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INTERNATIONAL STANDARD

Solar thermal electric plants –
Part 4-1: General requirements for the design of solar power tower plants

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FOREWORD

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IEC 62862-4-1 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
117/166/FDIS	117/169/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 www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/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- withdrawn,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.

SOLAR THERMAL ELECTRIC PLANTS –

Part 4-1: General requirements for the design of solar power tower plants

1 Scope

This part of IEC 62862 specifies the general requirements for the design of solar power tower plants and covers the electric power system requirements, the solar resource assessment, the site selection, the overall planning, the layout of the heliostat field and the receiver tower, the layout of the power block, the collector system, the heat transfer, the thermal energy storage and steam generation system, the steam turbine system, the water treatment system, the information system, instrumentation and control, the electrical equipment and system, occupational safety and occupational health.

This document is applicable to the design requirements of newly built, expanded or rebuilt solar power tower plants employing steam turbines with molten salt or water-steam as heat transfer fluid. If other heat transfer fluids are employed, it is possible that the provisions set out in this document will need to be adapted.

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 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-3, *Rotating electrical machines – Part 3: Specific requirements for synchronous generators driven by steam turbines or combustion gas turbines and for synchronous compensators*

IEC 60034-16 (all parts), *Rotating electrical machines – Part 16: Excitation systems for synchronous machines*

IEC 60038, *IEC standard voltages*

IEC 60045-1, *Steam turbines – Part 1: Specifications*

IEC 60076-1, *Power transformers – Part 1: General*

IEC 60076-2, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers*

IEC 60076-3, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-4, *Power transformers – Part 4: Guide to the lightning impulse and switching impulse testing – Power transformers and reactors*

IEC 60076-5, *Power transformers – Part 5: Ability to withstand short circuit*

IEC 60076-7, *Power transformers – Part 7: Loading guide for mineral-oil-immersed power transformers*

IEC 60086-1, *Primary batteries – Part 1: General*

IEC 60183, *Guidance for the selection of high-voltage A.C. cable systems*

IEC 60255 (all parts), *Measuring relays and protection equipment*

IEC 60479 (all parts), *Effects of current on human beings and livestock*

IEC TS 60815 (all parts), *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles*

IEC 60839-11-2, *Alarm and electronic security systems – Part 11-2: Electronic access control systems – Application guidelines*

IEC 60870-5 (all parts), *Telecontrol equipment and systems – Part 5: Transmission protocols*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61511 (all parts), *Functional safety – Safety instrumented systems for the process industry sector*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 62040-1, *Uninterruptible power systems (UPS) – Part 1: Safety requirements*

IEC 62052-11, *Electricity metering equipment – General requirements, tests and test conditions – Part 11: Metering equipment*

IEC 62053 (all parts), *Electricity metering equipment – Particular requirements*

IEC 62053-21, *Electricity metering equipment – Particular requirements – Part 21: Static meters for AC active energy (classes 0,5, 1 and 2)*

IEC 62053-41, *Electricity metering equipment – Particular requirements – Part 41: Static meters for DC energy (classes 0,5 and 1)*

IEC 62271 (all parts), *High-voltage switchgear and controlgear*

IEC 62305-1, *Protection against lightning – Part 1: General principles*

IEC 62642-1, *Alarm systems – Intrusion and hold-up systems – Part 1: System requirements*

IEC 62676-1-1, *Video surveillance systems for use in security applications – Part 1-1: System requirements – General*

IEC TS 62749, *Assessment of power quality – Characteristics of electricity supplied by public networks*

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

IEC TS 62862-2-1, *Solar thermal electric plants – Part 2-1: Thermal energy storage systems – Characterization of active, sensible systems for direct and indirect configurations*

IEC 81346 (all parts), *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations*

ISO/IEC 11801-3, *Information technology – Generic cabling for customer premises – Part 3: Industrial premises*

ISO 8995-1, *Lighting of workplaces – Part 1: Indoor*

ISO/CIE 8995-3, *Lighting of workplaces – Part 3: Lighting requirements for safety and security of outdoor workplaces*

ISO 11064-3, *Ergonomic design of control centres – Part 3: Control room layout*

ISO 11064-6, *Ergonomic design of control centres – Part 6: Environmental requirements for control centres*

ISO 12100, *Safety of machinery – General principles for design – Risk assessment and risk reduction*

