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**Code for Commissioning of Electrochemical Energy Storage
Station**

电化学储能电站调试规程

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Code for Commissioning of Electrochemical Energy Storage Station

1 Scope

This document specifies the commissioning items, methods and technical requirements for the joint commissioning of subsystems and the whole station of electrochemical energy storage station (abbreviated as the “energy storage station”), including energy storage system, monitoring system, power transformation and distribution system, relay protection and automatic safety devices, communication and dispatching automation systems, station power supply, etc.

This document is applicable to the commissioning of subsystems and joint commissioning of the whole station of newly built, rebuilt and expanded electrochemical energy storage stations with lithium-ion batteries, lead-acid (carbon) batteries, sodium-ion batteries, flow batteries, water electrolysis hydrogen production / fuel cells as energy storage carriers.

2 Normative References

The contents of the following documents constitute indispensable clauses of this document through the normative references in the text. In terms of references with a specified date, only versions with a specified date are applicable to this document. In terms of references without a specified date, the latest version (including all the modifications) is applicable to this document.

GB/T 156 Standard Voltages

GB/T 1980 Standard Frequencies

GB/T 7261 Basic Testing Method for Relaying Protection and Security Automatic Equipment

GB/T 14285 Technical Code for Relaying Protection and Security Automatic Equipment

GB/T 19774 Specification of Water Electrolyte System for Producing Hydrogen

GB/T 20297 Static Var Compensator Field Tests

GB/T 24554 Performance Test Methods for Fuel Cell System

GB/T 26862 Test Specification for Synchrophasor Measurement Unit for Power Systems

GB/T 27748.1 Stationary Fuel Cell Power Systems - Part 1: Safety

GB/T 27748.4 Stationary Fuel Cell Power Systems - Part 4: Performance Test Methods for Small Fuel Cell Power Systems

DL/T 1101 Acceptance Specification for 35 kV ~ 110 kV Substation Automation System

DL/T 1215.4 Chain-circuit Static Synchronous Compensator - Part 4: Field Tests Guide

DL/T 1379 Test Specifications for Equipment of Electric Power Dispatching Data Network

DL/T 1455 Technical Requirements of Safety and Security for Electric Power System Control Software and Software Testing

DL/T 2246.5 Technical Specification for Grid-connected Operation and Control of Electrochemical Energy Storage Station - Part 5: Security and Stability Control

DL/T 2253 Technical Supervision Guide for Relaying Protection and Security Automatic Equipment of Power Plants

DL/T 2528 Basic Terminology of Electrical Energy Storage

DL/T 5003 Code for Design of Dispatch Automation in Power System

DL/T 5044 Technical Code for Designing DC System of Power Projects

DL/T 5202 Code for Design of Electric Energy Metering System

3 Terms and Definitions

The terms and definitions defined in DL/T 2528 are applicable to this document.

4 General Requirements

4.1 The commissioning of the energy storage station includes subsystem commissioning and joint commissioning. Joint commissioning is carried out after the subsystem commissioning is completed.

4.2 The commissioning outline, commissioning scheme and emergency plan shall be prepared for the commissioning of the energy storage station.

4.3 Before the grid-involved commissioning of the energy storage station, an application shall be submitted to the grid dispatching institution, and the commissioning may be implemented upon receiving approval.

4.4 The commissioning safety of the energy storage station shall comply with the provisions of GB/T 42288, and temporary fire-fighting facilities and emergency materials shall be equipped.

4.5 The commissioning personnel shall be familiar with the working principle and structure of the equipment of the energy storage station, as well as the commissioning procedures, commissioning quality standards and safety work procedures, and can correctly use tools, instruments and apparatus, and safety protection equipment.

4.6 The tools, instruments and apparatus, and safety protection equipment used for the commissioning of the energy storage station shall be inspected and calibrated, and within the validity period.

4.7 Records shall be kept during the commissioning of the energy storage station, and a commissioning report shall be prepared after the commissioning is completed. The contents of the commissioning records and commissioning report are respectively shown in Appendix A and Appendix B.

5 Subsystem Commissioning

5.1 General Requirements

5.1.1 The subsystem commissioning of the energy storage station shall include commissioning items, such as the energy storage system, monitoring system, power transformation and distribution system, relay protection and automatic safety devices, communication and dispatching automation systems, and station power supply, etc.

