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Specification of Supervision and Control System for Electrochemical Energy Storage Station

电化学储能电站监控系统技术规范

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1 Scope

This document specifies the requirements for data collection, data processing, control and adjustment, alarms, event sequential record, post disturbance review, communication, data storage, human-machine interface, system time synchronization and system load rate of the supervision and control system for electrochemical energy storage station (hereinafter referred to as “supervision and control system”). It also describes the corresponding test methods, and specifies the normal operating conditions, system architecture, marking, packaging, transportation and storage, etc. of the supervision and control system.

This document is applicable to the design, manufacturing, testing, detection, operation, maintenance and overhaul of the supervision and control system for electrochemical energy storage station.

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 191 Packaging - Pictorial Markings for Handling of Goods

GB/T 4798.2 Classification of Environmental Conditions - Classification of Groups of Environmental Parameters and Their Severities - Part 2: Transportation and Handling

GB/T 13384 General Specifications for Packing of Mechanical and Electrical Product

GB/T 19582 (all parts) Modbus Industrial Automation Network Specification

GB/T 22239 Information Security Technology - Baseline for Classified Protection of Cybersecurity

GB/T 36572 Guidelines of Cyber Security Protection for Electric Power System Supervision and Control

DL/T 634.5104 Telecontrol Equipment and Systems - Part 5-104: Transmission Protocols - Network Access for IEC 60870-5-101 Using Standard Transport Profiles

DL/T 667 Telecontrol Equipment and Systems - Part 5: Transmission Protocols Section 103

Companion Standard for the Information Interface of Protection Equipment

DL/T 698.41 Data Acquisition and Management System for Electrical Energy - Part 4-1: Communication Protocol - Master Station Communication with Data Acquisition Terminal

DL/T 719 Telecontrol Equipment and Systems - Part 5: Transmission Protocol Section 102: Companion Standard for the Transmission of Integrated Totals in Electric Power Systems

DL/T 860 (all parts) Communication Networks and Systems for Power Utility Automation

DL/T 2528 Basic Terminology of Electrical Energy Storage

3 Terms and Definitions

What is defined in DL/T 2528, and the following terms and definitions are applicable to this document.

3.1 station level

Station level refers to a power station control level that is composed of supervision and control system equipment intensively arranged in the computer room or secondary equipment room (cabin) to realize functions, such as: full-station supervision and control, etc.

3.2 local level

Local level refers to a power station control level that is composed of supervision and control system equipment arranged on the site of the controlled equipment to realize functions, such as: data collection, equipment monitoring and control, etc.

4 Overall Requirements

4.1 The architecture of the supervision and control system shall include the station level and the local level to satisfy the system reliability, real-time and scalability requirements. See Appendix A for the typical system architecture.

4.2 The supervision and control system shall be equipped with the functions of monitoring, control, protection and communication, etc.

4.3 The supervision and control system shall utilize important equipment, such as: servers and telecontrol workstations, which should be redundantly configured.

4.4 Before exiting the factory, the supervision and control system shall be subject to various functions and related performance tests.

4.5 The network security protection of the supervision and control system shall comply with the stipulations of GB/T 22239 and GB/T 36572.

6.1.1 The supervision and control system shall collect operation information of equipment, such as: battery management system, energy storage converter, power transformation and distribution equipment, and auxiliary system, etc.

6.1.2 For information collected on the battery management system, see Table B.1 in Appendix B.

6.1.3 For information collected on the energy storage converter, see Table B.2.

6.1.4 For information collected on the power transformation and distribution equipment, see Table B.3.

6.1.5 For information collected on auxiliary systems, such as: fire-fighting system, heating ventilation and air-conditioning system, environmental monitoring device and DC power supply, etc., see Table B.4.

6.1.6 The data collection response time of the supervision and control system shall satisfy the following requirements:

a) The response time of digital quantity information (from I/O input terminal to station level) does not exceed 2 s;

b) The response time of analog quantity information (from I/O input terminal to station level) does not exceed 3 s.

