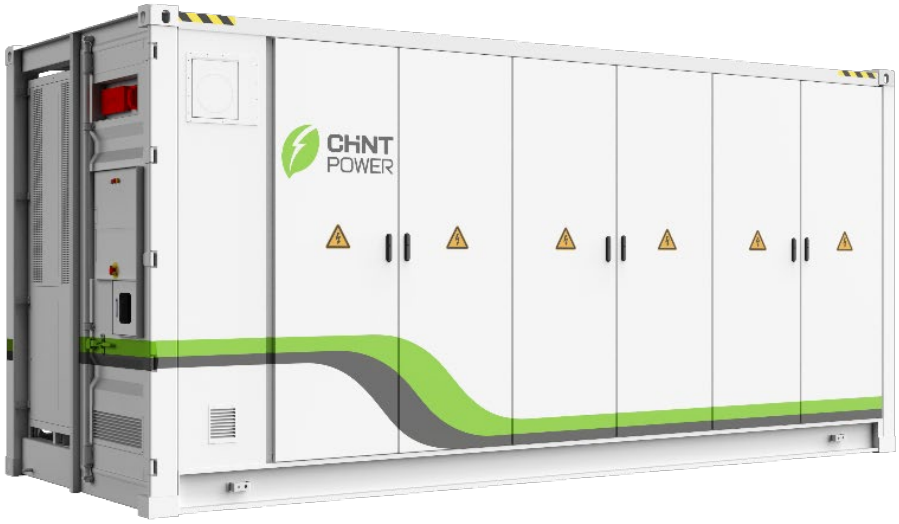
CPS ES-5015KWH-EU

Liquid Cooling Battery Energy Storage System

Operation and Maintenance Manual



Shanghai Chint Power Systems Co., Ltd.

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Content

Change Record

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V1.0	31/03/2025	First issue

1. Foreword

This O&M Manual is applicable to the CPS ES-5015KWH-EU Liquid Cooling Battery Energy Storage System (BESS) developed and produced by Shanghai Chint Power Systems Co., Ltd.

Important:

Please read this Manual carefully and make sure that you fully understand all contents before performing any operation.

Main content

This Manual contains instructions on how to operate the BESS, such as how to conduct the debugging and shutdown of the BESS properly, a maintenance plan for the BESS, and handling and recycling considerations for system hardware. Therefore, please read this Manual carefully before using this system and operate this system according to the method described in this Manual, to avoid equipment damage or personal injury.

Target readers

This Manual is only applicable to authorized and qualified after-sales service engineers or authorized operators.

Copyright restriction

Version upgrade

Due to the update and improvement of products, the contents of the Manual will be updated, adjusted and revised accordingly, and the products purchased by users shall be subject to the physical objects. You can get the latest version of the Manual through the corresponding sales channels, or you can download the latest version of the O&M Manual from our official website www.chintpower.com.

2. Safety Instructions

The following warnings, safety instructions and precautions are the safety measures provided and the measures to prevent damage to products or the equipment parts connected.

This Manual summarizes the warnings and safety precautions which are generally effective during the application of BESS system. Please read this information carefully to ensure your personal safety and extend service life of the product. If the operation and maintenance are not carried out according to the safety instructions in this Manual, resulting in personal injury or equipment damage, the Company has the right not to assume responsibility and provide quality assurance.

This Manual addresses and reduces personnel exposure to electrical hazards through effective equipment operation, design, specification, installation, and maintenance. All electrical work shall be carried out according to local electrical, architectural and fire protection codes, standards, regulations or utility requirements, and by the qualified service personnel who have been properly trained and authorized according to appropriate instructions.

2.1. Warning Identifications in this Manual

Prior to utilizing this system, kindly take note of the following safety warning messages as they are of utmost importance. Familiarizing oneself with these messages will enhance both the safety of your operations and maintenance procedures:

	Do not smoke or ignite flame near the battery PACK!
	Do not use organic solvents to clean the battery PACK!
	Do not dismantle the battery PACK as it contains electrolytes that can be harmful to the skin and eyes.
	Do not throw the battery PACK into fire, as it may result in an explosion!
	Replacing the battery PACK may lead to electric shock or short circuit. Please use tools with insulated handles for operation!
	Maintain a safe distance of 0.5 meters from any source of heat or potential ignition points (such as circuit breakers or fuse boxes)!
	Avoid the risk of local overheating, such as direct sunlight on the battery PACK.

Prior to system operation, only certified personnel holding valid electrical certifications as per specifications and safety standards, with electric power systems work experience, shall perform electrical circuit and equipment operations. Such personnel must thoroughly comprehend all warnings and maintenance procedures outlined in this manual.

Before operation and maintenance, the following requirements must be met:

- All live electrical work requires a live work permit. Prior to commencing electrical operations, certificated personnel should disconnect and verify that the equipment is de-energized, while also following appropriate lockout/tagout procedures.
- Before performing any operations or maintenance tasks, relevant personnel shall undergo safety training and complete the Safety Training Record Form as outlined in Annex 1 Safety Training Record Form.
- Before performing any operations or maintenance tasks, it is essential to prepare the required personal protective equipment (PPE) in accordance with the requirements outlined in Annex 2 List of Personal Protective Equipment (PPE).
- Before performing any operations or maintenance tasks, be sure to cut off the power supply of the grid and ensure that the battery system is disconnected.
- All power cables shall be considered energized unless appropriate de-energization measures have been taken.
- All battery racks shall form a conductor grounding grid.
- The fastening screws at the power interface of the BMS high-voltage box are M8 hexagon socket screws, with a torque range of 19-24 N.m (168-212 in-lbs) and are fixed by a torque wrench. Before performing debugging tasks, it is imperative to inspect the fastening condition of the screws at the DC confluence when the system is powered off and completely de-energized. Whenever the equipment is being transported, the screws must be re-tightened.
- Prior to conducting any other electrical performance tests, it is necessary to check whether the cable's fastening screws are loose. If any looseness is detected, a specialized tool shall be used to tighten them securely.
- All maintenance and replacement of components must be carried out by certificated personnel, using approved materials, parts, and components exclusively.

