

Maintenance Guidelines

Integrated Energy Storage System

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1 Maintenance Precautions

Scope of Application

This guideline applies to the operation and maintenance (O&M) management of integrated energy storage systems (ESS). It defines the basic requirements for operation and maintenance management, site conditions, personnel qualifications, service standards, safety management, emergency response, operation and maintenance records, and continuous improvement.

Basic Requirements

- O&M activities for the energy storage system shall comply with applicable national laws, regulations, and relevant standards.
- O&M activities shall follow a complete management system and applicable safety requirements.
- Responsibilities, work procedures, duties, and standard operating procedures shall be clearly defined for all relevant personnel.

Facility Requirements

- The equipment infrastructure shall be complete and compliant with applicable national or industry standards. Operation, maintenance, and management shall be performed by designated personnel.
- Maintenance personnel shall conduct weekly, monthly, quarterly, and annual inspections in accordance with the inspection schedule.
- The inside of the cabinet shall be kept clean and free from dust, debris, contamination, rust, and stains.
- Areas around electrical installations shall be free from flammable, explosive, contaminating, and corrosive materials.

Personnel Requirements

General Requirements

- The system shall be operated and maintained by designated personnel. Each station shall have no fewer than two assigned personnel.
- Maintenance personnel shall receive safety training and job-specific technical training, and shall only start work after passing the required assessment.
- Maintenance personnel shall follow applicable operating procedures and job specifications when performing tasks.
- Maintenance personnel shall perform their duties responsibly, fulfill service commitments, and communicate in a professional manner.

Job Responsibility Requirements

- O&M personnel are responsible for facility upkeep, including monitoring operating status, troubleshooting faults, and maintaining key components.
- O&M personnel are responsible for equipment safety, including establishing an equipment safety management system, performing periodic safety inspections, and reporting safety conditions.

Job Skill Requirements

- Maintenance personnel shall understand the operating principles of energy storage systems, common troubleshooting methods, maintenance procedures, emergency response procedures, and safety requirements.
- Maintenance personnel shall be familiar with applicable safety regulations, electrical safety practices, and accident response procedures.

Service Requirements

Condition Monitoring

- Maintenance personnel shall continuously monitor the operating status of the energy storage system, develop preventive actions for potential issues, and promptly address any existing problems.
- Maintenance personnel shall analyze customer operating data on a weekly, monthly, quarterly, and annual basis and shall prepare preventive maintenance plans based on the analysis.

Periodic Inspection and Maintenance

- Maintenance personnel shall conduct weekly, monthly, quarterly, and annual inspections, repairs, and maintenance to ensure reliable operation and extend the service life.
- Inspection and maintenance records shall be documented in writing and compiled into maintenance records.
- If maintenance work may affect plant operation, advance notice shall be issued to relevant stakeholders.

Spare Parts and Tools Management

- Maintenance personnel shall manage spare parts and tools, including inventory and usage status.
- The procurement and issuance of equipment and spare parts shall be documented.

DANGER

- Before maintenance, open the PCS DC-side isolator to disconnect the battery from the PCS.
 - Open the circuit breaker inside the PDU, disconnect the PDU from the battery box, and shut down the energy storage system.
 - Ensure proper grounding. Completely isolate the integrated energy storage system from all DC and AC power sources for at least 20 minutes, then verify the absence of voltage with a voltmeter.
 - Ensure all power sources are disconnected and in a safe state before performing maintenance.
- Hazardous voltage may still be present inside the energy storage system even when it is not operating.**

2 Periodic Maintenance

WARNING

- Regular maintenance shall be performed to ensure proper operation of all components in the integrated energy storage system.
- The maintenance intervals in this section are recommended intervals only. Actual intervals shall be determined based on project-site environmental conditions. In harsh environments, such as desert areas, maintenance intervals shall be shortened. Internal and external cleaning, anti-corrosion treatment, and rust prevention shall be performed more frequently.
- If the integrated energy storage system is installed in a desert area, thorough internal and external inspection and cleaning shall be performed after each sandstorm.
- Begin inspection only after all internal components of the integrated energy storage system have been completely powered off. Correct any nonconforming items immediately.

Safety Management

Organizations and Personnel

- The operation and maintenance management system shall include a safety management team, full-time or part-time safety officers, and clearly defined responsibilities for all relevant parties.
- Maintenance personnel shall follow job-specific safety procedures and work only within designated areas. Operating mechanical or electrical equipment unrelated to their duties is strictly prohibited.
- Maintenance personnel shall wear required work clothing, insulating footwear, and appropriate PPE during operation.
- Maintenance personnel shall promptly correct or report any safety hazards identified during inspection or troubleshooting.

Equipment

- Maintenance personnel shall ensure the electrical safety of the equipment.
- Faulty equipment shall be replaced promptly. Operating faulty equipment is strictly prohibited.
- The power supply shall be switched off before equipment maintenance.
- Safety signs shall be inspected during routine inspections. Deformed, damaged, or faded signs shall be repaired or replaced promptly.

Patrol Inspections: Safety management personnel shall conduct routine and unscheduled inspections, correct violations, and promptly address or report identified safety hazards.

Fire Safety

- Fire safety management shall comply with applicable laws, regulations, and standards.
- Fire protection facilities shall be installed in compliance with applicable requirements and shall be complete, functional, and clearly marked.
- Fire safety inspections shall be conducted monthly. Fire protection facilities shall be maintained by designated personnel, and both fire suppression and monitoring systems shall remain in proper working condition.

