

ICS 27.160
CCS F 12



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 44140-2024

**Technical requirements for heliostats of solar power tower
plant**

塔式太阳能光热发电站定日镜技术要求

Issued on: June 29, 2024

Implemented on: January 1, 2025

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

Table of Contents

1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Normal service conditions	2
5 Appearance, dimensions and structure	2
6 Functions and performance	3
6.1 Functions	3
6.2 Performance	3
7 Tests and inspections	4
7.1 Test and inspection items	4
7.2 Test and inspection rules	5
7.3 Appearance inspection	6
7.4 Dimension inspection	6
7.5 Position locking function inspection	11
7.6 Status feedback function inspection	12
7.7 Communication inspection	12
7.8 Fault diagnosis function inspection	13
7.9 Tracking accuracy inspection	14
7.10 Mirror reflectance inspection	14
7.11 Homing accuracy inspection	15
7.12 Rotation angle inspection	15
7.13 Electromagnetic compatibility inspection	17
7.14 Insulation and withstand voltage inspection	17
7.15 Environmental adaptability	17
7.16 Power supply inspection	17
7.17 Earthing inspection	17
8 Packaging, storage and transport	18
8.1 Packaging	18
8.2 Storage	18
8.3 Transport	18
Bibliography	19

3 Terms and definitions

3.1 Heliostat: a reflector that by mechanical drive reflects the direct normal solar radiation constantly in one direction; a note states that a heliostat comprises the mirror, the support and the drive. Taken from GB/T 12936-2007, 8.9, modified. 3.2 Transmission mechanism: the device that drives the heliostat so that it tracks the sun, generally comprising the transmission gear, the motor and the driver or controller.

3.3 Homing: a rotation of the heliostat that brings it to the reference position. 3.4 Tracking accuracy, also called tracking error: the angle subtended by the line joining the geometric centre of the pattern formed on the target surface by the sunlight reflected from the heliostat and the target point on that surface, seen from the centre of rotation of the heliostat; a note states that it is usually expressed in milliradians. 3.5 Tracking: automatic following of the sun by the heliostat so that direct solar radiation is thrown onto the stated position on the surface of the receiver.

3.6 Slope deviation: the angular difference between the actual normal vector and the ideal normal vector at a point on the reflecting surface of the heliostat; notes state that it is usually expressed in milliradians and refer to the calculation and to a diagram. 3.7 Windproof mode: the state of the heliostat when it is at the angle of its greatest wind resistance; a note states that in windproof mode the heliostat is often close to a flat attitude.

4 Normal service conditions

4.1 Ambient temperature: -40 °C to 55 °C for the low-temperature type and -10 °C to 55 °C for the normal-temperature type. 4.2 Relative humidity not greater than 95 %.

4.3 Altitude is graded at 1 000 m, 2 000 m, 3 000 m, 4 000 m and 5 000 m. 4.4 Operating wind speed is below 13 m/s, taken as the 10 min average at 10 m above the ground.

5 Appearance, dimensions and structure

5.1 to 5.3 The heliostat shows no obvious deformation, denting or breakage, the anti-corrosion coating does not peel, and the marking or nameplate is clear and complete.

5.4 to 5.7 For a single heliostat the mirror thickness deviation is not greater than 0.2 mm and the deviation of any other single dimension is not greater than 2 mm; the deviation between the actual and design mirror area is not greater than 0.2 %; where the outline is rectangular, the ratio of mirror width to mirror height is preferably 1.0 to 2.0; and the root mean square of the slope deviation of the mirror surface in the x and y directions is not greater than 2.5 mrad in either direction.

5.8 to 5.11 In the working state the heliostat meets the safety requirements at the maximum operating wind speed and in windproof mode it meets those at the local extreme wind

speed with a return period of 50 years; its stiffness satisfies the tracking accuracy requirement; and the minimum distance between the mirror and the ground in any state is preferably not less than 0.5 m for a heliostat with a single reflecting area greater than 100 square metres and not less than 0.3 m for one with a single reflecting area of 100 square metres or less.

6 Functions and performance

6.1 The heliostat tracks the sun and reflects the direct normal radiation in real time; it locks its position when it stops rotating under any permitted condition; each rotation axis carries a zero-position sensor and has a homing function; it feeds its status back, the status covering at least homing, rotation angle and tracking; it can be controlled locally and remotely; it has a communication interface through which it receives control commands and reports its status, angle and fault diagnosis information; communication may be wired or wireless and may use RS485, industrial Ethernet including Ethernet and wifi, zigbee or Lora; a fault in one or some heliostats on a communication bus does not affect the normal running of the others on that bus; and the security of the data communication network meets GB/T 33009.1. Under safety protection, the heliostat enters windproof mode automatically when the wind speed exceeds the maximum operating wind speed, and it has a fault diagnosis function covering at least homing faults, abnormal rotation, which includes motor stalling and wrong direction of rotation, and communication faults.