2.2. Warning Identifications on Equipment

Warning signs inside container

Please read the Manual carefully

Warning

Electric shock hazard

Recycle

Warning signs outside container

Protective earthing

Emergency shutdown

2.3. Safety Requirements for the Owner

The Owner must follow the following requirements:

- The personnel operating the energy storage system should be fully familiar with the working principle of the energy storage system;
- The personnel operating the energy storage system should be fully familiar with this Manual;
- The personnel operating the energy storage system should be fully familiar with the local electrical regulations and standards;
- Regularly inspect the safety equipment within the system to ensure its reliability;
- Any warning signs on the equipment that are damaged or illegible shall be replaced immediately;
- The ground on which the energy storage system products are stored must be firm and reliable;
- Transportation, installation and debugging can only be carried out by professional personnel recognized by the manufacturer;
- This Manual describes the safety instructions in details. Working personnel shall read it carefully for full understanding.
- The software, housing and internal components of the equipment cannot be changed without the approval of the manufacturer; if they are changed without authorization, the quality assurance of energy storage system is invalid;
- The sealing strip on the equipment shall not be damaged. If it is damaged, the quality assurance of the equipment will be invalid.

2.4. Safety Requirements for Operation and Maintenance Personnel

2.4.1. Qualifications

A qualified operation and maintenance personnel is a person who has been trained and have necessary electrical knowledge, he must be able to:

- Understand the installation, use, disassembly, earthing, short circuit, and maintenance of the product;
- Evaluate the assigned tasks and spot possible hazardous events;
- Provide immediate rescue for the injured;
- Understand the relevant maintenance criteria of the product;
- Comply with local regulations and standards.

2.4.2. Responsibility

The operation and maintenance personnel must make sure that:

1. Before operation and maintenance, carry out step-by-step inspection according to the safety contents of this Manual;
2. Before system operation, please ensure that it is ready and safe;
3. Use appropriate inspection equipment to check that the components are completely de-energized before maintenance;
4. Before using the inspection equipment, ensure that it can function properly. If you are not familiar with the equipment, please read this user manual carefully.
5. When maintaining the energy storage system, in order to prevent irrelevant personnel from entering the site and causing miss operation, please observe the following regulations:
    - The safety warning identification of energy storage system contains important information for safe operation, and no man-made damage is allowed;
    - The nameplate of energy storage system contains important information of relevant products, and no man-made damage is allowed;
    - Obvious safety warning tapes are set up near the operation area.

2.4.3. Safe Operation and Maintenance

We shall observe following rules in order to use the energy storage system in a safe way:

- Only authorized working personnel can operate the energy storage system;
- Before starting the system, please check the energy storage system to ensure that it is ready and safe. It is not allowed to start the system if a danger may be caused;
- Procedures described in this Manual shall be implemented strictly during operation of the energy storage system;
- It is not allowed to open any cabinet door or touch any internal conductor during operation of the system;
- Maintenance can be started at least 5 min after the energy storage system is powered off;
- Disconnect all circuit breakers and provided signs to prevent accidental closing before maintenance;
- Check the components before maintenance to ensure that they are completely de-energized;
- At least two persons, one for operation and the other for ensuring safety, shall be on site during maintenance;
- Inspections shall be carried out after maintenance to make sure that no tool is left inside the system;
- Key must be pulled out and kept properly after maintenance;
- If the maintenance components will always be live, please take insulation measures, such as wearing insulating gloves;
- Due to the extremely high voltage of the battery string and the grid, it is crucial to avoid direct contact with energized conductors to prevent potential severe injuries. During maintenance procedures, please ensure that both the AC and DC switches are turned off and the grid is disconnected;
- It is not allowed to touch the battery electrode, which may lead to serious injury, because short-circuit current of the battery PACK is very high;
- Maintenance shall be avoided as far as possible in rainy days, and doors of the system products shall be closed;
- No flammable or explosive articles are stored near the energy storage system products.

2.5. Terms and Definitions

Terms	Definitions
Battery PACK	Battery assembly consisting of battery cells connected in series, parallel, or both, with a pair of positive and negative output terminals, which should also include housings, management and protection components.
High-voltage box	It is used for the protection and control during charging and discharging of battery cluster, and consists of the cluster-level battery management unit, relay, fuse, power resistor and disconnector.
Battery cluster	Battery assembly that is connected by the battery PACK in series and can run independently after being connected with a PCS and ancillary facilities, which shall also include the battery management system, monitoring and protection circuit, electrical and communication interfaces and other components.
PCS	(Power Conversion System), which accepts the EMS or BMS requirements, and charges and discharges batteries.
BMS	(Battery Management System), used to detect the voltage, current, temperature and other parameter information of the battery and manage and control the state of the battery.
ESBMM	(Energy Storage Battery Management Module), the slave module in BMS, which is used to collect the voltage and temperature of battery cell in the battery PACK, control fans, and achieve the balance management of battery.
ESBCM	(Energy Storage Battery Control Module), the main control module in BMS, which enables the real-time monitoring of battery cluster parameters, fault handling, SOC/SOH estimation, insulation detection, alarm display, remote monitoring, relay control, equalization algorithm, and collection of total voltage and main loop current, communication with ESBMM in the system BMS, and communication with the master control module and uploading of real-time battery data.
ESMU	(Energy Storage Management Unit), the master control module in BMS, which communicates with the main control module to query the information inside the module, and summarizes the information of multiple battery clusters; communicates with HMI to query on the corresponding HMI; communicates with the background to query in the corresponding background; communicates with PCS to control the charging and discharging of PCS; and inputs and outputs dry contacts as required, and communicates with air conditioning, fire protection and other system equipment as required.
EMS	(Energy Management System) of the whole power station, which is used for dispatching, monitoring and management of the whole power station.
Auxiliary control distribution box	It is mainly used to supply power to the system communication components and system equipment, and is arranged in the equipment compartment.