6.2 Data Processing

6.2.1 The supervision and control system shall identify different data quality statuses and display them in different colors.

6.2.2 The supervision and control system shall be equipped with the function of common mathematical operation and support data statistics within a set period.

6.3 Control and Adjustment

6.3.1 The control function of the supervision and control system mainly includes:

a) Start-stop, grid-connected / off-grid operation mode switching, and charge / discharge mode switching of the energy storage system;

b) Connecting / disconnecting operation of circuit breaker and isolation switch, etc.

6.3.2 The time from when the station level of the supervision and control system issues a control command to when the local level equipment responds to the command shall not exceed 1 s.

6.3.3 The supervision and control system shall be able to receive dispatching commands, support active and reactive power control and adjustment, and be equipped with the functions of automatic generation control (AGC) and automatic voltage control (AVC).

levels, and forward corresponding alarm screens. After an alarm event occurs, the time for the supervision and control system to display the information or issue an audible and visual alarm shall not exceed 2 s.

6.4.6 If the self-diagnosis status is abnormal, the supervision and control system shall send out an alarm signal.

6.5 Event Sequential Record and Post Disturbance Review

6.5.1 The supervision and control system shall sequentially record important events of the electrochemical energy storage power station. The records should include the following contents:

a) Action signals, alarm signals and timescales uploaded by the equipment, such as: battery management system and energy storage converter, etc.;

b) Action signals, alarm signals and timescales uploaded by power transformation and distribution equipment, such as: circuit breaker, isolation switch and transformer, etc.

6.5.2 The supervision and control system shall be equipped with the function of post disturbance review. The sampling frequency of the post disturbance review records should not be less than 1 time/s, and the duration of post disturbance review should not be less than 180 s. In addition, two periods: before the disturbance and after the disturbance, shall be included, and no less than 60 s for before the disturbance and no less than 120 s for after the disturbance.

6.6 Communication

6.6.1 The communication among the equipment of the supervision and control system shall adopt Ethernet interfaces, and should adopt communication protocols that comply with the standards, such as: GB/T 19582 (all parts), DL/T 667 and DL/T 860 (all parts).

6.6.2 The supervision and control system shall be equipped with the function of communicating with the superior dispatching, and support Ethernet interfaces and serial interfaces, etc.; for electrochemical energy storage power stations connected to public power grids with a voltage level of 110(66) kV and above, the communication channels between the supervision and control system and the dispatch terminal shall be redundantly configured, one of which is an optical cable channel. The telecontrol workstation of the supervision and control system shall satisfy the following requirements:

a) Adopt communication protocols that comply with the standards, such as: DL/T 634.5104 and DL/T 719, etc.;

b) Be equipped with the function of direct acquisition and direct sending of telecontrol information;

c) Be equipped with the capability of communicating with one or multiple superior dispatching.

6.6.3 The communication between the station level and local level of the supervision and control system should adopt Ethernet, and satisfy the following requirements:

a) The communication with the battery management system and energy storage converter should adopt communication protocols that comply with the standards, such as: GB/T 19582 (all parts), DL/T 634.5104 and DL/T 860 (all parts), etc.;

b) The communication with the protection devices should adopt communication protocols that comply with the standards, such as: GB/T 19582 (all parts), DL/T 667 and DL/T 860 (all parts), etc.;

c) The communication with the electric energy collection terminal should adopt communication protocols that comply with the standards, such as: GB/T 19582 (all parts), DL/T 698.41, DL/T 719 and DL/T 860 (all parts), etc.;

d) The communication with the fault recording device should adopt communication protocols that comply with the standards, such as: GB/T 19582 (all parts), DL/T 667 and DL/T 860 (all parts);

e) The communication with the equipment, such as: fire-fighting system, heating ventilation and air-conditioning system, and environmental monitoring device, etc., should adopt communication protocols that comply with the standards, such as: GB/T 19582 (all parts) and DL/T 860 (all parts), etc.

6.6.4 The supervision and control system shall be equipped with the function of automatic switching between main and backup communication channels.

