SLOVENSKI STANDARD

oSIST prEN IEC 62862-1-5:2023

01-julij-2023

Sončne termoelektrarne - 1-5. del: Preskus postopkov merjenja učinkovitosti za sončne termoelektrarne

Solar thermal electric plants - Part 1-5: Performance code test for solar thermal electric plants

Centrales électriques solaires thermiques - Partie 1-5 : Essai du code de performance pour les centrales électriques thermosolaires

Ta slovenski standard je istoveten z: **prEN IEC 62862-1-5:2023**

ICS:

27.160	Sončna energija	Solar energy engineering

oSIST prEN IEC 62862-1-5:2023 **en**

IEC

117/177/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: **IEC 62862-1-5 ED1**	
DATE OF CIRCULATION: **2023-05-12**	CLOSING DATE FOR VOTING: **2023-08-04**
SUPERSEDES DOCUMENTS: **117/170/CD, 117/176/CC**	

IEC TC 117 : SOLAR THERMAL ELECTRIC PLANTS	
SECRETARIAT: Spain	SECRETARY: Ms Lourdes González Martínez
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☒ ENVIRONMENT	☒ QUALITY ASSURANCE ☐ SAFETY
☒ SUBMITTED FOR CENELEC PARALLEL VOTING **Attention IEC-CENELEC parallel voting** The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	☐ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any relevant "In Some Countries" clauses to be included should this proposal proceed. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (see AC/22/2007 or New Guidance.doc).

TITLE:

Solar thermal electric plants – Part 1-5: Performance code test for solar thermal electric plants

PROPOSED STABILITY DATE: 2028

NOTE FROM TC/SC OFFICERS:

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

SOLAR THERMAL ELECTRIC PLANTS –
Part 1-5: Performance test code for solar thermal electric plants

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 62862-1-5 has been prepared by IEC technical committee TC 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
XX/XX/FDIS	XX/XX/RVD

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 https://www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at https://www.iec.ch/standardsdev/publications.

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.

INTRODUCTION

Solar thermal power plants are electricity generation plants that use solar radiation to heat a fluid to a high temperature. This fluid usually transfers its heat to water to produce superheated steam, which is expanded in a turbine-generator machine to transform thermal energy first into mechanical energy and finally into electricity. These plants use solar collectors to concentrate the solar radiation, and they are classified depending on the concentration technology, including but not limited to Parabolic-Trough Collector (PTC), Central Receiver Collector (CRC) also called Solar Tower, and Linear Fresnel Collector (LFC).

Solar thermal power plants are made of a solar field interconnected to a power block, but sometimes they also include a non-solar energy source and a thermal storage system which enable electricity generation under conditions of reduced or no solar radiation (see Figure 1). Depending on the concentration technology, the solar field may consist of a set of parabolic-trough collector rows, linear Fresnel collector rows, or a set of heliostats with a central receiver located in a tower. All these systems track the sun and collect the energy that it projects in the form of direct radiation.

The Plant Performance must be demonstrated, or verified, as part of the commissioning and acceptance process, for all the configurations agreed by the parties involved.

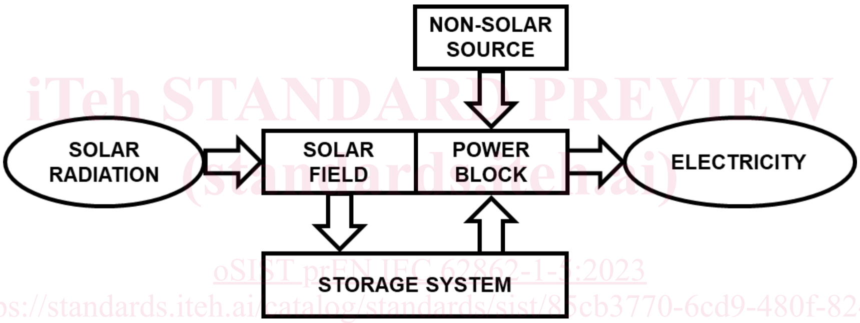

Figure 1 – Energy flows in a Solar Thermal Power Plant

The complexity and duration of performance acceptance tests depend on what these tests are for. There are several different types of tests:

- **Short quasi-stationary tests**: Their purpose is to verify the characteristics and features of the power plant systems (solar field, thermal storage system, power block, and auxiliary non-solar energy systems)
- **Short-duration testing** (at least 24 hours): The purpose is to verify the performance of the power plant over a short period of time (usually associated with Provisional Plant Acceptance Testing)
- **Long-duration tests** (at least 365 days): The purpose is to verify or validate annual plant production and auxiliary consumptions (electricity and non-solar energy source) (These tests are usually associated with Final Plant Acceptance).
- **Dispatchability tests**: The purpose is to verify the ability of the solar thermal power plant to respond to grid operator signals regardless of meteorological conditions.
- **Durability and integrity testing**: The purpose is to verify integrity and validate equipment durability

This standard focuses on acceptance testing of the complete power plant and defines the measurement procedures for short-duration and long-duration efficiency testing.