DC confluence unit	It mainly includes functions of the DC confluence part, and is arranged in the equipment compartment.
Fire suppression system	It mainly includes the fire-fighting gas extinguishing cylinder, gas extinguishing controller and module control box, and is arranged in the equipment compartment.
Thermal management system	Use a liquid cooling unit to adjust the battery temperature within an appropriate range, and uniformly control the temperature of each battery through liquid cooling pipelines and liquid cooling plates.
Lighting system	Lighting lamps are arranged in the container.
Cycle	When the battery PACK is charged and discharged once as per the specified standard, it is considered as a cycle.
MSD	(Maintenance Switch Disconnector) Manual maintenance switch.
Unit of measurement	Unit of voltage: "V" (volt) Unit of current: "A" (ampere) Unit of power: "W" (watt) Unit of capacity: "Ah" (Ampere-Hour) Unit of energy: "Wh" (Watt-Hour) Unit of internal resistance: "mΩ" (milliOhm) Unit of temperature: "℃" (degree Celsius) Unit of length: "mm" (millimeter) Unit of time: "s" (second) Unit of frequency: "Hz" (Hertz) Unit of mass: "kg" (kilogram) Unit of force: "N" (Newton)

3. System Introduction

3.1. System Application

The CPS ES-5015KWH-EU Liquid Cooling Battery Energy Storage System (BESS) features a modular design that is widely used in MW-scale energy storage systems for renewable energy integration, commercial and industrial (C&I), and utility applications. The CPS ES-5015KWH-EU Liquid Cooling Battery Energy Storage System is mainly applicable to BCP (emergency power supply in case of accidents or disasters), peak-load shifting, PV self-generation and self-consumption, and VPP virtual grid or power grid dispatching system solutions to improve energy utilization efficiency and power quality. The energy storage system is characterized by high efficiency, energy conservation, environmental protection, high integration, convenient installation, standardized scheme, intelligent control, remote monitoring, easy operation, stable performance, safety and reliability, and long service life.

3.2. System Function

Intelligent management:
The energy storage system consists of large-capacity cells and is an intelligent device supporting management, dispatching, grid connection, black-start and convenient transportation. Main components of the system include bidirectional power converter system (hereinafter referred to as PCS), battery management system (hereinafter referred to as BMS) and large-scale battery clusters. PCS charges and discharges the battery PACK stably according to the battery state and working mode provided by EMS or BMS.

High reliability:
BMS realizes automatic balancing, automatic patrol protection and power data request by monitoring the battery cells in real time, thus ensuring good operation of battery at all times. The black-start system is adopted to support the operation of energy storage station in case of power failure, thus overcoming the difficulty in power supply.

High flexibility:
The energy storage system of the whole station can be configured flexibly according to users' requirements. It can be designed for grid-connected wind power/PV energy storage, off-grid energy storage, etc. It is a set of energy storage products with powerful functions, stability and reliability and complete technical indicators.

3.3. System Description and Parameters

3.3.1. System Notes

This energy storage system consists of multiple energy storage components, including thermal management system, fire suppression system, power distribution system, battery management system and the most important battery PACK. Detailed system notes are shown in the following figure:

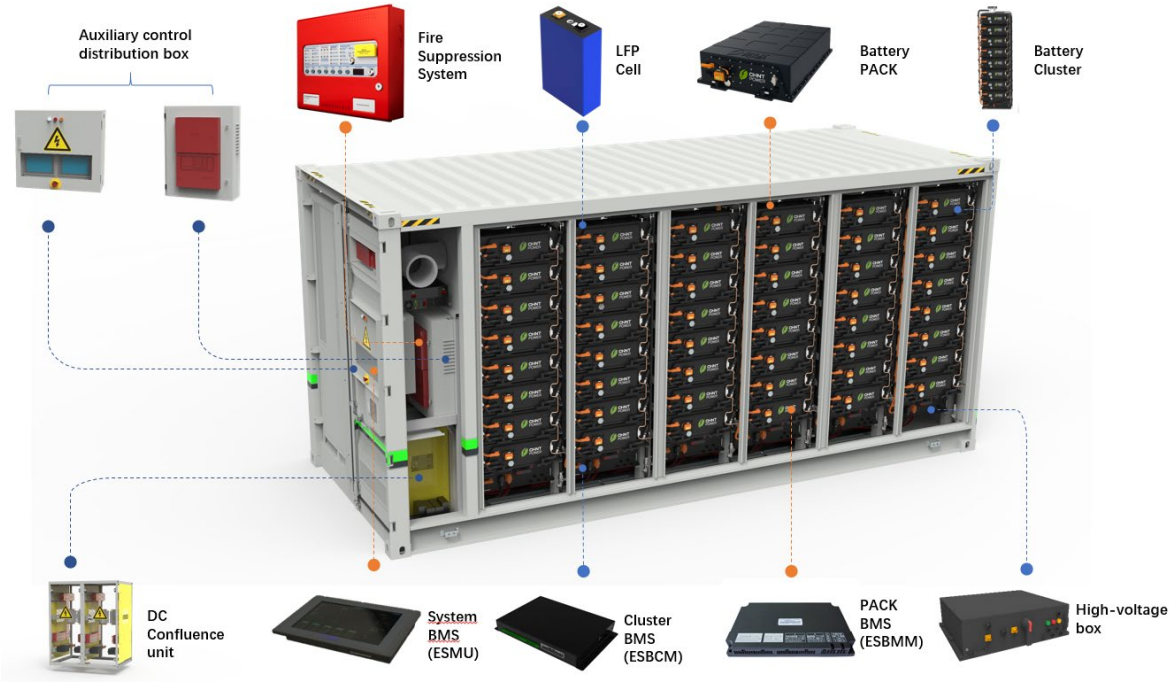


Figure 3- 1 Notes of System Components

3.3.2. Detailed System Parameters

The technical parameters of this energy storage system are based on the test results of standard battery clusters at room temperature (25±2)℃ and humidity (55±20)%. See the following table for detailed parameters:

Table 3- 1 Battery Container Detailed System Specifications

Item	Parameter	Condition
Cell capacity	314Ah	CHG/DCHG rate. 0.5C
Serial/parallel mode	12P416S	N.A.
Nominal voltage	1331.2V	Standard charge and discharge
Nominal capacity	5015.96kWh	Standard charge and discharge
Overall size	238.5 *114.0 * 96.0 (in) /6058 * 2896 * 2438 (mm)	See drawings for details
Weight	＜45T	N.A.
Discharge cut-off voltage	1164.8V or any battery cell in the battery cluster reaches 2.8V	Temperature T＞0℃
Charge cut-off voltage	1497.6V or any battery cell in the battery cluster reaches 3.6V	N.A.
Rated charge/discharge current	157A	(25±2)℃
Communication mode	CAN、RS485、TCP/IP	N.A.
Operating temperature range	-25~50℃	N.A.
Storage temperature range	-30~60℃	N.A.
Service life of the product guaranteed under the operating condition	(25±5)℃	N.A.
System thermal management mode	Liquid cooling	N.A.
Fire protection system	NOVEC1230	It can be replaced with other gas extinguishing media according to customer's requirements and equipped with water spraying system.
IP rating	IP54	N.A.
Noise	80dB	At a distance of 1 m, a height of 1.7 m, 35°C

