 7.5.1	Required
7.5 Control Verification	Required	Required	Required	Not Required			
7.5.1 Protection.Overtemperature	Action .Defocus	Action .Defocus	Action .Defocus				
7.5.2 Protection.ThermalShock	Action .ThermalShock	Action .ThermalShock	Action .ThermalShock				
7.5.3 Protection.Structural	Action .Stow	Optional	Optional				
7.5.4 Protection.BackupPower	Action .BackupPower	Action .BackupPower	Action .BackupPower				
7.6 Static Pressure Test	Required	Required	Required	Required			
7.7 Operational Pressure Drop Test	Optional	Optional	Optional	Optional			
7.8 Impact Resistance Test	Optional	Optional	Optional	Optional			

The main branches are:

If wet thermal control is used for thermal limit protection for exposure testing, then active control alternate track can be selected and the controls must be verified.

If active control is used for internal thermal shock control, module 7.4 can be skipped and then active control operation with relevant operation control points and actions must be verified.

Figure C 4 – Track Example (2)

600						
Application	Selection & Inspection	Durability Testing	Thermal Performance Testing	Active Control Testing	Final Inspection	Final Report

600 Track 1						
Application	Selection & Inspection	Durability Testing	Thermal Performance Testing	Active Control Testing	Final Inspection	Final Report

600 Track 2						
Application	Selection & Inspection	Durability Testing		Active Control Testing	Final Inspection	Final Report
		Thermal Performance Testing				

600 Track 3						
Application	Selection & Inspection	Durability Testing			Final Inspection	Final Report
		Thermal Performance Testing				
		Active Control Testing				

600 Track 4							
Application	Selection & Inspection	Durability Testing	Range Thermal Performance Testing	Range Thermal Performance Testing	Active Control Testing	Final Inspection	Final Report