SOLAR THERMAL ELECTRIC PLANTS –
Part 1-5: Performance test code for solar thermal electric plants

1 Scope

The purpose of this standard is to provide procedures and guidelines to carry out acceptance tests for solar thermal power plants, of any concentration technology, with the uncertainty level given in the ISO/IEC Guide 98-3.

This standard establishes the measurements, instrumentation and techniques required for determining the following performance parameters for a given period:

- Available solar radiation energy
- Plant electricity consumptions
- Net electricity generation
- Non-solar energy
- Net plant efficiency

Other parameters that characterize the solar thermal power plant system features are not dealt with in this standard but are the subject of other complementary standards.

Due to the variability of the sun as the energy source for a solar power plant, it is necessary to compare any measured production data (performance) of the system to a jointly agreed calculation tool serving as a reference for expected production in the specific period and under the real-time solar irradiance and other meteorological data.

This standard is applicable to solar thermal power plants of any size using any concentration technology, where the sun is the main source of energy, and all elements and systems are operative. Such power plants may optionally have non-solar energy sources, such as natural gas or other renewable energies, and a thermal storage system.

It is applicable to acceptance testing in such power plants, as well as in any other scenario in which their performance must be known. Acceptance tests serve for the purpose of verification of a contractual performance measure, and for establishing claims in case of non-fulfillment of performance. In this document the owner, builder, financier, and any other entity interested in knowing these features are called “parties involved.”

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 60044-7:1999, *Instrument transformers – Part 7: Electronic voltage transformers*

IEC 60044-8:2002, *Instrument transformers – Part 8: Electronic current transformers*

IEC TS 62862-1-1:2018, *Solar Thermal Electric Plants – Terminology*

IEC 62862-3-2:2018, *Solar Thermal Electric Plants – Part 3-2: Systems and components. General requirements and test methods for large-size parabolic-trough collectors*

IEC 62862-5-2:2022, Solar thermal electric plants - Part 5-2: Systems and components - General requirements and test methods for large-size linear Fresnel collectors

ISO 9060:1990, *Solar energy. Specification and classification of instruments for measuring hemispherical solar and direct solar radiation*

ISO 9488:1999, *Solar energy – Vocabulary*

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

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

UNE 206010:2015, *Tests for the verification of the performance of solar thermal power plants with parabolic trough collector technology*

3 Terms and definitions

For the purposes of this standard, the terms and definitions included in IEC TS 62862-1-1 apply.

4 Symbols

The symbols and units used in this document are displayed in Table 1.

Table 1 – Symbols and units

Symbol	Description	Units
A_{net}	Net collection area	m²
C_p	Specific heat capacity	J/(kg·K)
E_b	Direct normal solar irradiance	W/m²
$E_{el,net}$	Net electricity generated and delivered to the grid	kWh
E_{ns}	Thermal energy supplied by fossil fuels and/or other non-solar energies	kWh
h	Specific enthalpy	J/kg
$\dot{m}$	Mass flow rate	kg/s
N_{col}	Number of single elements in operation in the solar field: parabolic-trough collectors, Fresnel reflectors or heliostats	-
P	Power	kW
p_{atm}	Atmospheric pressure	bar
RH	Relative humidity	%
t	Time	h
T	Temperature	ºC
U_B	Type B uncertainty	

Symbol	Description	Units
v	Wind speed	m/s
$\dot{V}$	Volumetric flow	m^3/s
Greek Symbols		
Δ	difference or variation	-
$\eta_{plant,net}$	net plant efficiency	%
ρ	Density	kg/m^3
τ	Test time	s
Subscripts		
accum	cumulative value	
atm	atmospheric	
aux	at auxiliar transformer high voltage side	
avail	available in the aperture area of the plant solar field	
con	consumption	
el	electricity	
gross	at generator terminals	
HTF	heat transfer fluid	
i, j	time interval, index	
in, out	inlet, outlet	
net	net value	
ns	non solar	
plant	related to the power plant	
solar	solar radiation	
startup	at startup transformer high voltage side	
tr	transformer	
trloss	transformer losses	
util	useful	
0, end	initial and final time	

5 Performance reference

5.1 Requirements

According to this standard, the verification of performance for a solar thermal power plant requires:

a) The use of a power plant simulation model, hereinafter simulation model, to generate reference values from the input and boundary conditions existing during a test.

b) To define the verification procedure. That is, the way measurements are to be compared with the reference considering uncertainties.

Clause 5.2 defines the simulation model, while the verification procedure is defined in clause 8.8.

5.2 Simulation model

This standard stablishes that the simulation model of the tested solar power plant and its systems is an essential element in the acceptance process. The simulation model to be used shall be agreed by the parties involved, and its validation must be documented. It is recommended that the simulation model meet at least with the requirements listed in this section.

