IEC 62862-5-2

Edition 1.0 2022-05

INTERNATIONAL STANDARD

colour inside

Solar thermal electric plants –
Part 5-2: Systems and components – General requirements and test methods for large-size linear Fresnel collectors

IEC 62862-5-2:2022-05(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC 62862-5-2

Edition 1.0 2022-05

INTERNATIONAL STANDARD

Solar thermal electric plants –
Part 5-2: Systems and components – General requirements and test methods for large-size linear Fresnel collectors

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-0096-4

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SOLAR THERMAL ELECTRIC PLANTS –

Part 5-2: Systems and components – General requirements and test methods for large-size linear Fresnel collectors

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62862-5-2 has been prepared by IEC technical committee 117: Solar thermal electric plants. It is an International Standard.

The text of this International Standard is based on the following documents:

Draft	Report on voting
117/148/CDV	117/160/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62862 series, published under the general title *Solar thermal electric plants*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

SOLAR THERMAL ELECTRIC PLANTS –

Part 5-2: Systems and components – General requirements and test methods for large-size linear Fresnel collectors

1 Scope

This part of IEC 62862 specifies the requirements and the test methods for the characterization of a large-size linear Fresnel collector.

This document covers the determination of optical and thermal performance of linear Fresnel collectors, and the tracking accuracy of the collector one-axis tracking system. This test method is for outdoor testing only.

This document applies to linear Fresnel collectors according to Annex A equipped with the manufacturer-supplied sun tracking mechanism.

The testing method in this document does not apply to any collector under operating conditions where phase-change of the fluid occurs. Although the principles of this document can be applied also to collectors with phases-change, however, the sensors (enthalpy, flow, temperatures) required for that are not described in this document.

This document applies to the whole collector field in-situ or as a minimum unit to be tested to an individual collector string (loop) connected to the main piping (flow, return flow) to and from a heat sink, covering the full temperature range of the field.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 62862-1-1, *Solar thermal electric plants – Part 1-1: Terminology*

ISO/IEC Guide 98-3, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 9488, *Solar energy – Vocabulary*

ISO 9806:2017, *Solar energy – Solar thermal collectors – Test methods*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9488, ISO 9806:2017, IEC TS 62862-1-1, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.2 Symbols

A_G	Gross collector aperture area (projected mirror area on the ground including the small gaps between facets and positioning of the mirrors for the sun in the zenith)	m^2
C_R	Geometric concentration ratio: gross collector aperture area A_G divided by the surface area of the receiver A_R	-
E_L	Long-wave infrared sky radiation	W/m^2
F_c	Ratio between the optical efficiency of the collector for normal incidence in a soiled state and a clean state.	-
f_{end}	Function describing the optical end loss of a collector with finite length when the sun is in the longitudinal collector plane	-
G	Solar irradiance	W/m^2
H_{rec}	Height of receiver above mirror plane	m
K_b	Incidence angle modifier for direct beam irradiation	-
K_d	Incidence angle modifier for diffuse irradiation	-
K_T	Incidence angle modifier for direct beam irradiation in the transversal plane	-
K_L	Incidence angle modifier for direct beam irradiation in the longitudinal plane	-
L_m	Length of primary mirror row in one collector module	m
L_{rec}	Length of receiver in one collector module	m
$\dot{Q}$	Thermal power net output of the collector	W
T_m	Mean fluid temperature	K
T_a	Ambient temperature	K
u	Wind speed	m/s
W_i	Project width of mirror row i on the horizontal	m
W_c	Collector width (Width of mirror field perpendicular to row orientation in one collector module)	m
ρ_{test}	specular reflectance of the soiled primary mirrors	-
ρ_{nom}	specular reflectance of the clean primary mirrors	-
θ_{LS}	Longitudinal solar incidence angle	°
θ_T	Transversal incidence angle	°
$\chi_{reflector}$	Ratio of specular reflectance of soiled and clean mirror material	-
η_{0b}	Collector optical efficiency for direct beam radiation at normal incidence	-

Indices

a	ambient
b	beam
dif	diffuse

L	longitudinal
n	normal
T	transversal
Tilt	tilted

4 Testing requirements

The linear Fresnel collector shall be equipped with all the components supplied by the manufacturer (such as support structure, primary reflectors, receiver casing and support, receiver tubes, actuator system and control) and mounted according to the manufacturer instructions.

The different component/elements (such as the receiver parts, reflectors, mirror drives, structure) should be previously tested separately by current testing methods or standards when available. The documentation to be fulfilled by the manufacturer shall be according to Annex B.

5 Instrumentation

5.1 Solar radiation measurement

Solar radiation measurement shall be performed using a pyrheliometer for direct irradiance according to 21.1 of ISO 9806:2017.

Incidence angles will be determined by calculation or with sun position sensors with accuracy equal or better than ± 0,1° with a resolution of 0,01°.

5.2 Flow rate measurement

Flow rate measurement shall be performed according to 21.4.1 of ISO 9806:2017.

5.3 Temperature measurements

Temperature measurements (inlet, outlet and ambient temperature) shall be performed according to ISO 9806:2017 with an accuracy better than 1 % of the temperature rise over the collector

The collector inlet and outlet positions shall be defined by the manufacturer and pairwise calibrated temperature sensors shall be installed at no more than 200 mm from this point. If due to constructional constraints it becomes necessary to position the sensor more than 200 mm away from the collector, then a test shall be made to verify that the measurement of fluid temperature is not affected.

The problems caused by the concentrated light on the sensors if the sensors are mounted in the focus zone shall be taken into consideration.

For piping diameters larger than 254 mm, 2 to 3 temperature sensors should be considered for each position to have a more representative average.

