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Code for operation of solar power tower plant

塔式太阳能光热发电站运行规程

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3 Terms and definitions

The receiver peak flux density is defined as the maximum radiant flux density received by the absorbing surface of the receiver; a note gives its unit as watts per square metre.

A cold start-up is defined as a start-up in which the gauge pressure on the steam and water side of the drum of the steam generation system is zero and the temperature is close to ambient. A hot start-up is a start-up in which that temperature is above 250 °C.

Four operating modes are defined. The collector and thermal storage mode is the mode in which the collector system, the heat transfer system and the thermal storage system are in operation while the heat exchange system and the steam turbine generator system are not. The power generation from thermal storage mode is the mode in which the thermal storage system, the heat exchange system and the steam turbine generator system are in operation while the collector and heat transfer systems are not. The collection, storage and power generation mode is the mode in which the collector system, the heat transfer, storage and heat exchange systems and the steam turbine generator system are all in operation. The anti-freezing mode is the mode in which the collector system and the storage and heat exchange systems are shut down for a long period and the molten salt is prevented from solidifying.

The terms and definitions of GB/T 40104 and GB/T 51307 also apply.

4 Basic provisions

4.1 Before the plant is put into operation, the selection of equipment and the configuration of the systems are to meet the requirements of GB/T 51307.

4.2 Before the plant is put into operation, the grid connection dispatch agreement and the power purchase and sale contract are to have been signed, and the grid connection technical requirements are to meet GB/T 28566 and GB/T 40103.

4.3 Before the plant is put into operation, an operating code is to be prepared and management systems drawn up, namely the duty management system, the daily management rules, the work ticket system, the operation ticket system, the shift handover system, the equipment patrol inspection system, the periodic testing and rotation system for equipment, the equipment defect management system, the operation analysis system, the training management system, the fire safety system, the technical document management system, the anti-accident measure plan, the labour protection measure plan and the emergency plan for accidents.

4.4 Operating staff are to have received pre-job training and obtained the corresponding certificate of qualification, to be in a state of health that meets the conditions for the post, to be familiar with the requirements of electrical safety work, and to have mastered the technical requirements, the methods of operation and the methods of fault handling of a solar power tower plant.

4.5 to 4.7 The operation, patrol inspection, routine maintenance, abnormal operation and fault handling of the step-up substation and of the high and low voltage electrical equipment, the secondary equipment and the common equipment are to meet DL/T 969. The operation, patrol inspection, routine maintenance, abnormal operation and fault handling of the electrical lines are to meet DL/T 1253. The operation of the dispatch automation equipment is to meet GB/T 31464 and DL/T 516.

4.8 and 4.9 The plant is to choose among the collector and thermal storage mode, the power generation from thermal storage mode, the collection, storage and power generation mode and the anti-freezing mode according to the meteorological conditions, the dispatch requirements, the system configuration and the operating state. After the plant is put into operation, equipment operating records are to be established, the operating condition of the equipment and the handling of abnormal operation and faults recorded and reported, and the operating data collected and analysed in good time.

5 Monitoring and operation

5.1 During operation, the state of the equipment, the operation of the production equipment and the adjustment of the parameters are to be monitored. The operation of equipment under the jurisdiction of the grid dispatch is to have the permission of the dispatch body.

The load of the unit is to be controlled according to the planned curve issued by the dispatch body, the control indices meeting GB/T 40103.

