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BSI Standards Publication

Solar thermal electric plants

Part 3-1: Systems and components — General requirements for the design of parabolic-trough solar thermal power plants

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee RHE/25, Solar Heating.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Part 3-1: Systems and components – General requirements for the design of parabolic-trough solar thermal power plants

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

Draft	Report on voting
117/153/FDIS	117/158/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.

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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.

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- reconfirmed,
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SOLAR THERMAL ELECTRIC PLANTS –

Part 3-1: Systems and components – General requirements for the design of parabolic-trough solar thermal power plants

1 Scope

This part of IEC 62862 specifies the general requirements for the design of parabolic-trough solar thermal power plants. It includes requirements for the electric power system, solar resource assessment, site selection, overall planning, collector system, heat transfer system, thermal energy storage system, steam generation system, steam turbine system, layout of solar field, layout of power block, electrical equipment and system, water treatment system, instrumentation and control, auxiliary system and ancillary facilities, as well as considerations concerning health and safety.

This document is applicable to the design of new, expanded or rebuilt parabolic-trough solar thermal power plants using a steam turbine.

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

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

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

IEC TS 62749, A*ssessment 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 62862-3-2, *Solar thermal electric plants – Part 3-2: Systems and components – General requirements and test methods for large-size parabolic-trough collectors*

IEC TS 62862-3-3, *Solar thermal electric plants – Part 3-3: Systems and components – General requirements and test methods for solar receivers*

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

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.

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

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

3.1
parabolic mirror
reflector with a parabolic cross section mounted on the supporting structure of a parabolic-trough collector

3.2
receiver efficiency
ratio of the thermal power transferred to the heat transfer fluid (HTF) to the radiant power at the receiver aperture

3.3
heat exchanger efficiency
ratio of the energy gained by the heat transfer fluid to the energy supplied to the heat exchanger in full-load discharge operation mode

3.4
thermal energy loss
<of thermal energy storage system> lost energy by the thermal energy storage system during the period of time considered, without involving any charge or discharge process and without any external energy supply

3.5
molten salt
inorganic salt in liquid state usually composed of mixtures of alkali nitrates, alkali nitrites, carbonates, chlorides, etc.

3.6
low-boiling-point substance
substance in heat transfer fluid whose distillation temperature is lower than the initial boiling point of the unused heat transfer fluid

3.7
high-boiling-point substance
substance whose distillation temperature is higher than the final boiling point of the unused heat transfer fluid, after heating testing similar to the distillation method

3.8
identification system
coding system allocating a unique identification tag to each physical object, in order to distinguish such an object from others

3.9
drought index
ratio of the annual evaporation to the annual rainfall in a region

3.10
turbine maximum continuous rating
TMCR
maximum continuous output of the steam turbine under the conditions of design steam intake, design live steam and reheat steam parameters, design exhaust pressure (4,9 kPa), and no make-up water

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3.11
boiler maximum continuous rating
BMCR
maximum evaporation rate of the boiler when it can produce steam safely and continuously at design steam parameters and design make-up water temperature using the designed fuel

Note 1 to entry: The boiler maximum continuous rating condition corresponds to the inlet steam parameters when turbine valves are wide open.

3.12
regulating volume
difference between the total volume of the heat transfer system at operating temperature and the total volume of the heat transfer fluid at filling temperature

4 General requirements

4.1 For the design of a parabolic-trough solar thermal power plant, 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 steam turbine capacity, thermal storage system capacity, solar field size and operation modes of the plant should be determined through techno-economic evaluation and should meet the requirements of local electric power planning.

4.3 The design capacity of the plant should meet the following provisions:

a) The overall optimization should be done among the solar field aperture area, steam generator evaporation, steam turbine capacity, HTF-thermal storage medium heat exchanger charging power and thermal energy storage capacity.
b) The BMCR evaporation of the steam generation system should match the maximum inlet steam flow rate of the steam turbine.
c) The turbine-generator capacity should match the maximum continuous output of the steam turbine.

4.4 The design life time of the plant should meet the client's requirements.

4.5 A uniform identification system should be deployed in the plant design and should meet the relevant provisions of the IEC 81346 series.

5 Electric power system requirements

5.1 General

The main transformer, circuit breaker and other electric equipment in connection with the power grid should meet the requirements of frequent start-up/shutdown of the plant.

5.2 Grid-connection

5.2.1 The grid-connection scheme of the plant can be subject to regulations, provisions and requirements of the local grid.

5.2.2 The voltage class for grid-connection should be selected according to the power plant capacity.

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

5.2.4 The rated power factor of the generating units of a 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 relevant requirements of IEC TS 62749.

5.3 Relay protection and automatic safety devices

5.3.1 Relay protection and automatic safety devices should be designed according to the IEC 60255 series, as well as the IEC 60870 series.

5.3.2 Configuration of line protection can be subject to requirements of the local grid.

5.4 Dispatching automation

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

5.4.2 The solar power forecasting system may be installed in the plant, which forecasts solar resource and power production together with the plant performance model.