5.1.2 The subsystem commissioning of the energy storage station shall meet the following conditions:

- a) The equipment is installed, the wiring is correct and firm, the numbering and identification are clear and correct, and the specifications and models meet the design requirements;
- b) The equipment type test report, exit-factory test report, technical instruction, design documents, construction and installation records and spare parts shall be complete;
- c) The voltage and frequency of the temporary power supply equipment on site comply with the provisions of GB/T 156 and GB/T 1980, and the capacity meets the commissioning requirements.

5.1.3 The heating, ventilation and air conditioning system, fire protection system, video and computer room environment monitoring system of the energy storage station are installed and meet the commissioning conditions.

5.1.4 Before the subsystem commissioning of the energy storage station, the commissioning personnel shall review the equipment specifications and models, electrical wiring, basic functions and safety performance.

5.2 Energy Storage System

5.2.1 Commissioning of lithium-ion battery, lead-acid (carbon) battery and sodium-ion battery array

5.2.1.1 Commissioning conditions

temperature setting values, confirm that the air conditioner and fan normally start and stop in accordance with the requirements for the temperature setting value, and that the temperature control range satisfies the design requirements;

- d) When the cooling / heating system adopts liquid cooling, change the cooling and heating temperature setting values, confirm that the liquid cooler enters the heating or cooling working mode in accordance with the requirements for the temperature setting value and normally operates without leakage, and that the temperature control range satisfies the design requirements;
- e) Restore the initial settings of the cooling / heating system and turn off the cooling / heating system.

5.2.1.4 Commissioning of battery management system

5.2.1.4.1 Insulation Resistance

The insulation resistance test is carried out in accordance with the following steps:

- a) Disconnect the power switch of the battery management system;
- b) Disconnect the battery management system from the external wiring, short-circuit or remove the elements that cannot withstand the test voltage;
- c) Respectively detect the insulation resistance between the acquisition terminal and the grounding terminal, between the communication terminal and the grounding terminal, and between the power supply terminal and the communication terminal, with the battery management system connected to the battery, and record the detection results;
- d) Restore the external wiring of the battery management system, and the short-circuited or removed elements.

5.2.1.4.2 Communication function

The commissioning of communication function is carried out in accordance with the following steps:

- a) Disconnect the switch on the DC side of the battery array and the converter;
- b) Start the battery management system and related equipment and confirm that communication is normal;
- c) Through the signal generation device, send and receive the unique message code or related commands, and confirm that the serial port and network port messages, and the communication function of the battery management system and the monitoring system, energy storage converter, battery management system of other levels, fire protection system, heating, ventilation and air conditioning systems satisfy the requirements of GB/T 43528;

- d) Clear the information of the messages and commands, close the switch on the DC side of the battery array and the converter, and turn off the battery management system and related equipment.

5.2.1.4.3 Control function

The commissioning of control function is carried out in accordance with the following steps:

- a) Disconnect the switch on the DC side of the battery array and the converter, and start the battery management system;
- b) Through the signal generation device, send the closing and disconnecting commands of the control port to the battery management system, and confirm that the closing and disconnecting status of the control port is consistent with the commands;
- c) Through the signal generation device, send the cooling and heating commands of the cooling / heating system to the battery management system, and confirm that the operating status of the cooling / heating system is consistent with the commands;
- d) Clear the information of the control commands of the battery management system, close the switch on the DC side of the battery array and the converter, and turn off the battery management system.

5.2.1.4.4 Acquisition function

The commissioning of acquisition function is carried out in accordance with the following steps:

- a) Start the battery management system and confirm that the battery management system normally displays without alarms;
- b) Respectively in the charging and discharging states, read the battery cell voltage, battery cell temperature, positive and negative terminal temperatures of the battery module, battery cluster voltage, battery cluster current and other parameters collected by the battery management system, and confirm that the battery management system normally displays and that the sampling accuracy satisfies the requirements of GB/T 34131;
- c) Respectively in the charging and discharging states, read the number of temperature measurement points of the battery cluster and battery array collected by the battery management system, and confirm that the number of actual measurement points on site is consistent with that displayed by the battery management system;
- d) Turn off the battery management system.

5.2.1.4.5 Battery energy status and voltage extreme difference

The commissioning of battery energy status and voltage extreme difference is carried out in accordance with the following steps:

- e) The pipelines, valves, battery stacks, electrical equipment, etc. in the battery array are correctly connected, the appearance is free of deformation or cracks, and the identification is clear and correct;
- f) The instrument calibration certificate and installation and commissioning materials are complete, and the instrument measurement, locally displayed readings and remotely transmitted readings are normal.