- Fire safety training and emergency drills shall be conducted twice a year. Safety management personnel shall understand the location, function, and use of fire protection equipment.
- Emergency exit routes shall remain unobstructed to ensure timely evacuation in the event of a fire.

Tool and Equipment Management

The operation and maintenance team shall be equipped with the tools required for daily work, including PPE and maintenance tools, to support inspection, maintenance, and repair activities.

Category	Tools
Personal protective equipment	Safety helmet; dust mask; insulating gloves; protective work gloves; insulating safety shoes
Hand tools	Toolbox; screwdrivers; electrician's pliers; wrenches; needle-nose pliers; electrician's knife; insulating tape; flashlight
Measuring instruments	Multimeter; Insulation resistance tester; Infrared thermometer; Digital thermometer and hygrometer; High voltage detector; Insulation resistance tester/megohmmeter
Lifting and test equipment	Scissor lift; charge-discharge tester

Maintenance Records

- Operation and maintenance personnel shall document the complete service process, including fault resolution records, periodic inspection and maintenance logs, and spare-parts replacement records.
- Original operation and maintenance data shall be retained. Records shall be timely, accurate, truthful, and complete.
- Paper records shall be converted into electronic copies. Original paper records shall be retained for not less than 3 years, and electronic records for not less than 5 years.

Interval	Maintenance Item	Maintenance Content
Daily	Routine check	Check the system main page/monitoring interface for fault alarms.
Monthly	Air filter / filter element	Check the filter cotton for foreign objects or blockages. If the energy storage integrated system operates in a harsh environment, such as a desert area, the corresponding maintenance cycle is once a month. If the energy storage integrated system operates in a conventional area, such as a plain, the corresponding maintenance cycle can be once every three months.
	Insect screen / insect mesh	Check the condition of the insect net. Due to environmental factors, insect nets are prone to leaks and need to be repaired in a timely manner. Check if any animals have fallen into the insect netting. If any are found, they need to be removed promptly to prevent the lifespan of the insect netting from being shortened due to decomposition of the carcass
Every 3 months	ESS cabinet inspection	Inspect the appearance of the energy storage system for damage, deformation, or rust. Listen for any abnormal sounds when the energy storage system is running. Observe the various parameters during runtime using BAU. Use thermal imaging cameras and other methods to detect the heating status of the system. Observe whether there is electrolyte seepage from the outside of the battery box. Check whether the environment around the energy storage, such as ventilation, ambient temperature, humidity, and dust, meets the requirements.
	Air-duct cleaning	Check the dust in the air duct. Listen for any abnormal vibrations when the fan is running. Use tools to clean.

	Fire protection system	Conduct visual inspections to assess the operational status of detectors and aerosol fire suppression systems.
	Battery appearance and structure	Inspect the housing for cleanliness; if stains are present, wipe them off thoroughly, and ensure proper ventilation and dryness. Inspect the housing for leaks or deformation; replace it promptly if found. Refer to the records and actually measure whether the ambient temperature is normal
	Voltage and internal resistance / conductance	Voltage measurement: Use a multimeter or DC voltmeter to measure the battery terminal voltage and the total voltage of the battery pack, record the results, and perform verification. Internal resistance (conductivity) measurement: Measure the internal resistance (conductivity) of individual battery cells using an internal resistance meter (or conductivity meter) and compare results between cells. If some batteries have high internal resistance, focus on checking the following items : a. Is the battery operating correctly? b. Whether the battery voltage and temperature are within the specified range. c. Whether the battery has been overcharged or undercharged for a long period of time. d. Whether the service life exceeds the manufacturer's recommended service life.
	Battery connections	Ensure all battery connection points are securely fastened, with no loose bolts or overheating at joints.
Every 6 months	Safety functions	Check emergency-stop operation, perform a simulated shutdown test, and inspect warning labels and equipment markings. Replace blurred or damaged markings immediately.
	Device maintenance	Conduct a routine inspection of all metal components for corrosion. Annual inspection of contactors (auxiliary switches and micro switches) Ensure its machinery operates smoothly. Check the operating parameters (especially voltage and insulation). Check all circuit breakers for malfunctions. Check the circuit breaker or load switch for damage. Check the cleanliness of the circuit board and components. Check the radiator temperature and for dust. If necessary, use a vacuum cleaner to clean the heat sink module or replace the filter.
	Circuit connections	Check all electrical connections for looseness or poor contact. Inspect all cables and metal surfaces for damage or scratches. Check that the insulating wrapping tape on all terminals is not loose. Check the screw locations for signs of overheating. Check the copper busbars and screws for any color changes.
	Door locks and hinges	After cleaning, check whether door locks and hinges operate properly and are in good condition. Lubricate the lock cylinder and hinges if necessary.
	Sealing strips	Inspect sealing strips carefully because they prevent water ingress into the ESS cabinet. Replace damaged strips immediately.
	Fans	Check fan operating status, blockage, and abnormal noise.
	Coolant top-up	When the return pressure is below 0.8 Bar, a replenishment pump should be used to inject coolant to increase the pressure. Remove the maintenance panel on the front of the chiller unit and close the ball valve behind the drain port. Open the automatic vent valve/manual valve at the highest point of the connecting pipe.