3.4. System Structure Diagram

3.4.1. Communication Architecture Diagram

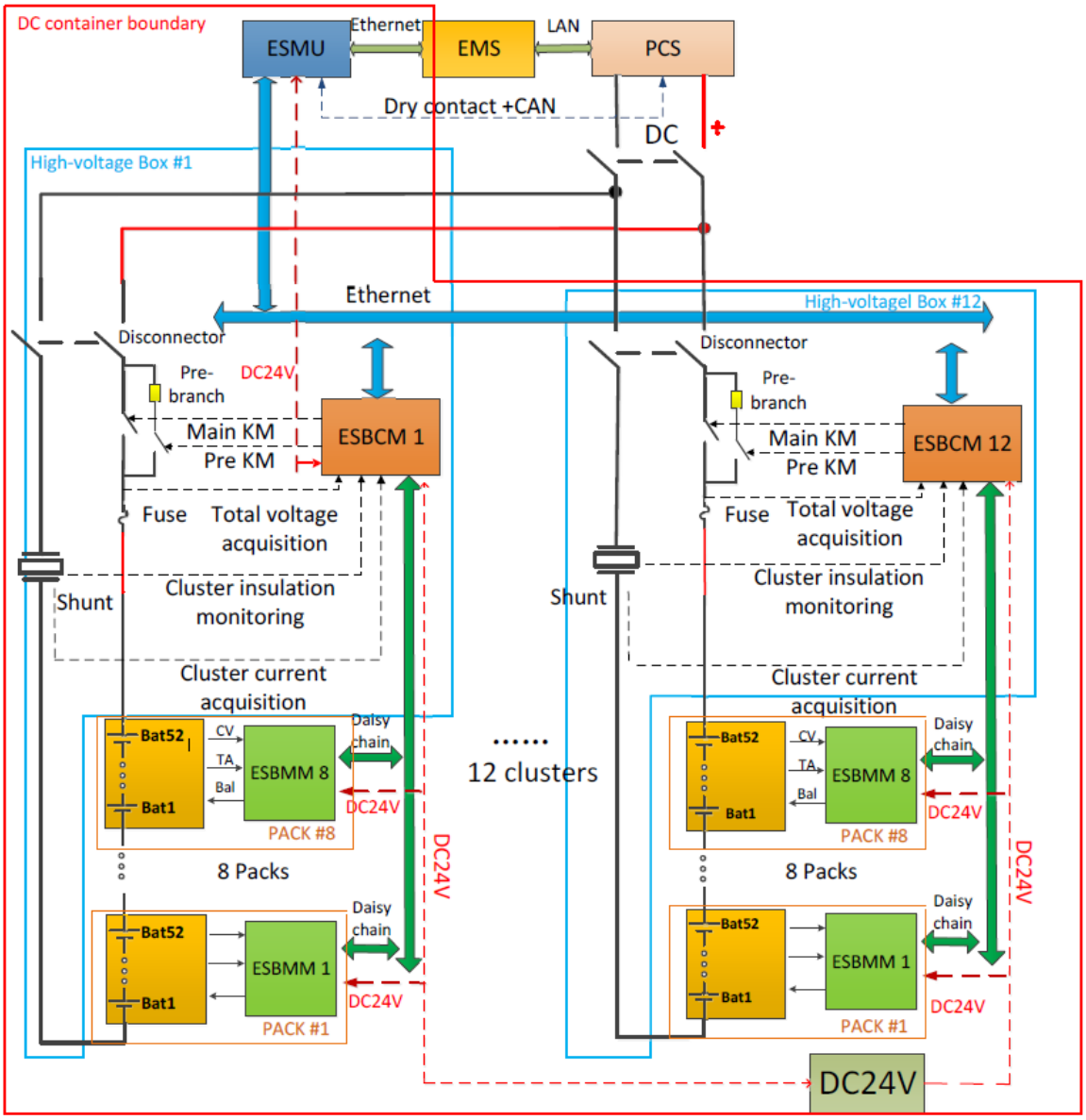


Figure 3- 2 System Communication Architecture

3.4.2. Electrical Architecture Diagram

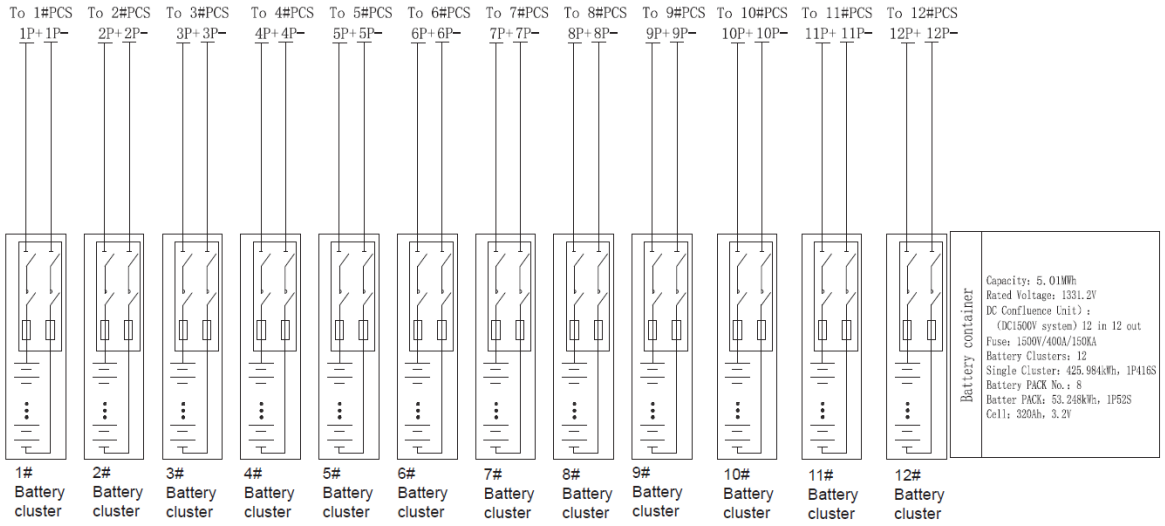


Figure 3- 3 System Electrical Architecture

3.4.3. Arrangement of System Equipment

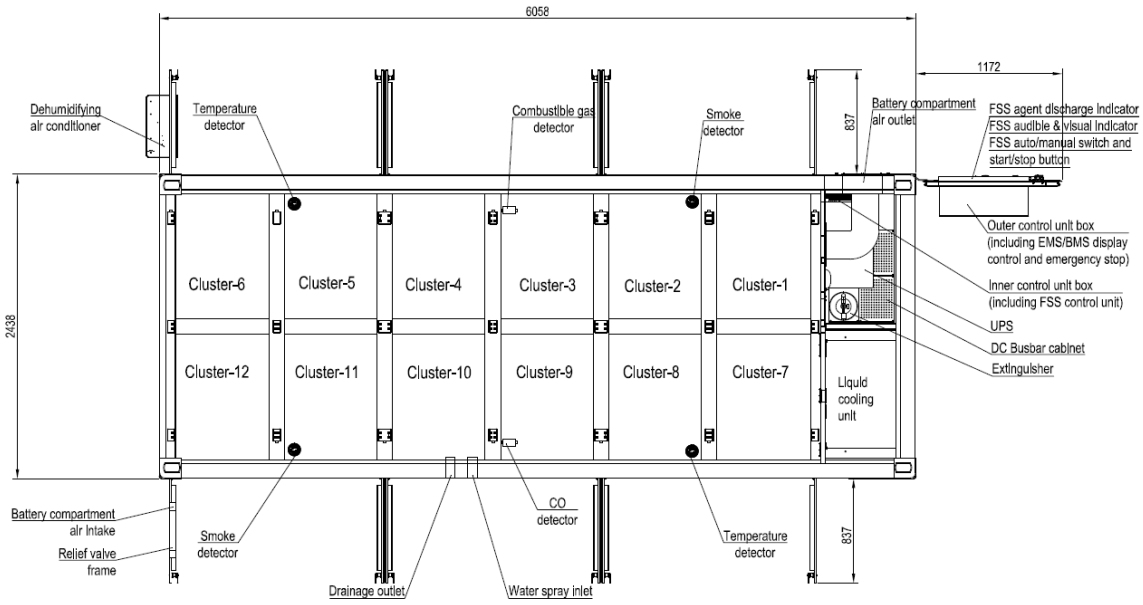


Figure 3- 4 Equipment Arrangement in Energy Storage System

4. Preparation

The following personnel requirements and items are required before continuing to operate and maintain the CPS ES-5015KWH-EU Liquid Cooling Battery Energy Storage System (BESS).

4.1. Personnel Requirements

All operation and maintenance personnel shall have received training on Chint BESS system and have relevant experience, so that they can perform operation and maintenance tasks in a safe manner and fully understand the risks involved. Relevant personnel must evaluate the data obtained on site and determine the availability of specific equipment. Relevant personnel include:

- The service personnel trained by Chint shall perform any maintenance work within the scope of Chint's work as determined in this Manual.
- The Owner's representative trained by Chint shall perform any maintenance work within the scope of the Owner's work identified in this Manual.

4.2. Personal Protective Equipment (PPE) and Tools

The after-sales service engineer shall prepare the required PPE and tools before operation and maintenance. Basic PPE and tools are shown in Annex 2 List of Personal Protective Equipment (PPE) and Annex 3 List of Tools. Types and quantities of items required by different projects vary according to the actual situation due to the different construction scope and scales.