5.2.2.2 Insulation resistance

The insulation resistance test is carried out in accordance with the following steps:

- a) Disconnect the switch on the DC side of the battery array and the converter and confirm that there is no short circuit between the positive and negative poles of the battery array;
- b) Disconnect the wiring between the positive and negative poles of the battery array and the external device, and short-circuit or remove the elements that cannot withstand the test voltage;
- c) Confirm that the DC bus of the battery array is connected;
- d) Respectively detect the insulation resistance between the positive pole of the battery array and the external exposed conductive part, and between the negative pole of the battery array and the external exposed conductive part, and record the detection results;
- e) Restore the wiring between the positive and negative poles of the battery array and the external device, and the short-circuited or removed elements.

5.2.2.3 Cooling / heating system

The commissioning of the cooling / heating system is carried out in accordance with the following steps:

- a) Confirm that the cooling / heating system has the conditions for starting and operating;
- b) Start the cooling / heating system and confirm that the cooling / heating system is normally operating;
- c) When the cooling / heating system adopts air cooling, change the cooling and heating temperature setting values, confirm that the air conditioner and fan normally start and stop in accordance with the requirements for the temperature setting value, and that the temperature control range satisfies the design requirements;
- d) When the cooling / heating system adopts liquid cooling, change the cooling and heating temperature setting values, confirm that the liquid cooler enters the heating or cooling working mode in accordance with the requirements for the temperature

setting value and normally operates, and that the refrigerant pipeline pressure and temperature control range satisfy the design requirements;

- e) Restore the initial settings of the cooling / heating system and turn off the cooling / heating system.

5.2.2.4 Battery management system

5.2.2.4.1 Insulation resistance

The insulation resistance test is carried out in accordance with the following steps:

- a) Disconnect the power switch of the battery management system;
- b) Disconnect the battery management system from the external wiring, short-circuit or remove the elements that cannot withstand the test voltage;
- c) Respectively detect the insulation resistance between the acquisition terminal and the grounding terminal, between the communication terminal and the grounding terminal, and between the power supply terminal and the communication terminal, with the battery management system connected to the battery, and record the detection results;
- d) Restore the external wiring of the battery management system, and the short-circuited or removed elements.

5.2.2.4.2 Communication function

The commissioning of communication function is carried out in accordance with the following steps:

- a) Disconnect the switch on the DC side of the battery array and the converter;
- b) Start the battery management system and related equipment and confirm that communication is normal;
- c) Through the signal generation device, send and receive the unique message code or related commands and confirm that the serial port and network port messages, and the communication function of the battery management system and the monitoring system, energy storage converter, battery management system of other management levels, fire protection system, heating, ventilation and air conditioning systems satisfy the requirements of GB/T 43528;
- d) Clear the information of the messages and commands, close the switch on the DC side of the battery array and the converter, and turn off the battery management system and related equipment.

5.2.2.4.3 Control function

that the results are consistent with the requirements of GB/T 34131;

- c) Turn off the battery management system.

5.2.2.4.6 Alarm and protection functions

The commissioning of alarm and protection functions is carried out in accordance with the following steps:

- a) Disconnect the switch on the DC side of the battery array and the converter, and start the battery management system;
- b) Through the signal simulation device, send the voltage over-limit, voltage deviation over-limit, current over-limit, temperature over-limit, flow over-limit, pressure over-limit, liquid level over-limit, leakage fault, communication abnormality and other commands of the battery management system and confirm that the alarm and protection functions of the battery management system are normal;
- c) Clear the fault signal of the battery management system and reset it, close the switch on the DC side of the battery array and the converter, and turn off the battery management system.

5.2.2.5 Electrolyte circulation system

The commissioning of the electrolyte circulation system is carried out in accordance with the following steps:

- a) Confirm that the positions and switch states of all electric valves and manual valves are correct, the electrolyte filling is completed, and the energy storage converter is in the shutdown state;
- b) Start the battery management system and confirm that the battery management system is normally operating and without alarms;
- c) Start the electrolyte circulation system, and through the battery management system, set the lowest frequency or speed that the electrolyte circulation pump can operate and confirm that the circulation pump is normally operating, without abnormal sound or severe vibration, and that there is no leakage in the system pipelines, valves and battery stacks, the battery array flow, pressure, temperature, pump current, and pump frequency detection values satisfy the design requirements, and the battery management system issues no alarm;
- d) Through the battery management system, gradually increase the electrolyte circulation pump frequency or speed to the maximum value allowed by the design and confirm that the circulation pump is normally operating;
- e) Through the battery management system, gradually reduce the electrolyte circulation pump frequency or speed to the lowest frequency or speed that the electrolyte

circulation pump can operate and confirm that the circulation pump is normally operating;

- f) Issue a shutdown command and confirm that the circulation pump stops working and the battery management system issues no alarm.