		Connect the outlet of the replenishment pump to the replenishment port of the chiller unit using a pipe, and connect the inlet to the external storage tank After connecting the power cord of the replenishment pump to the corresponding terminal, power on the chiller unit. Turn on the coolant pump to flush in coolant. When the return pressure is stable at 0.8 Bar~1 Bar, the injection should be stopped between these points. After the injection is complete, close the automatic vent valve/manual valve at the highest point of the connecting pipeline, close the ball valve after the replenishment port, and then remove the replenishment pump. Reinstall the maintenance panel located at the bottom of the unit.
Every 12 months	Fire protection system	Verify system function. Disconnect the wiring between the detector and the aerosol fire suppression device before testing. Confirm that the detector can issue alarm signals when smoke or temperature signals are detected, and that a 24 V start signal is present during level-2 alarm output.
	Cable-shield grounding	Check cable-shield grounding to ensure reliable contact between the shielding layer and the insulating sleeve. Ensure the grounding copper busbar is properly fixed.
	Lightning protection devices and fuses	Check that lightning protection devices and fuses are properly secured.
	External inspection of the ESS cabinet	Check for loose screws, oxidation, corrosion, door operation, cleanliness, exterior corrosion or peeling, grounding, warning labels, secure cabinet fixation, cable-entry sealing, and cable-trench condition.
	Internal inspection of the ESS cabinet	Check for foreign objects, dust, dirt, and condensation. Check the temperature and dust accumulation at the air inlet, outlet, and radiator. Clean with a vacuum cleaner if necessary.
	Wiring and cable routing	Check the cable layout, inlet/outlet seals, water leakage, moisture conditions, power cord connection torque, cable sheath damage, loose terminal insulation tape, grounding accuracy, grounding resistance (whether it is below 4 ohms), and internal equipotential bonding.

System Cleaning

Cleanliness around and inside the integrated energy storage system is an important part of routine maintenance.

Dust may accumulate due to temperature, humidity, dust exposure, and equipment vibration. Accumulated dust may block air inlets or enter internal components, resulting in operating faults, reduced service life, or reduced system output. Regular inspection and cleaning shall be performed to maintain proper operating conditions.

Item	Requirement
Cleaning interval	Determine the cleaning interval based on the operating environment and climate. In harsh environments, such as desert areas, shorten the maintenance interval.
Internal cabinet cleaning	Do not sweep accumulated dust directly with a broom, because this may disperse dust into components. Use a vacuum cleaner to remove dust.
Foundation interior cleaning	Users shall regularly inspect the inside of the foundation for cleanliness. If necessary, clean it with an industrial vacuum cleaner.

WARNING

- Check ventilation at the air intake. If the module is not cooled effectively, it may fail due to overheating.
- The intervals above are recommended only. The actual maintenance schedule shall be determined based on the installation environment, plant capacity, geographical location, and site conditions.
- In environments with strong windblown sand or heavy dust, shorten maintenance intervals and increase maintenance frequency.

3 Maintenance of the Liquid Cooling System

The following maintenance intervals are recommended. The actual interval shall be adjusted according to the product installation environment. Plant size, installation location, and site conditions all affect the maintenance schedule. In environments with strong wind, heavy sand, or significant dust accumulation, shorten the maintenance interval and increase maintenance frequency.

Maintenance Item	Maintenance Content	Inspection Criteria	Tools
Fan	Check that the fan blades are rotating normally and are undamaged. If the blades are damaged or cannot rotate, replace the fan.	The fan blades rotate smoothly without any abnormal noise. The fan blades are intact.	Long-handled screwdriver
Water pump	Check whether the cooling-air inlet of the water pump is blocked by more than 5%. If blocked, clean it with a brush. Visually inspect the pump body, excluding pipe connections, for obvious dripping other than condensation. If dripping is found, replace the pump seal.	The pump operates smoothly without abnormal noise. There is no obvious dripping from the pump body, eliminating condensation.	Brush
Coolant circuit	Check whether the liquid-cooling unit has reported any warnings.	If a "low coolant level" warning is reported, top up the coolant.	Flat-head screwdriver; Phillips screwdriver; refill pump; hose; clamp

Replacement Item	Replacement Criteria	Period	Tools / Notes
Coolant	The coolant contains obvious impurities or has become noticeably darker in color.	5 – 6 years, or as specified in the technical agreement.	Refill pump; hose clamp; screwdriver. Contact after-sales service for assistance before replacement.

Coolant Replacement

WARNING

Under normal conditions, coolant does not pose a significant health risk. Excessive exposure may irritate the eyes, skin, respiratory tract, or other areas.

When replacing coolant, wear PPE that complies with applicable national standards.

Body Area	Required PPE
Respiratory system	Use a respirator in areas with high vapor or mist concentration.
Hands	Use oil-resistant and chemical-resistant safety gloves.
Eyes	Use protective eyewear.
Skin and body	Use impermeable protective clothing and safety shoes.

Waste treatment

Waste Category	Disposal Measures
Coolant	Waste coolant shall be disposed of in accordance with local regulations. Do not discharge it into drains, soil, or water bodies.
Residue	Residues that are sorted, recycled, and compliant with relevant regulations may be incinerated or reused where permitted.
Waste containers	Uncontaminated containers may be recycled. Containers that cannot be cleaned shall be handled as hazardous waste in accordance with local regulations.