5.2 The monitoring of the plant is to include the irradiance, ambient temperature, ambient humidity, wind speed, wind direction and cloud monitoring data; the operating mode of the plant; the grid voltage and frequency; the operating state of the heliostat field; the temperature of each panel of the receiver, the level of the inlet and outlet buffer tanks and the change of the inlet and outlet molten salt temperature; the pressure, temperature and pump state of the heat transfer system; the tank wall temperature, foundation temperature, expansion indication, cooling fan state, molten salt temperature and level of the storage system; the pressure, temperature and level of the heat exchange system together with the main steam flow and the temperature and pressure of the reheat steam; the operating state of the electric tracing and electric heating systems; the turbine back pressure and low pressure cylinder exhaust temperature, the steam pressure and temperature at the high pressure cylinder exhaust and at each regenerative extraction stage, and the turbine speed and differential expansion; the active and reactive power, voltage, current and frequency of the generator, the stator and rotor winding temperature and the stator core temperature, and the inlet water temperature, pressure and flow and the outlet water temperature of the generator cooler; the metal temperature of the thrust and support bearings of the turbine generator set, the vibration of the shaft and bearing pedestals, the axial displacement, the inlet and return oil temperature of each bearing, and the rotor vibration and eccentricity; the state of the electrical equipment; the state, bearing temperature, speed, pressure, flow, current and vibration of the rotating machines; the state of the valves and actuators; the state of the fire protection and fire detection alarm; the fault, accident and protection actuation signals; the real-time monitoring of the video surveillance system; and the parameters of the other auxiliary systems that need to be monitored. Alarm information found by the operating staff is to be acknowledged in good time.

5.3.1 The operations are to include the start-up, operation and shutdown of the collector and heat transfer systems, of the storage and heat exchange systems and of the steam turbine generator set.

5.3.2 For the collector and heat transfer systems, the checks before start-up are to include that the meteorological conditions meet the start-up requirements; that the station service power system is running normally; that the storage system is ready to receive molten salt; that the uninterruptible alternating current supply, the meteorological observation device and the infrared imager of the heliostat field are running normally; that the working indication signals of the heliostat field control network communication are correct; that the receiver and heliostat control systems are running normally; that the instruments, the equipment state and the parameter display are normal and the relevant protections are in service, the protections of the main systems and equipment being given in Annex A; that the main control system is working normally, the main analogue control systems being given in Annex B; that the electric tracing and electric heating systems are running normally

under automatic control and the temperature meets the conditions for filling the system with salt; that the level of the low temperature molten salt tank meets the requirements for start-up and for operation on load; that the valve positions are correct and their drives normal; and that the compressed air system is running normally. The start-up operations are to include putting the electric tracing and electric heating of the collector and heat transfer systems into service; putting the heliostats into service and preheating the receiver; putting the receiver compressed air system into service; starting the receiver molten salt circulating pump so that the receiver begins to fill with salt; and adjusting the molten salt flow so that the receiver molten salt circulation is established.

5.3.2 (continued) The operating actions are to include adjusting the flow of the receiver molten salt circulating pump so that the level of the inlet buffer tank is controlled; adjusting the number of heliostats in operation or the flow between the circuits so that the receiver outlet molten salt temperature is controlled and the temperature difference between the circuit outlets is lowered; operating the valves according to the receiver outlet molten salt temperature so that the salt flow is switched to the low or the high temperature tank; and keeping the receiver peak flux density within the technical requirements of the receiver when the heliostat field is adjusted. The shutdown actions are to include reducing the number of focusing heliostats; adjusting the flow of the receiver molten salt pump so that the cooling rate of the panels meets the technical requirements of the receiver; switching the downcomer salt flow to the low temperature tank at a suitable time according to the receiver outlet temperature; keeping the receiver inlet molten salt flow not less than the minimum safe operating flow; opening the receiver drain valve so that the receiver is drained; adjusting the number of heliostats in service after draining so that the panel cooling rate meets the technical requirements; and withdrawing the heliostats from tracking.

5.3.3 For the storage and heat exchange systems, the checks before start-up are to include that the electric tracing and electric heating of the equipment are running normally; that the system equipment is intact, the valve positions correct and the drives normal; that the instruments, the equipment state and the parameter display are normal and the protections in service, the protection items being given in Annex A; that the control system is working normally, the main analogue control systems being given in Annex B; that the level of the high temperature molten salt tank meets the needs of unit start-up and operation on load; that the water treatment, dosing and sampling systems are working normally; that the compressed air, fire protection, industrial water, circulating water and other common systems are running normally; and that all the tests before start-up have passed. The hot start-up actions are to include checking that the drum level is normal and the water quality qualified and confirming that the drum is under heat and pressure preservation; choosing, according to the pressure parameters of the heat exchange system, the temperature at which the high temperature molten salt circulating pump and the tempering pump mix the salt for filling the system; and adjusting the output of the feedwater heater or the feedwater flow so that the preheater inlet feedwater temperature meets the technical requirements.