All tools shall be calibrated by an approved calibration procedure and the calibration records are not expired. The status of PPE shall be checked and availability confirmed before any maintenance.

4.3. System Inspection

4.3.1. Container Overview

Table 4- 1 Record of Container Overall Inspection

Specification							
Size							
Weight and load							
Container appearance	Side			Front			
	Battery cluster	High-voltage box	Liquid cooling unit and pipeline	Fire detection and alarm system	Fire extinguishing system	Power distribution system	Confluence assembly
Equipment in containers							

4.3.2. Safety Inspection

- The energy storage system involves high voltage and strong current. It shall not be operated by anyone not accompanied by professionals. Operators shall improve their sense of security and vigilance, and wear personal protective equipment, especially insulating gloves, all the time. Equipment shall not be closed or opened without permission during operation. The main circuit breaker shall be disconnected immediately after an accident, and a report shall be made to relevant responsible person in a short time.
- Pay attention to the weather conditions and improve the awareness of safe operation in rainy days. Operating environment of the energy storage system shall be checked to ensure cleanliness. The fire protection equipment shall be checked for good maintenance and the escape route for smoothness.
- The energy storage system shall be free of insulation fault, and the insulation resistance of all busbars to ground shall not be less than 2.5 MΩ specified in national standards.
- Connection points of all wires shall be checked to ensure secure connection. You are required to refer to the national standards for details, and visually check the electrical safety clearance between power line electrodes. See the following table for details:

Table 4- 2 Allowable Values of Electrical Clearance and Creepage Distance

Rated line voltage / kV	Electrical clearance / mm	Creepage distance / ram
0.38 (0.4)	8	12 (max)
0.66 (0.69)	10	20 (max)
3 (3.5)	36	75 (max)

Note: Refer to the UL 1973-2022.

4.3.3. Equipment State Inspection

1. Check whether the internal wiring of the distribution box is loose, and control the outside power supply within the normal voltage range.
2. Check whether the BMS display and control panel is normal, whether the total voltage of each cluster of batteries (1331.2V) and the rated voltage of each battery cell (3.2V) are normal, and ensure that the BMS connection is normal.
3. Check whether the equipment in the battery system operates normally and whether the power line and communication line of each subunit of BMS are connected correctly.
4. Check the fuse at DC confluence unit for failure and normal state.
   - When all the relays in the high-voltage box are in open state, it is necessary to first place the DC-side switch of the PCS in the open circuit state before closing the DC air switch of the PCS.
5. Check whether display screen of the liquid cooling unit works normally and whether there is an alarm message on the display screen. If any, refer to Chapter 7 Troubleshooting.
6. Check the fire suppression system for normal operation and its display screen for alarm message. If any, refer to the manual of fire suppression system for troubleshooting.

4.3.4. Inspection Records

Each BESS produced by Chint is checked and tested before delivery. After the final installation, BESS shall receive another safety review before being shipped to the customer for operation.

The system shall be subject to a visual inspection to ensure its continuous safe operation throughout its service life.

The inspection content can refer to the equipment factory report issued by Chint.

The visual inspection shall be recorded. The inspection record is as follows:

Table 4- 3 Visual Inspection Record

Time	Inspection category	Details	Remarks

5. Emergency Disposal Procedures

5.1. First Aid Measures for Chemical Leakage

Measures to be taken in case of leakage or overflow of electrolyte and other substances:

- In the event of electrolyte or other material leakage, evacuate the area immediately.
- Ensure maximum ventilation to remove harmful substances or gases. Wipe clean with a cloth, dispose of it in a plastic bag, and then place it in an iron can for the battery to cool down and allow the vapor to dissipate.
- Avoid skin and eye contact or inhalation of vapors, or use absorbents to remove spilled liquid and incinerate it.

First aid measures for different body parts are as follows:

First aid for eyes

- Flush eyes with plenty of water for at least 15 minutes, lift the upper and lower eyelids occasionally, and seek medical assistance at the same time.

First aid for skin

- Take off the contaminated clothes, wash your skin with plenty of water or take a shower for 15 minutes and seek medical assistance at the same time.

First aid for accidental inhalation

- Move from the leakage area to a place with fresh air, and use oxygen if possible.

First aid for accidental ingestion

- Drink milk or water immediately to induce the patient to vomit, and seek medical advice immediately if the patient loses consciousness.

5.2. Fire Risk Assessment

5.2.1. General Principles

Chint's principle is to protect all people, including employees, customers and contractors, from potential injuries and health damage that may be caused by work activities.
Chint will provide and maintain a safe and healthy working environment, equipment and work system for all employees, and provide them with necessary information, training and supervision for this purpose.
Chint will pay high attention to health and safety, and comply with all statutory requirements.

5.2.2. Overview

This system mainly includes equipment such as battery, BMS, protection system (such as disconnector, fuse and DC contactor), fire protection system, thermal management system, cabinet and cable.
The fire resistance time of the container body reaches to 90 minutes, which meets the fire protection requirements of EN1364-1. The container is equipped with NOVEC1230 automatic detection, alarm and fire extinguishing system, and the whole set of fire protection system meets the regulations and certification requirements of the project district. The interior and exterior of the container are equipped with alarm bells and audible and visual alarms, and fire alarms can be seen immediately when the container door is opened and closed.
The container is non-accessible, and anyone can escape from the 20 foot container in a short time.