Emergency Response for Leaks:

- Contact qualified professionals immediately and evacuate unauthorized personnel to a safe area.
- Stop or isolate the leakage source as far as possible. Prevent coolant from entering sewers, drains, water bodies, or enclosed spaces.
- Wear appropriate PPE when handling leaked liquid and avoid direct contact with spilled substances.
- Large leak: Build a dike or excavate a containment pit, then transfer the liquid into suitable containers using pumps.
- Small leak: Absorb with clay, sand, or other suitable absorbent, then place the waste in a sealed container for disposal.

Exposure Route	First-Aid Measures
Inhalation	Move the affected person to fresh air and keep the airway open. If breathing is difficult, administer oxygen if trained to do so. If breathing stops, begin artificial respiration immediately and seek medical attention.
Skin contact	Remove contaminated clothing. Rinse thoroughly with plenty of running water and seek medical attention if irritation persists.
Eye contact	Rinse with clean running water or saline solution for at least 15 minutes, then seek medical attention.
Ingestion	Seek medical help immediately. Do not induce vomiting unless instructed by a doctor. If medical help is not immediately available, take the patient, container, and label to the nearest medical emergency center or hospital. Do not give food or drink to an unconscious person.

4 Battery Maintenance

4.1 Regular Maintenance and Maintenance Frequency

The following intervals are recommended. The actual interval shall be adjusted according to the product installation environment. Plant size, installation location, and site conditions all affect the maintenance cycle. In environments with strong wind, heavy sand, or significant dust accumulation, shorten maintenance intervals and increase maintenance frequency.

CAUTION

- If the voltage of a single cell is below 2.5 V, contact the manufacturer for replacement. Capacity loss caused by continued use will not be covered under warranty.
- If the voltage of a single cell falls below 2.0 V, stop using it immediately and contact the manufacturer for recycling.

Interval	Maintenance Item	Requirement
Every 6 – 12 months	Environmental temperature and humidity	Check environmental temperature and humidity records to ensure they are within the recommended ranges.
	Functional check	Check the operation of the DC contactor. After the equipment is shut down, send an on/off command once to verify its normal operation. Check if the 24V output voltage is within the normal range. Check the battery pack operation record to confirm that the current, voltage, and temperature are all within the specified range.
Annually	Switch box, if equipped, and battery-module housing	Check for flammable materials on the battery pack, secure and corrosion-free mounting points, housing damage, or paint peeling, oxidation, foreign objects, dust, or dirt condensation. Correct nonconforming items immediately.
	Wiring and cable layout	Inspection can only begin after all internal components of the battery pack have been completely de-energized. Check the cable layout, short-circuit risks, sealed wiring ports, leaks, loose power cords, and busbar connections, torque specifications, and for damage to power cords or communication cables, paying particular attention to any breaks in the insulation at the points where cables come into contact with metal surfaces.
	Grounding connection	Check whether grounding is correct. Grounding resistance shall not exceed 4 ohms.
	Fan	Check for blockage, failure to rotate, and abnormal noise during operation.
	Screws	Check whether screws have fallen out or become rusted inside the battery pack.
Every 2 years	Battery cluster condition and cleaning	Check whether the battery pack and internal components are damaged or deformed; check for abnormal noise, high internal temperature, abnormal humidity, or dust level; clean if required; and check whether air intake and exhaust ports are clogged.
	Warning labels	Check whether warning labels and tags are clear and undamaged. Replace if necessary.
	Wiring and cables	Check wiring and cables. Verify that the switch box, if equipped, and the battery module are correctly connected.
	Corrosion	Check for oxidation or corrosion inside the battery cluster.

4.2 Maintenance Precautions

To maintain the system safely and effectively, qualified personnel shall read and comply with the following safety requirements:

- Personnel shall hold a valid electrical work certificate issued by the relevant authority and complete required professional training before starting work.
- Wearing metal accessories, such as jewelry or watches, is strictly prohibited.
- Never touch the high-voltage positive and negative terminals of the energy storage system with both hands at the same time.
- Before maintaining the battery energy storage system, disconnect all high-voltage and low-voltage switches.
- Direct washing with water is strictly prohibited during cleaning. Use a vacuum cleaner when necessary.
- When inserting or removing cables, follow standard operating procedures. Avoid excessive force or rough handling.
- After maintenance, clean all tools and materials promptly and check for metal debris inside or on top of the equipment.
- Contact customer service for questions about operation or maintenance. Unauthorized operation is strictly prohibited.