6.7 Data Storage

6.7.1 The supervision and control system shall be equipped with the function of converting real-time data into historical data for storage.

6.7.2 The supervision and control system shall be equipped with the function of regular and triggered storage of real-time data of the power station.

6.7.3 The supervision and control system shall be equipped with the function of event sequential record storage.

6.7.4 The supervision and control system shall have a data storage capacity of no less than 3 months.

6.8 Human-machine Interface

6.8.1 The human-machine interface of the supervision and control system shall be equipped with the functions of data input, display and output, etc.

6.8.2 The human-machine interface of the supervision and control system shall be equipped with the functions of equipment control and adjustment operation, and parameter setting, etc.

e) Record the calculation results.

7.4 Test of Control and Adjustment

7.4.1 Equipment control test

The test of equipment control shall be carried out in accordance with the following steps:

a) On the control interface of the supervision and control system, select a controllable switch device, perform opening and closing, or start and stop operations, and record the operation time t_1;

b) Record the time t_2 when the status of the equipment in the supervision and control system starts to change and the changes;

c) Calculate and record the control command response time $\Delta t = t_2 - t_1$;

d) In accordance with a) ~ c), successively test other controllable equipment of the energy storage station in the analog device.

7.4.2 Test of power adjustment

The test of power adjustment shall be carried out in accordance with the following steps:

a) Set the control level of the supervision and control system to “station level” and the control mode to “manual”;

b) On the supervision and control system, adjust the active power or reactive power setting of each energy storage system, and record the operation time t_1;

c) Check that the active power or reactive power of the relevant energy storage system in the analog device shall change accordingly, and record the change time t_2;

d) Calculate and record the power adjustment response time $\Delta t = t_2 - t_1$.

7.4.3 Test of automatic generation control (AGC)

The test of automatic generation control (AGC) shall be carried out in accordance with the following steps:

a) Set the control level of the supervision and control system to “station level” and the control mode to “automatic”;

b) On the supervision and control system, set the active power distribution strategy of each energy storage system of the energy storage station;

c) Through the analog device, simulate the superior dispatching to issue active power adjustment commands that exceed the adjustable range of the energy storage station, and record the execution of the supervision and control system;

d) Through the analog device, simulate the superior dispatching to issue active power adjustment commands within the adjustable range of the energy storage station;

e) Record the output value of active power of the energy storage station and the power distribution of each energy storage system in the supervision and control system.

7.4.4 Test of automatic voltage control (AVC)

The test of automatic voltage control (AVC) shall be carried out in accordance with the following steps:

a) Set the control level of the supervision and control system to “station level” and the control mode to “automatic”;

b) On the supervision and control system, set the reactive power distribution strategy of each energy storage system of the energy storage station;

c) Through the analog device, simulate the superior dispatching to issue reactive power adjustment commands that exceed the adjustable range of the energy storage station, and record the execution of the supervision and control system;

d) Through the analog device, simulate the superior dispatching to issue reactive power adjustment commands within the adjustable range of the energy storage station;

e) Record the output value of reactive power of the energy storage station and the power distribution of each energy storage system in the supervision and control system.

7.4.5 Test of operation mode setting

The test of operation mode setting shall be carried out in accordance with the following steps:

a) Select one of the energy storage station operation modes listed in 6.3.4, and set the energy storage station to operate in this mode on the supervision and control system interface;

b) Through the analog device, simulate the superior dispatching to issue power commands;

c) Record the supervision and control system receiving and issuing power commands;

d) Successively select all the operation modes of the energy storage station listed in 6.3.4, and repeat b) and c); record the supervision and control system receiving and issuing power commands in different operation modes.

7.4.6 Test of prevention of mis-operation locking

The test of prevention of mis-operation locking shall be carried out in accordance with the following steps:

The test of alarm response shall be carried out in accordance with the following steps:

a) Through the analog device, trigger the alarm event in Appendix C, and record the trigger time t_1;

b) Record the alarm information forwarded by the supervision and control system and the corresponding alarm time t_2;

c) Calculate and record the alarm response time $\Delta t = t_2 - t_1$;

d) In accordance with a) ~ c), successively test the Level-1, Level-2 and Level-3 alarm events in 6.4.