Due to the importance of inertial and transient phenomena during performance tests, the simulation model must be dynamic, or at least consider solar field inertia phenomena, to be able to calculate the reference performance indicators, like electrical power or plant efficiency, for the test boundary conditions.

For short-duration and long-duration efficiency tests, the simulation model will include commonly the following inputs and outputs (see Figure 2):

- Input specifications:
  - Power plant location (geographic latitude and longitude)
  - Test start and end dates and times
  - Date and time, direct solar irradiance, and other meteorological conditions during testing (temperature, wind speed, atmospheric pressure, relative humidity, and, if needed by the simulation model, wind direction), recorded in time intervals no longer than 10 minutes and averaged as specified in clause 8.6
  - Plant operating modes during testing
  - Solar field and power plant availability during testing
  - Reflectance of mirrors in the solar field over time
  - Starting conditions of the thermal storage system
  - Starting conditions of the power plant when testing begins (type of startup)
  - Non-solar energy consumption during testing
- Output specifications:
  - Available solar radiation energy
  - Net electricity production (at test boundaries)
  - Auxiliary electricity consumption
  - Consumption of electricity imported from the grid

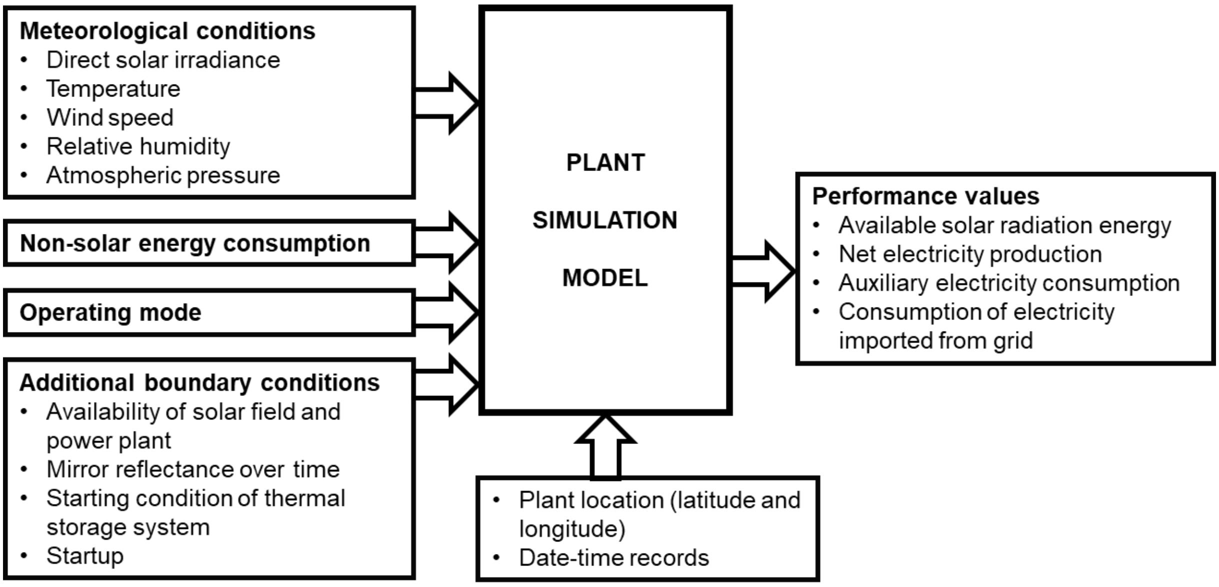

Figure 2 – Required simulation model inputs and outputs

The simulation model used in the acceptance process must be previously validated and agreed upon by the parties. It is recommended that the simulation model validation include the following:

- Verification that the simulation model reproduces nominal performance values at reference conditions (i.e., design point conditions).
- Consistency in predicting performance values at conditions other than those of reference; showing that when input parameters are varied, output trends are congruent with these variations.

6 General test guidelines

This section provides the general instructions to carry out performance tests for solar thermal power plants, with the steps required to plan, prepare, and perform them.

6.1 Test procedure

The Test procedure is a detailed document on the test plan, which must be prepared and approved beforehand by the parties involved. This basic document must include all the details for preparing and conducting a test, as well as how to make calculations and report the results.

It is recommended that it includes at least the following:

1) Purpose of the test, indicating foreseen duration.
2) Features to be verified, along with their guaranteed values and uncertainty margins, if applicable.
3) Test boundaries, identifying the input and output flows and measurement points.
4) Basic test plan.
5) Description of the activities to be performed during test preparation, such as calibration and verification of measurement equipment, training of personnel who take part in the test, inspection and cleaning of equipment, and carrying out a pretest if so agreed. The instrumentation that is to be used during the tests must meet the specifications defined in clause 7. All measuring equipment, both permanent and temporary instruments, necessary for the test, must be checked, inspected, and tuned before starting the test.