5.5 Electric power system communication

The electric power system communication shall meet the requirements of the IEC 61850 series.

5.6 Electric energy metering

The electric energy metering device should meet the relevant requirements of the IEC 62053 series.

6 Solar resource assessment

Solar resource at the site should be assessed according to IEC TS 62862-1-2 and IEC 62862-1-3.

7 Site selection

7.1 When selecting a site for a parabolic-trough solar thermal power plant, the following factors should be considered:

a) local grid structure and local electric power planning;

b) auxiliary fuel supply;

c) requirements of urban planning;

d) water source;

e) traffic and transportation for large equipment;

f) environmental impact assessment;

g) social impact assessment;

h) outgoing line corridor;

i) landform;

j) geology;

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k) seismicity;

l) hydrology;

m) meteorology;

n) construction.

7.2 When selecting a site for a parabolic-trough solar thermal power plant, the water source should meet the following provisions:

a) If river water is used as water source, the water intake point should be located in the riverbed section which is stable all year around, so that the impact of mud, sand, vegetation, ice, drifting sundries and drained water backflow can be avoided.

b) If underground water is used as water source, a hydro-geological investigation report can be subject to local requirements.

7.3 When selecting a site for a parabolic-trough solar thermal power plant, the natural conditions should meet the following provisions:

a) The site should be selected in regions with abundant and stable DNI resources.

b) The site shall not be located in regions that include dangerous rocks, landslide, karst development, mudslide section, seismogenic fault and goaf zone.

c) If geological disaster prone region cannot be avoided, risk assessment should be done, and geological disaster risks should be comprehensively assessed.

d) Suspended particulate matter, airport runways and air routes, high wind speed regions, and surrounding obstacles such as tall and large trees, mountains, buildings should be taken into consideration.

e) The site should be located in a flat region.

f) Buildings or structures inside and outside the site should not shadow the solar field during most of the daylight hours.

7.4 When selecting a site for a parabolic-trough solar thermal power plant, essential data of the geological conditions of the site should be obtained, which will be used as the design basics for buildings and structures.

7.5 The seismic fortification intensity of the site shall be determined subject to the local provisions of seismic fortification intensity or seismic ground motion design parameters.

8 Overall planning

8.1 General

8.1.1 Overall planning of parabolic-trough solar thermal power plants should be done considering the following factors:

a) impact of DNI on the solar field layout;

b) requirements relating to construction and production of the plant;

c) natural conditions of the site;

d) construction schedule;

e) water supply and drainage facilities;

f) heat supply piping;

g) off-site traffic;

h) outgoing line corridor;

i) flood control and drainage;

j) current stage and long-term development of the site.

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8.1.2 Planning for flood control and drainage should be done according to the natural conditions and safety requirements of the site. A flood bank, flood trench or floodwall may be used.

8.2 Off-site planning

8.2.1 Planning for off-site transportation can be subject to local laws and regulations.

8.2.2 Planning for off-site water supply and drainage facilities should be determined by comparing alternative options, considering plant capacity, water source, topographic conditions, environmental protection, soil and water conservation requirements, etc. Locations and piping for off-site water intake and drainage should be planned in a harmonized way.

8.2.3 Planning for an outgoing line corridor should be done according to the design capacity of the plant, construction scale of the current stage, planning of local electric power, as well as direction, voltage and circuit number of transmission lines.

8.2.4 Auxiliary fuel supply, if any, shall be reasonably planned according to local requirements of fuel supply, transportation and environmental protection.

8.3 On-site planning

8.3.1 On-site planning should meet the following provisions:

a) As per its different functions, the plant may be divided into solar field, power block and thermal storage system. The solar field may be subdivided into subfields according to different loop combinations.

b) Planning for corridors of incoming and outgoing power lines should be done according to system requirements and line directions, and line crossing should be avoided.

c) Location of entrances and exits of the plant should be convenient for transportation, and road specification can be subject to local requirements for production, living and fire protection.

8.3.2 Planning for solar field should meet the following provisions:

a) The solar field should be reasonably arranged according to topographic conditions, equipment specifications and construction requirements. The solar field should use the modularization arrangement in subfields.

b) The layout of the solar field should be comprehensively determined considering longitude, latitude, altitude and other geographical factors of the site, as well as site area and collector cost.

c) The installation height of the collector should be determined considering local flood levels and snow thickness.

d) For a site with high wind and dust, wind barriers and dust control facilities should be considered according to the wind direction and collector layout direction.

e) The layout of piping in the solar field should be planned in a harmonized way, and pipelines of HTF and cables should be laid along roadsides.

8.3.3 Planning for the power block should meet the following provisions:

a) The power block should be located in the centre of the plant.

b) Taking into account rational process flow, the planning for the subregion division and building layout in the power block should be done according to local sunlight direction, wind direction, topographical and geotechnical conditions.

c) Auxiliary and ancillary buildings with similar functions should be arranged side by side in the same subregion.

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