4.3 Equipment Maintenance

- Operating temperature range: 0°C to 45°C. During charging and discharging, keep the temperature within 15°C to 30°C, with 25°C as the typical value.
- Avoid high-rate charging and discharging of the PACK. The continuous charging/discharging current of a single PACK shall not exceed the rated current.
- If the battery energy storage system remains unused for an extended period, perform one charge-discharge cycle every six months and adjust the state of charge (SOC) to approximately 50%. Maintain this SOC level during storage.
- Before initial use, fully charge the system at least once to restore battery performance to the optimal level.
- Regularly inspect cooling-system air ducts for blockage. Clean the fan inlet and outlet ports. Use a vacuum cleaner when required to ensure free airflow. Disconnect power before dust removal. Washing with water is strictly prohibited.
- Regularly inspect high-voltage cables and connection terminals for loose bolts, poor contact, severe corrosion, or oxidation on terminal surfaces.
- Regularly inspect high-voltage protective covers on PACK positive and negative terminals for aging, damage, or missing parts.
- Regularly inspect cables for looseness, aging, damage, breakage, and proper insulation.
- Regularly check the energy storage system for unusual odors, especially burnt odors at high-voltage connection points.
- Regularly verify monitored parameters, such as voltage and temperature, and check for abnormal alarms on the alarm panel.
- Regularly check the system status and verify that all alarm indicators function properly.
- Regularly check the emergency-stop switch to ensure rapid shutdown during emergencies.
- Regularly inspect the fire protection system to ensure it is in good condition and within the valid service period.
- Do not connect different types of battery modules in series or parallel.
- PACK A and PACK B are not interchangeable.

WARNING

- Batteries present potential hazards. Appropriate protective measures shall be taken during operation and maintenance.
- Incorrect operation may cause serious personal injury and property damage.
- Use the correct tools and PPE when handling batteries.
- Battery maintenance shall be performed only by personnel with battery-specific expertise and proper safety training.

4.4 Battery Recycling

The company does not handle battery recycling. Used batteries shall be disposed of in accordance with local laws and regulations and shall not be disposed of as household waste. Improper disposal may cause environmental pollution or an explosion. If no local recycling facility is available, contact the nearest national or regional recycling provider.

WARNING

- If the battery leaks or is damaged, contact technical support or a qualified battery recycling company for disposal.
- When the battery has exceeded its service life and is no longer usable, contact a battery recycling company for disposal.
- Avoid exposing used batteries to high temperatures or direct sunlight.
- Avoid exposing used batteries to high humidity or corrosive environments.
- Defective batteries shall not be reused. They shall be disposed of promptly by a battery recycling company to prevent environmental pollution.

Recycling Process:

- Step 1: Contact the nearest recycling facility.
- Step 2: The recycling facility will assess recycling costs.
- Step 3: The recycling agency will arrange collection. For on-site collection, pricing depends on distance and transportation costs. For centralized collection, customers shall place collected lithium batteries in a designated area for centralized processing by the agency.

5. Maintenance of Explosion Relief Panels

5.1 Regular Maintenance

- Inspect and maintain the product according to the standard equipment maintenance schedule.
- Under normal operating conditions, perform maintenance at least once per year. Under abnormal or special operating conditions, increase maintenance frequency and prepare corresponding maintenance plans.
- Perform visual inspection to confirm whether the explosion relief panel and fasteners are rusted or deformed, and whether the sealant is detached or aged. Replace affected components promptly if any of these conditions are present. found.
- If any fastener on the explosion relief panel assembly becomes loose during operation, tighten it promptly to the specified torque using a torque wrench.

5.2 Pre-Maintenance Notes

- Before maintaining the explosion relief panel system, fully understand and comply with applicable local laws, as well as the company-recommended safety regulations and procedures.
- Before maintenance, ensure that no hazardous or flammable gases are present inside the cabinet.
- Before disassembling the explosion relief panel assembly, implement protective measures to protect the eyes, skin, mouth, and nose from irritation or injury.
- Do not repair the explosion relief panel without authorization from the company. If any defect or damage is found, contact customer service.

5.3 Maintenance Steps

- Before maintenance, check the explosion relief panel assembly for leakage. If leakage is present, replace the assembly with a new one.
- Loosen and remove the nuts and fastening bolts.
- Remove the explosion relief panel assembly from the equipment and place it on a workbench for inspection. Check all components and gaskets for damage. Under normal operating conditions, no damage should be present. If damage is found, replace the assembly with a new one.
- When reinstalling the explosion relief panel assembly, restore it to the same installation condition as before removal.

5.4 Replacement of the Explosion Relief Panel Assembly

- The replacement interval shall be determined based on equipment operating conditions, medium properties, and other influencing factors.
- For explosion relief panels used in corrosive, toxic, or harsh operating conditions, shorten the replacement interval.
- Replace the explosion relief panel assembly immediately if the P_{max} value on the nameplate does not match actual operating conditions, or if equipment temperature exceeds the allowable range of the panel material.
- Replace the assembly if the membrane is significantly deformed, has foreign matter attached, or leaks.
- Replace the assembly if operating pressure exceeds the static opening pressure without relief activation.
- Replace the assembly if damaged or aged gaskets cause leakage.

6 Diagnosis of Common Abnormal Conditions

When the integrated energy storage system is started but does not operate normally, do not immediately conclude that the system is faulty. Use the following tables to identify possible causes. Also, check whether external environmental factors, such as temperature, humidity, or load overload, are contributing factors. If the problem remains after the troubleshooting steps below, have the system repaired by qualified personnel. This chapter covers only basic fault diagnosis. If the diagnosis is unclear or insufficient, contact customer service.