5.4 Wind speed measurement

The mean wind speed in the horizontal plane shall be determined with a standard uncertainty < 0,5 m/s. The sensor shall be installed at (10 ± 0,1) m height from the ground. The sensor shall be installed within the collector field / solar plant. If there is no wind speed sensor close enough to the meteorological station of the plant, one temporary sensor should be added at a distance from the collector extremity (end support as shown in Figure A.1) not larger than 100 m away.

5.5 Data acquisition

Data acquisition shall be according to 23.5.3 of ISO 9806:2017.

5.6 Tracking accuracy measurement

Experimental tracking accuracy measurements can be obtained using inclinometers. Resolution of the inclinometers shall be at least 0,01° and accuracy shall be better than 0,1° over the whole range of tracking angles. Combination of two or more inclinometers often solves this requirement.

The true tracking angle is measured at two locations of the collector, one near the centre (where the drive system is usually located) another one at one collector end.

A more detailed tracking error testing is optional (see 6.3.3).

6 Test procedure

6.1 General

Performance testing includes at least the assessment of the heat power delivered by the collector under various operating and environmental conditions and the measurement of the dependence of the thermal performance on the incidence angle of the irradiation onto the collector. These two sets of parameters are required for the calculation of the collector heat output. If possible, an effective thermal capacity according to ISO 9806:2017 should be also determined. A minimum collector unit (Figure 1) as already stated in the scope may be a complete collector row, a loop or even a subfield, covering the whole temperature range of operation.

6.2 Collector description

The description of collector(s) should be supplied by the manufacturer according to Annex B.

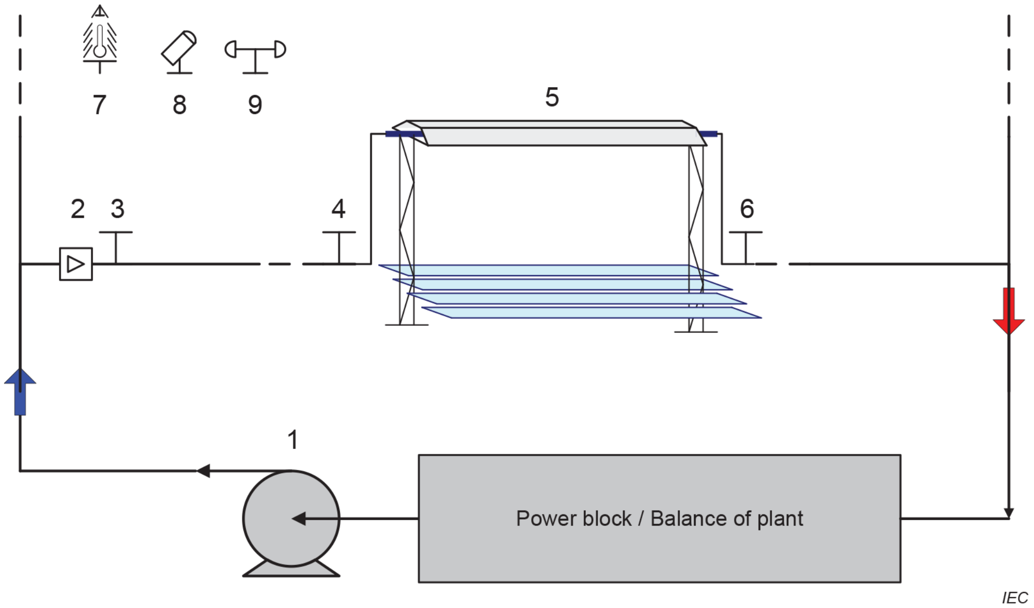
All the components of the tested collector (reflectors, receiver, structure, etc.) shall be representative of the product. The components shall have been selected randomly from the production during the erection of the collector.

All the serial numbers and identification of those components should be reported in the testing report.

6.3 Test equipment

6.3.1 Performance test

The sensors shall be mounted according to ISO 9806:2017. A scheme of principle for the test installation is presented in Figure 1.



Key

1	pump	6	temperature sensor (T_{out})
2	flow meter	7	ambient temperature sensor (T_a)
3	temperature sensor	8	direct solar irradiance sensor
4	temperature sensor (T_{in})	9	anemometer
5	linear Fresnel collector unit		

Figure 1 – Test equipment installation

During the tests of a linear Fresnel collector it will be necessary to guarantee that the reflectors and glass envelopes of the receivers are kept clean. For testing purposes, the cleanliness factor is defined as the ratio between the average optical efficiency during the test and the optical efficiency with ideal clean surfaces. Depending on the receiver construction, not only the cleanliness of the primary mirrors, but to a lesser degree also soiling of the tubular or plane glass cover, and the secondary reflector may impact the collector cleanliness. The target is to keep the collector's cleanliness factor F_c within the range $0{,}95 < F_c < 1{,}0$.

6.3.2 Optical characterization for performance testing

6.3.2.1 Cleanliness

If possible, the collector components primary mirrors, secondary mirrors and cover glasses should be cleaned before the testing. However, in outdoor testing soiling may occur continuously. Therefore, it is important to determine the average cleanliness of a collector before and after a performance test in order to be able to relate the results to a maximum performance with clean mirrors.

The reflectance of the primary mirrors ρ_{nom} (clean state) and ρ_{test} (soiled) will be measured with a portable reflectometer. ρ_{nom} and ρ_{test} shall be measured with the same equipment.

So far there is no field instrumentation available to determine the degree of dirt in the receiver cover and on a secondary reflector once installed in the collector; as the receiver faces the ground it is assumed a good approach to neglect the much smaller percentage of reduction in optical efficiency due to soiling during the test period of the cleaned glass cover and secondary mirror compared to fast soiling of primary mirrors.