ISO/TR 14121-2, *Safety of machinery – Risk assessment – Part 2: Practical guidance and examples of methods*

ISO 45001, *Occupational health and safety management systems – Requirements with guidance for use*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in 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

3.1
receiver tower
tall structure which supports the receiver and auxiliary systems

3.2
solar power tower plant
solar thermal power plant consisting of a point-focus solar system that is composed of heliostats, a receiver system, and a receiver tower

3.3
heliostat field
area on which the heliostats are installed to concentrate the solar radiation onto the receiver

3.4
molten salt
inorganic salt in the liquid phase, usually composed of mixtures of alkali nitrates, carbonates or chlorides

3.5
annual efficiency of collector system
ratio of the thermal energy transferred to the heat transfer fluid from collector system to the total direct normal irradiation multiplied by the heliostat field aperture area over a year

3.6
shading loss
energy loss due to the reduction in the effective aperture of the heliostat caused by shadows cast by other heliostats or the tower

3.7
blocking loss
energy loss due to reflected rays being blocked by adjacent heliostats

3.8
capacity factor
ratio of the number of equivalent operating hours to the total number of hours in a year (8 760)
ratio of equivalent full-load operating hours to the total hours in a year

3.9
heliostat field efficiency
ratio of the solar radiant power incident in the receiver aperture from the heliostat field to the available radiant solar power over a given period (hourly, daily, weekly, etc.)

3.10
receiver efficiency
ratio of the thermal power transferred to the heat transfer fluid to the solar radiant power incident in the receiver aperture from the heliostat field over a given period

3.11
cosine loss
energy loss due to the incident direction of sunlight being not parallel to the normal direction of the mirror surface

3.12
atmospheric attenuation
energy loss due to the reflected rays from the heliostats being absorbed and scattered by the air before reaching the receiver

3.13
receiver spillage
energy that is reflected from the heliostats but fails to reach the receiver, after deduction of the blocking loss and the atmospheric attenuation

4 Basic requirements

4.1 For the design of a solar power tower plant, the site resource conditions should be evaluated considering long-term meteorological conditions at the proposed location of the plant. As a minimum, the evaluation of average yearly direct normal irradiance (DNI) values (P50 and P90), typical meteorological year series (P50), ambient temperature, ambient pressure, wind speed, wind gust and relative humidity should be performed.

4.2 The power block capacity, the storage capacity and the operation modes of solar power tower plants are determined by a techno-economic evaluation on the basis that the electric power system requirements are satisfied.

4.3 For the system capacity matching of solar power tower plants, the following provisions apply.

a) The overall optimization should be performed between the heliostat field, the receiver capacity, the steam generator capacity, the steam turbine capacity and the storage capacity.
b) The maximum continuous flow rate of the steam generation system shall match the maximum turbine inlet steam flow rate.
c) The maximum continuous capacity of the generator shall match the maximum continuous output of the steam turbine.

4.4 The annual electricity output may be estimated as specified in Annex A.

4.5 The design lifetime for solar power tower plants shall meet customer requirements.

4.6 A uniform identification system should be employed for the plant design and the uniform identification system employed shall meet the requirements of the IEC 81346 series.

4.7 All computer-based systems shall meet the local information technology requirements for security protection.

5 Electric power system requirements

5.1 General requirements

The main transformers, circuit breakers and other electric equipment connected to the power grid shall meet the frequent start-up/shutdown requirement for the plant.

5.2 Requirements for grid-connection

5.2.1 The grid-connection scheme for solar power tower plants shall meet the local grid-connection requirements.

5.2.2 The voltage class for grid-connection should be selected according to the power plant capacity, and there should be one or two voltage classes.

5.2.3 Off-load tap-changing transformers should be selected. On-load tap-changing transformers may be selected as main transformers if the voltage adjustment calculation is proved to be necessary.

5.2.4 The rated power factor of the generating units of the power plant should meet the local grid operation demands.

5.2.5 The power quality level at the point of common coupling shall meet the requirements of IEC TS 62749.

5.3 Relay protection and automatic safety device

5.3.1 The relay protection and the automatic safety device shall meet the requirements of IEC 60870-5 (all parts).

5.3.2 The configuration of the line protection shall meet the local grid requirements.

5.4 Dispatching automation

5.4.1 Telecontrol information shall meet the requirements of the IEC 60870-5 series.