Energy Storage System Faults

No.	Fault / Alarm	Possible Cause	Troubleshooting Solution
01	Wi-Fi communication fault	Wi-Fi module is damaged; poor contact or loose wiring-harness connection.	Replace the Wi-Fi module; reconnect or replace the wiring harness.
02	Battery and PCS communication failure	Abnormal wiring-harness connection; BMS cannot start; RJ45 port is damaged; PCS fault.	Check wiring connections; replace the BMS; replace the RJ45 connector with the same brand and model; replace the PCS if confirmed faulty.
03	Charge overcurrent protection	The system charging current is too high.	Reduce charging power/current.
04	Discharge overcurrent protection	The system's discharging current is too high.	Reduce discharging power/current.
05	Discharge high-temperature protection	Ambient temperature is too high; single-cell temperature is abnormal; charge/discharge current is too high.	Stop discharging and wait for the battery compartment temperature to decrease before continuing. Check abnormal cell temperature.
06	Discharge low-temperature protection	Ambient temperature is too low.	Stop discharging and wait for the battery compartment temperature to rise before continuing.
07	Charge high-temperature protection	Ambient temperature is too high; single-cell temperature is abnormal; charge/discharge current is too high.	Stop charging and wait for the battery compartment temperature to drop. If the cell temperature is abnormal, replace the battery pack. If the charging current is too high, reduce the charging current.
08	Charge low-temperature protection	Ambient temperature is too low.	Stop charging and wait for the battery compartment temperature to rise before continuing.
09	Total battery voltage is too high	Total voltage is too high.	Stop charging.
10	Total voltage undervoltage protection	Battery is overdischarged.	Stop discharging and charge immediately.
11	Cell overvoltage protection	Cell voltage is too high.	Stop charging and check/balance the affected cell.
12	Cell undervoltage protection	Cell is overdischarged.	Stop discharging and recharge the cell.
13	Relay stuck	The relay is damaged or stuck.	Replace the relay.
14	NTC sensor fault	The NTC sensor is damaged.	Replace the NTC sensor.
15	Insulation fault	Battery pack leakage or insulation abnormality.	Power off immediately and contact customer service.
16	DC fuse fault	DC fuse status abnormal or auxiliary contact wiring disconnected.	Shut down the faulty system immediately, disconnect external power, and replace the DC fuse.
17	RUN indicator fault	High-voltage relay fault; abnormal 24 V power supply; indicator damaged.	Replace the relay; replace the 24 V power supply; replace the indicator.

18	POWER indicator fault	Poor contact in the indicator wiring harness; BMU fault; indicator damaged.	Check the indicator wiring harness; replace the BMU; replace the indicator.
19	AC overvoltage	A/B/C phase inverter voltage is too high.	Contact customer service.
20	AC undervoltage	A/B/C phase inverter voltage is too low.	Contact customer service.
21	PCS phase-sequence fault	Incoming AC cable phase sequence is incorrect.	Adjust the phase sequence of the incoming AC cable.
22	Mains circuit breaker cannot open or close	Mains circuit breaker is damaged.	Replace the mains circuit breaker.
23	Islanding protection	The energy storage inverter detects an islanding condition.	Check grid status and inverter settings; contact customer service if the alarm persists.
24	PCS overtemperature	PCS internal temperature is too high; heat sink/radiator overheated.	Shut down and wait for the temperature to decrease before restarting. Check cooling and heat dissipation.
25	CAN communication fault	CAN communication failure.	Check the PCS communication cable harness.
26	DC overvoltage	DC bus voltage is too high.	Adjust the PCS battery-voltage protection threshold as instructed by qualified personnel.
27	DC undervoltage	DC bus voltage is too low.	Adjust the PCS battery-voltage protection threshold as instructed by qualified personnel.
28	The AC relay cannot close	The AC relay circuit is short-circuited.	Check the AC circuit.
29	Abnormal PCS output voltage	Output voltage is abnormal.	Check the load and disconnect high-power loads.
30	PCS overload	Load current is too high.	Reduce high-power loads.
31	PCS soft-start failure	PCS soft-start failure.	Contact customer service.
32	The PDU DC contactor cannot close	The DC circuit breaker is damaged.	Replace the DC circuit breaker.
33	Battery output overload	Battery overcurrent.	Disconnect high-power loads on the load side.
34	BMS internal communication error	Wiring-harness connection error.	Check wiring connections.

Liquid-Cooling Unit Faults

No.	Fault / Alarm	Possible Cause	Troubleshooting Solution
01	Sensor fault	Sensor wiring is loose or the cable is damaged; the sensor is damaged.	Secure the electrical control wiring or replace the cable; replace the sensor.
02	System high-pressure alarm / switch	Ambient temperature is too high; the high-pressure switch circuit is loose or the cable is damaged; the condenser is dirty; the air inlet or return air outlet is blocked; the condenser fan is abnormal; the refrigerant overcharge.	Check the outdoor temperature; secure wiring or replace the cable; clean the condenser; clear the air inlet/outlet; repair or replace the condenser fan; recover the appropriate amount of refrigerant.
03	Water pump fault	Water-pump wiring is loose or the cable is damaged; air in the coolant circuit or insufficient coolant causes dry running; the pump body is burned out.	Secure wiring or replace the cable; check the coolant level in the chiller and vent air from the circuit; inspect and replace the pump if burned.