6.2.1 Tracking accuracy satisfies three conditions at once: at a wind speed of 4 m/s it is preferably not lower than 2.5 mrad, at 8 m/s not lower than 4.0 mrad and at 11 m/s not lower than 6.0 mrad.

6.2.2 Mirror reflectance: for a glass mirror, not less than 94.5 % where the mirror thickness is greater than 0 mm and not greater than 2 mm, not less than 93.5 % where it is greater than 2 mm and not greater than 4 mm, and not less than 92.5 % where it is greater than 4 mm and not greater than 6 mm; for a highly reflective aluminium mirror, not less than 89 %; and for a silvered polymer or other type of mirror, not less than 91 %.

6.2.3 to 6.2.9 Homing accuracy is not lower than 0.5 mrad. The rotation angle accuracy of each axis is not lower than 2 mrad and the rotation speed of each axis is not lower than 0.01 r/min and satisfies the speed needed for emergency defocusing and emergency field shutdown, the time to reach windproof mode from any position being not greater than 10 min. Immunity reaches test level 3 of GB/T 17626.2, GB/T 17626.3, GB/T 17626.4 and GB/T 17626.5. The insulation resistance and insulation strength between the electronic parts and the metal structure meet GB/T 15479. The enclosure protection of the electrical housing reaches IP54, the protective coating of the mirror covers and protects the reflecting layer for the 25-year design life, and the heliostat withstands the local extreme temperature with a return period of 50 years without damage. The supply may be alternating or direct current and the permitted voltage deviation is $\pm 10\%$. The heliostat body has an earthing

point, its metal parts and structures are bonded equipotentially with a connection resistance to that point not greater than 1 ohm, and the earthing resistance is not greater than 4 ohm where the supply is not at safety voltage, or is determined by the requirements of the electrical equipment inside where it is.

7 Tests and inspections

7.1 Table 1 lists the fifteen inspection items with, for each, the technical requirement clause and the clause of the test method under each of the three inspection classes, type test, factory test and site test, a dash marking a class in which the item is not tested. The items are appearance; dimensions, split into dimensional deviations and slope deviation; position locking function; status feedback function; communication; fault diagnosis function; tracking accuracy; mirror reflectance; homing accuracy; rotation angle, split into accuracy and speed; electromagnetic compatibility; insulation and withstand voltage; environmental adaptability, split into degree of protection and high and low temperature endurance; power supply; and earthing, split into connection resistance and earthing resistance.

7.2 A type test checks whether the heliostat meets the document and all its items have to pass; it is carried out on trial production of a new product, after a major change of material or process in series production that may affect quality, on resumption of production after a long stoppage, where the factory test result differs markedly from the last type test, and where the national market supervision body calls for a routine inspection. The factory test is carried out when the product leaves the works, may use sampling with not fewer than 10 units sampled from one batch, and all its items have to pass. The site test is carried out before delivery and acceptance, is run with the heliostat operating normally and free of faults unless otherwise stated, and all its items have to pass.

7.3 and 7.4 Appearance inspection uses a magnifier and a video camera, the heliostat being laid horizontally in a well-lit position; the marking or nameplate is checked for presence and completeness and the surface for deformation, denting, breakage and peeling of the anti-corrosion coating, a magnifier assisting where viewing conditions are poor and a camera or other photographic equipment being used where direct viewing is not possible. Dimensional deviation inspection uses an invar rule of accuracy not lower than 1 mm and a vernier caliper of accuracy not lower than 0.02 mm, the caliper measuring the mirror thickness and the rule the mirror width and height, from which the mirror area and, for a rectangular outline, the width to height ratio are calculated. Slope deviation inspection uses a ground camera of resolution not lower than 2456 by 2058, a measuring camera of resolution not lower than 3856 by 2764, a projector of resolution not lower than 1920 by 1080 and brightness not lower than 5 000 lm with keystone correction, and a total station with an angle accuracy better than ± 1 arcsecond and a distance accuracy better than ± 1 mm plus 1.5 parts per million, measuring to a prism.

7.4 (continued) The slope deviation inspection is carried out at night or in a dark room. A