5.2.3. Management System

The fire safety management plan is included in the document of "**Health and Safety**". It will confirm the completion of fire risk assessment to ensure adequate fire safety and will be reviewed as necessary.
Priority will be given to any deficiencies identified during the fire risk assessment, which will be corrected properly.
Chint decides the safety protection and preventive measures for firefighting, and the customer is responsible for notifying other responsible persons.
The following requirements needs to be met:

- Make sure that these recommendations are implemented and communicated to other employees
- Ensure coordination between other responsible persons
- Fire safety shall be an agenda item at the weekly end-user manager meetings

5.2.4. Classification of Fire Sources

Table 5- 1 Nature and Types of Fire Sources

No.	Fire risks	Detailed description	Countermeasures
1	Internal short circuit	Undervoltage, overheating and bulging of battery	The system has passed the UL 9540 certification, and the racks have passed the safety test certification of IEC 62619, UL 1973 and EMC.
2	External fire source	There is a risk of battery failure and fire if the temperature exceeds 130°C	The container body is provided with a fireproof insulation layer. As long as the container is kept away from fire and heat sources.
3	External heat source		
4	External short circuit	There may be risks such as external short circuit, arc flash and fire during installation, or if the fuse is not installed properly.	Install screws according to the Installation Instruction Manual and check them thoroughly to ensure tightness.
5	Loose screw	Excessive contact resistance and heating of connections and cables	
6	Overcharge	It occurs only if the system does not detect a BMS failure, protection, parameter error or communication fault	The system complies with UL1973 standard and has software-hardware dual protection, so the risk is low.
7	Overdischarge		

5.2.5. System Security Protection

Consideration is given to five aspects: component safety, battery cell safety, electrical safety (BMS), mechanical safety and environmental safety.

Safety of parts and components

Table 5- 2 Compliance of Parts and Components with UL Standards

No.	Name of parts and components	Standard No.
1	Plastic components	UL 94-V0
2	Fuse	UL 248
4	Relay	UL 61810
5	BMS	UL 991, UL1998
6	Anti-corrosion	UL 50E

Cell safety

- The battery is designed according to UL1642, IEC62133, UN38.3 and other standards.

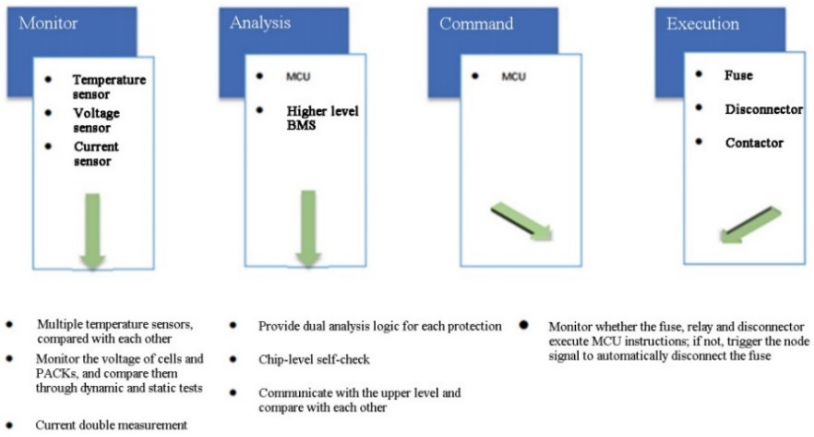
Electrical safety

Table 5- 3 Protection Thresholds (Reference)

BMS function	Detailed description	Parameter
Single cell overcharge	Overcharge voltage protection threshold	3.65V
	Overcharge protection delay time	3s
Single cell over-discharge	Over-discharge voltage protection threshold	2.50V
	Over-discharge protection delay time	3s
	Discharge recovery voltage threshold	3.0V
Battery PACK overcharge	Overcharge voltage protection threshold	189.8 V
	Overcharge protection delay time	3s
	Overcharge recovery voltage threshold	182 V
Battery PACK over-discharge	Over-discharge voltage protection threshold	130 V
	Over-discharge protection delay time	3s
	Discharge recovery voltage threshold	156 V
Overcurrent protection	Discharge overcurrent protection delay time 1	5s
	Discharge overcurrent protection 2	205A
	Discharge overcurrent protection delay time 2	500±50ms
	Charge overcurrent protection	205A
Short circuit	Short-circuit protection	-
	Protection condition	Load short circuit
	Recovery condition	Load disconnection
Overtemperature protection	Charge overtemperature protection	55℃
	Charge temperature recovery	45℃
	Discharge overtemperature protection	55℃

	Discharge temperature recovery	45℃
	Charge under temperature protection	0℃
	Charge temperature recovery	5℃
	Discharge under temperature protection	-20℃
	Discharge temperature recovery	0℃

Dual protection mechanism



Mechanical safety

- Comply with UN38.3 standard and pass static pressure, impact, dropping, installation and other tests.

Environmental safety

- Preventive measures: temperature monitoring, UL94-V0 material, metal housing, safety valve design, BMS high temperature protection, etc.

5.2.6. Fire Protection System

Fire Detection

- "Smoke detector" and "heat detector" are installed and connected to the "audible and visual alarm" by the "signal input/output module".
- When the sensitivity of smoke exceeds 2.5%/m, or the temperature rise is higher than 10°C per minute, the system may consider that there is a fire risk and will trigger the local alarm system "audible and visual alarm". Meanwhile, it is reported to the background monitoring system for remote notification.

Fire Alarm System

- There is a manual and automatic fire alarm system (including automatic smoke detectors. It will warn all persons approaching the container by the sound and light alarm when being started.
- Audible and visual alarms are set up indoor and outdoor, so that people entering and leaving the container can notice the fire alarm immediately.