7.5.2 Test of self-diagnosis

The test of self-diagnosis shall be carried out in accordance with the following steps:

a) By disconnecting physical connection or simulating communication interruption, trigger the communication failure on the station level of the supervision and control system;

b) Through the supervision and control interface, check and record the operating status of all the equipment of the supervision and control system;

c) Record the retreat of the failure equipment and the corresponding redundant equipment;

d) Record the relevant alarm events.

7.6 Test of Event Sequential Record and Post Disturbance Review

7.6.1 Test of event sequential record

The test of event sequential record shall be carried out in accordance with the following steps:

a) Through the analog device, within 10 s, trigger 100 action signals and alarm signals of the battery management system, energy storage converter, circuit breaker, isolation switch and transformer, etc.; record the time and content of each trigger;

b) Check the consistency between the event sequential record and event trigger in the supervision and control system.

7.6.2 Test of post disturbance review

The test of post disturbance review shall be carried out in accordance with the following steps:

a) In the supervision and control system, set the post disturbance review duration to 60 s before the disturbance and 120 s after the disturbance;

b) After the supervision and control system operates for more than 60 s, through the analog device, respectively issue three disturbance signals;

c) Start inversion of the disturbance, and play back the data records from 60 s before the disturbance to 120 s after the disturbance;

d) Check and record the consistency between the data records of three disturbance inversions and the operating data generated by the analog device in the disturbance.

7.7 Communication Test

7.7.1 Test of telecontrol communication

The test of telecontrol communication shall be carried out in accordance with the following steps:

a) In accordance with the downlink information point table of superior dispatching, through the analog device, simulate the superior dispatching to issue control and adjustment commands;

b) Record the commands received by the supervision and control system, and check the consistency;

c) In accordance with the uplink information point table of the supervision and control system, through the supervision and control system, send uplink information to the superior dispatching simulated by the analog device, and check the consistency;

d) Record the information received by the analog device, and check the consistency.

7.7.2 Test of in-station communication

The test of in-station communication shall be carried out in accordance with the following steps:

a) In accordance with the downlink information point table, through the station level of the supervision and control system, send control and adjustment commands to the local level equipment simulated by the analog device;

b) Record the commands received by the analog device, and check the consistency;

c) In accordance with the uplink information point table, through the analog device, simulate the local level equipment to send equipment information to the station level of the supervision and control system;

d) Record the information received by the supervision and control system, and check the consistency.

7.7.3 Test of communication fault alarm

The test of communication fault alarm shall be carried out in accordance with the following

with system query data.

7.10 Test of System Time Synchronization

The test of system time synchronization shall be carried out in accordance with the following steps:

a) Maintain normal communication connects between the time synchronization system and the various servers and workstations of the supervision and control system, and record the times of the time synchronization system and the various servers and workstations, and check the consistency;

b) Disconnect the network communication between the time synchronization system and other equipment;

c) Randomly adjust and record the times of the various servers and workstations;

d) Restore the network communication between the time synchronization system and other equipment;

e) Record the times of the time synchronization system and the various servers and workstations, and check the consistency.

7.11 Test of System Load Rate

The test of system load rate shall be carried out in accordance with the following steps:

a) Through the analog device, within 10 s, simulate and trigger the action signals and alarm signals of the battery management system, energy storage converter, circuit breaker, isolation switch and transformer, etc. for 100 times;

b) Record the peak CPU load rate and network load rate of the various servers and workstations during the operation;

c) Repeat a) and b) twice, calculate and record the maximum value of three test results as the test result of the CPU load rate and network load rate under the condition of energy storage system failure;

d) Simulate the normal operation signal of the energy storage system for 10 min and send up to the supervision and control system;

e) Record the peak CPU load rate and network load rate of the various servers and workstations during the operation;

f) Repeat d) and e) twice, calculate and record the maximum value of three test results as the test result of the CPU load rate and network load rate of the energy storage system under normal conditions.

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