04	High discharge superheat / insufficient subcooling	The electronic expansion valve is faulty or the opening is excessive; the coolant flow rate is too low; the refrigerant is excessive; the suction temperature sensor or low-pressure sensor failed, causing inaccurate detection.	Replace the electronic expansion valve; top up the coolant; recover the appropriate amount of refrigerant; check and replace the sensor if necessary.
05	Low suction pressure	Refrigerant leakage; electronic expansion valve not operating properly.	Repair the leak and refill refrigerant; replace the electronic expansion valve.
06	High discharge pressure	Condenser is dirty; air inlet/outlet is blocked; condenser fan is abnormal.	Clean the condenser; keep air ducts clear; check the condenser fan and replace it if necessary.
07	High discharge temperature	Ambient temperature is too high; the condenser is dirty; the air inlet/outlet is blocked; or the condenser fan is abnormal.	Check the outdoor temperature; clean the condenser; keep air ducts clear; check and replace the condenser fan if required.
08	High pressure ratio	Condenser is dirty; air inlet/outlet is blocked; condenser fan is abnormal; refrigerant is overcharged; compressor is faulty.	Clean the condenser; keep air ducts clear; check/replace condenser fan; recover a small amount of refrigerant; replace the compressor if necessary.
09	Low pressure ratio	Compressor speed too low or internal leakage due to component wear; refrigerant leakage; electronic expansion valve faulty or opening excessively.	Replace the compressor; repair the leak and refill the refrigerant; replace the electronic expansion valve.
10	System leakage	Broken pipe fittings; aged seals; impact damage to the condenser, evaporator, or other equipment.	Replace or weld copper piping; replace the seal; replace damaged equipment.
11	Compressor overcurrent protection	Voltage is below the required level; inverter output circuit is grounded or short-circuited; compressor is damaged.	Adjust the voltage to the normal range; check the output circuit; replace the compressor.
12	Compressor drive overtemperature protection	Ambient temperature is too high; insufficient airflow at the drive-unit radiator; the drive is damaged.	Reduce ambient temperature; clean the compressor cooling air duct; replace the compressor drive.
13	Outlet water temperature too low	Outlet water temperature sensor fault; electric heater or internal circulation pump fault; customer heat load exceeds the chiller's heating capacity.	Replace the water temperature probe; check the electric heater and internal circulation pump; check the customer's heat load.
14	Low water-pressure protection	Insufficient coolant; expansion tank gas leakage.	Top up coolant; inspect the expansion tank and refill gas or replace the tank if leakage is detected.
15	Overpressure protection	The water/coolant circuit is clogged; excessive coolant.	Check for blockages in filters, valves, elbows, and the coolant circuit; open the drain valve to release a small amount of coolant.
16	High water-temperature difference protection	Temperature sensor fault; low flow rate; customer load increases.	Replace the water temperature sensor; increase coolant flow; check the cooling load.
17	Compressor drive offline	Host controller fault; frequency-converter communication wiring loose or cable damaged; communication parameters incorrect.	Check the host controller cable; secure communication wiring, or replace the cable; set communication parameters correctly.

18	Compressor drive failure	Drive board fault; frequency-converter input voltage outside the specified range.	Replace the frequency converter; adjust voltage to the normal range.
19	Host controller offline	Communication cable damaged; communication port wiring error; chiller communication baud rate differs from host controller.	Replace the communication cable; reconnect the communication line; and set the same baud rate for the chiller and the host controller.
20	High water-temperature protection	Outlet water temperature sensor fault; compressor, electronic expansion valve, internal circulation pump, or external fan malfunction; customer heat load exceeds chiller cooling capacity; coolant leakage.	Replace the water temperature sensor; check the compressor, electronic expansion valve, internal circulation pump, and external fan; check cooling load; repair leaks and top up coolant.

7 Replacing Electronic and Electrical Components

- When replacing electronic or electrical components in the integrated energy storage system, always use components from the same manufacturer and of the same model. The component model can be identified from the system identifier or product label. If the model cannot be determined, contact the company.
- If components from another manufacturer or a different model from the same manufacturer must be used on site, prior analysis and approval by the company are required. Otherwise, the company shall not be liable for any resulting personal injury or property loss.
- Strictly follow the procedures in this chapter when replacing electronic components. The company shall not be liable for losses caused by failure to follow these instructions.
- Only qualified technical personnel may perform the operations described in this chapter.

8 Maintenance of Fire Suppression Systems

- Comply with fire safety laws and regulations in the country or region where the project is located. Regularly inspect and maintain fire protection equipment to ensure all functional parameters are normal.
- The system is equipped with a heat-sensitive tube fire suppression device. The tube is made of specialized polymer material and contains a clean fire-extinguishing agent. When the tube surface is heated, it ruptures and forms a nozzle that releases the extinguishing agent to suppress the fire.
- The tube surface is highly sensitive to heat. When heated, the device responds rapidly by releasing fire-extinguishing agent to suppress the fire promptly.

DANGER

Asphyxiation risk!

During fire suppression, the equipment automatically releases a large amount of gas.

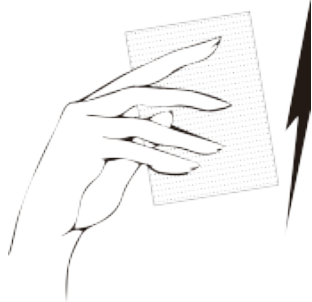
Do not approach the integrated energy storage system while fire suppression is in progress.

9 Paint Repair Measures

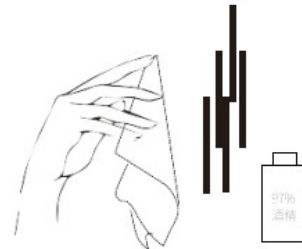
Check the exterior of the integrated energy storage system for damage. Surface contaminants caused by water stains or dust may be cleaned thoroughly.