5.2.3 Commissioning of water electrolysis hydrogen production / fuel cell array

5.2.3.1 Commissioning conditions

The commissioning of battery array shall meet the following conditions:

- a) Battery array equipment installation and pipeline construction are completed;
- b) Battery array electrical and communication cable wiring construction is completed;
- c) The appearance of each component is free of deformation and cracks, and the identification is clear and correct;
- d) The instrument calibration certificate and installation and commissioning certificate are complete, and the instrument measurement, locally displayed readings and remotely transmitted readings are normal;
- e) The air supply pump, water supply pump, compressor unit and battery management system normally communicate, and the start and stop status of the air supply pump, water supply pump and compressor unit are correctly displayed.

5.2.3.2 Grounding resistance

The grounding resistance test is carried out in accordance with the following steps:

- a) Disconnect the electrolysis power supply of the water electrolysis hydrogen production module and the converter switch at the output end of the fuel cell module;
- b) Disconnect the power switch of the water electrolysis hydrogen production module and the fuel cell module control cabinet;
- c) Disconnect the connection point between the grounding trunk line and the grounding body or all grounding branch line connections on the grounding trunk line;
- d) Respectively test the resistance between the metal shell, metal pipeline, metal base or frame of the battery array and the grounding terminal, and confirm that the grounding resistance value is consistent with the requirements of GB 50177;
- e) Test the resistance between the hydrogen inlet pipeline of the fuel cell module and the grounding terminal, and confirm that the grounding resistance value is consistent with the requirements of GB/T 34872;
- f) Respectively test the resistance at both ends of the jumper wire at the flange and valve

pipeline pressure and the water electrolyzer and fuel cell operating temperature range satisfy the design requirements;

- d) Restore the initial settings of the cooling system and shut down the cooling system.

5.2.3.5 Air tightness

The air tightness test is carried out in accordance with the following steps.

- a) Adjust the electrolyzer hydrogen production module to the standby state and perform the air tightness and leakage test of the water electrolysis hydrogen production module. Close the hydrogen side outlet valve of the electrolyzer and the outlet valve of the purification unit, and continuously pass inert gas, for example, nitrogen or helium, into the electrolyzer to gradually increase the internal pressure of the electrolyzer to the test pressure, maintain the pressure stable for a certain period of time, and record the internal pressure value of the electrolyzer before and after the pressure maintenance. For water electrolysis hydrogen production electrolyzers with a design working pressure of 10 MPa or less, the air tightness and leakage of the water electrolysis hydrogen production module shall be consistent with the requirements of GB/T 19774.
- b) Confirm that the electrolysis power supply of the water electrolysis hydrogen production module and the converter switch at the output end of the fuel cell module are disconnected and perform air tightness commissioning of the hydrogen storage module. Close the inlet valve and outlet valve of the hydrogen storage tank, open and close the pipeline control valve in sections, and use inert gas, for example, nitrogen or helium, to test the air tightness of the pipeline and valve group. The test methods and technical requirements shall be consistent with the requirements of GB 50177.
- c) Disconnect the converter switch at the output end of the fuel cell module and perform the air tightness and leakage test of the fuel cell module. Close the hydrogen exhaust valve and air exhaust port of the fuel cell module, and use inert gas, for example, nitrogen or helium, to test the air tightness and leakage. The test methods and technical requirements shall be consistent with the requirements of GB/T 27748.1.
- d) Close the power switch of the water electrolysis hydrogen production module and the fuel cell module control cabinet.
- e) Close the electrolysis power supply of the water electrolysis hydrogen production module and the converter switch at the output end of the fuel cell module.

5.2.3.6 Circulating water quality

The circulating water quality test is carried out in accordance with the following steps:

- a) Adjust the electrolyzer hydrogen production module to the standby state and the fuel cell module to the idle / zero power output state;

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