- Use a cloth or other cleaning tool dampened with water to wipe dirt from the surface.
- If the stain cannot be removed with water, wipe with 97% alcohol until the surface reaches an acceptable level of cleanliness. A locally available non-corrosive cleaning agent may also be used.

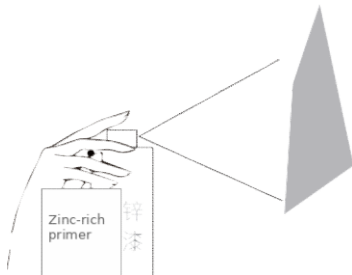
If the topcoat is damaged and surface stains cannot be completely removed, follow the repair procedure below.



Step 1: Clean the damaged area with water or 97% alcohol to remove surface stains.



Step 2: Wipe the affected area with a cloth dampened with water or 97% alcohol to remove surface stains.



Step 3: After the surface dries, apply a zinc-rich primer to exposed substrate areas.



Step 4: After the primer dries, apply the topcoat evenly with a soft-bristle brush.

Note: This product does not use standard RAL 7035 paint.
Contact after-sales service before repainting.

WARNING

- Check whether the protective paint on the housing of the integrated energy storage system has peeled off or shows other signs of damage. Repair any damage promptly.
- This product requires periodic maintenance. The entire exterior of the integrated energy storage system should be repainted with specialized protective coating every five years.

10 Accident Handling

The emergency response plan shall be directed by the operation and maintenance center and implemented by maintenance personnel. Communication shall remain available throughout the response. Emergency measures in the plan shall be carried out effectively by maintenance personnel. Comprehensive training and drills shall be conducted every six months, and the plan shall be continuously improved based on problems identified during drills. When system abnormalities or incidents occur, appropriate and effective measures shall be implemented promptly to prevent further damage or escalation of losses.

Incident	Response Measures
Overheating	If the battery pack temperature exceeds the safe operating limit, the management system will issue a warning and require immediate shutdown. Stop operation immediately and notify qualified technical personnel for a comprehensive inspection. The system may be used again only after the fault has been resolved.

Electrical leakage	If leakage current or electrical leakage is detected during operation, evacuate all personnel immediately and notify qualified technical personnel for troubleshooting. The system may be restarted only after the fault has been resolved. Operating the system with a fault or forcing continued operation is strictly prohibited.
Short circuit	If a short circuit occurs, evacuate all personnel, disconnect the relevant power supply and electrical equipment if safe to do so, isolate the battery from the system, and notify qualified technical personnel for repair and troubleshooting. Equipment and components affected by severe short circuits shall be fully inspected by the manufacturer before reuse.
Impact	If the equipment is impacted, deformed, or penetrated by a foreign object, immediately disconnect the system power cable and notify qualified technical personnel. In special circumstances, only personnel with appropriate PPE may perform on-site disassembly.
Fire response	Step 1: Evacuate personnel to a safe area, establish an isolation zone, and call emergency services as required. Step 2: If power is off and personal safety is assured, use CO2 or dry-powder extinguishers for smoking or burning wiring harnesses. If an energy storage battery catches fire, use a high-pressure water hose from a safe distance. If dense smoke is inhaled, move away immediately and seek medical attention. Step 3: Notify the system manufacturer for further handling recommendations.
Water inundation	Step 1: Regardless of whether the system is powered on, evacuate personnel to a safe area and establish an isolation zone. Step 2: Notify the system supplier and perform maintenance after the water has receded. Step 3: Do not energize the system until the manufacturer provides a safety assessment report.
Server / monitoring platform outage	When a server or monitoring platform fails, operation and maintenance personnel shall verify equipment operating status and contact the manufacturer's maintenance engineers to confirm the recovery timeline. If recovery cannot be completed within one hour, report the situation to the responsible manager for discussion and approval.
Power-supply system disconnection	If the power-supply system of the plant fails, maintenance personnel shall proceed to the site immediately, disconnect the equipment power switch, and press the PCS emergency stop button if required by site procedures. Contact the electrical supervisor to determine the outage cause and estimated restoration time, then report to management. After power is restored, reactivate the system according to standard procedures and verify normal operation.
Electrical shock	In the event of an electrical shock, maintenance personnel shall cut off power to the affected facility immediately while ensuring their own safety, assess the injured person, and call emergency services. Provide first aid to seriously injured persons as appropriate. Movement of the injured person and first-aid procedures shall follow relevant standards to prevent secondary injury.
Other incidents	If maintenance or disassembly of equipment or components is required due to other incidents, disconnect the battery circuit first to prevent electric shock. Do not disassemble any component until it has been confirmed that no short circuit is present. Prevent secondary damage caused by collisions, dropping, inversion, or other incidents during handling.

DANGER

- If any issues are found that may affect the battery or energy storage integrated system, please contact after-sales personnel. Do not attempt to disassemble it yourself.
- If exposed copper wires are found inside the conductive wires, do not touch them. There is a high voltage hazard. Please contact after-sales personnel. Do not attempt to disassemble it yourself.
- In case of other emergencies, please contact after-sales personnel immediately and operate under their guidance, or wait for after-sales personnel to handle the situation on-site.