Fire extinguishing system

- A sufficient number and types of fire extinguishers are arranged throughout the container system. They are adequate for the risks inside the container and are checked regularly every 6 months. For the steps of fire extinguisher examination, please refer to the 8.3 Fire Protection Maintenance Procedure.
- The automatic fire extinguishing system (containing NOVEC1230 gas extinguishing agent) complying with NFPA 2001 will be triggered automatically.
- BMS sends out signal to turn off the main switch of power supply. All fans and air conditioners will stop working to prevent fresh air from entering the container. Relief valve of the container will open when the internal pressure is greater than the external pressure by 1 MPa.
- NOVEC1230 is harmless to human body.

5.2.7. Identification of Fire Hazards

Ignition Sources

- There is no obvious ignition source in the whole container system, and smoking is prohibited in the container;

Combustion Raw Materials

- There is no fuel or a large amount of paper; there are only some paper records for maintenance.

Working Process

- No process will lead to serious fire hazard.

5.3. Emergency Measures

5.3.1. Emergency Measures

Safety assembly point will be determined by the final customer.

Measures to be taken after discovering fire are as follows:

- Use the nearest fire alarm call point to give an alarm
- Gather at the safe assembly point
- Call the fire brigade with mobile phone (after leaving the container)
- Contact the fire brigade when they arrive
- Do not try to deal with small fires even if you are confident
- Do not expose yourself to fire hazard

Measures to be taken after hearing the alarm are as follows:

- Make sure whether the alarm is true
- Gather at the safe assembly point
- Call the fire brigade with mobile phone (after leaving the building)
- Contact the fire brigade when they arrive

For visitors:

- Make sure that all visitors and contractors are taken to a secure assembly point
- Assist in the evacuation of any disabled person if necessary

The energy storage system shall be installed on the structure supported by cement foundation or channel steel, with surface made of flame-resistant materials. It is necessary to make sure that the foundation is smooth, solid, safe and reliable, and has sufficient bearing capacity. The foundation surface shall not be sunk or inclined.

6. Operating Procedures

6.1. Container Operating Procedure

1. Turn on all the control power supply inside the external distribution box (BMS, switching power supply, lighting, liquid cooling unit, fire protection, etc.), as shown in the following figure and table:

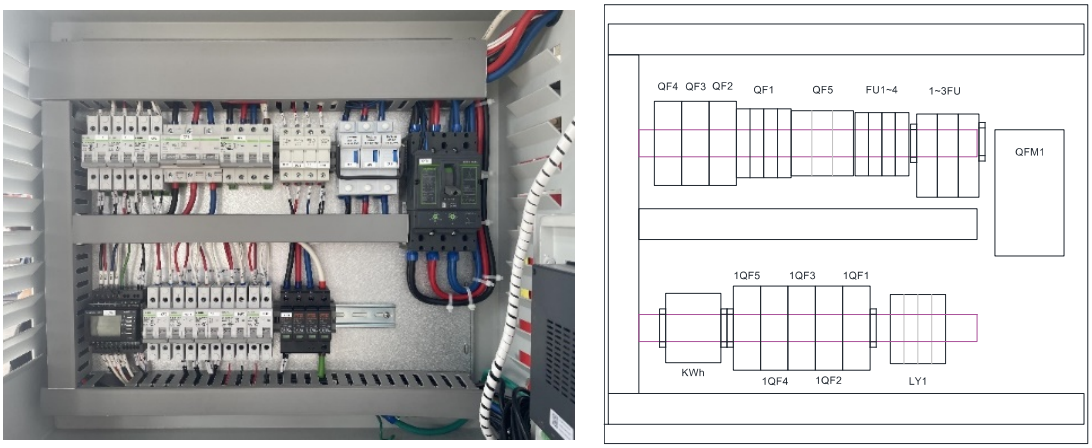


Figure 6- 1 Internal Layout of Distribution Box

Electrical Code	Electrical Component Name
QF4	Circuit breaker of equipment compartment fan power
QF3	Circuit breaker of UPS power
QF1	Circuit breaker of liquid cooling unit power
QF2	Circuit breaker of lighting power
QF5, 1QF5	Spare circuit breaker
FU1-4	DC power supply fuse protection
1-3FU	Distribution bus fuse protection
QFM1	Circuit breaker of distribution main inlet wire
KWh	Multifunctional measuring instruments
1QF4	Micro circuit breaker of firefighting equipment power
1QF3	Micro circuit breaker of DC switch power
1QF2	Micro circuit breaker 2 of BMS power
1QF1	Micro circuit breaker 1 of BMS power
LY1	Surge protective device of distribution main inlet wire

2. Turn on power supply of the control panel in the equipment compartment, and turn on the system circuit on ESMU.

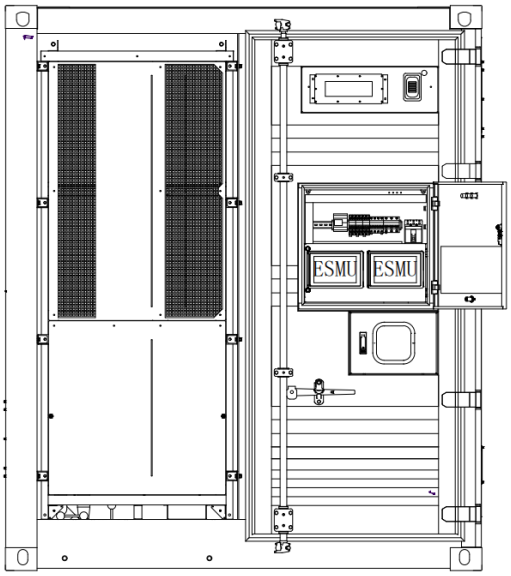


Figure 6- 2 Installation position of ESMU

6.2. BMS System Operating Procedure

6.2.1. BMS Operation Inspection

BMS shall run according to the following procedure:

1. Check whether there are system status faults in battery charge and discharge state, voltage, current, SOC, rack operation state, etc. through ESMU. The fault will be shown in “Warning info”. The main interface is shown in the figure below:

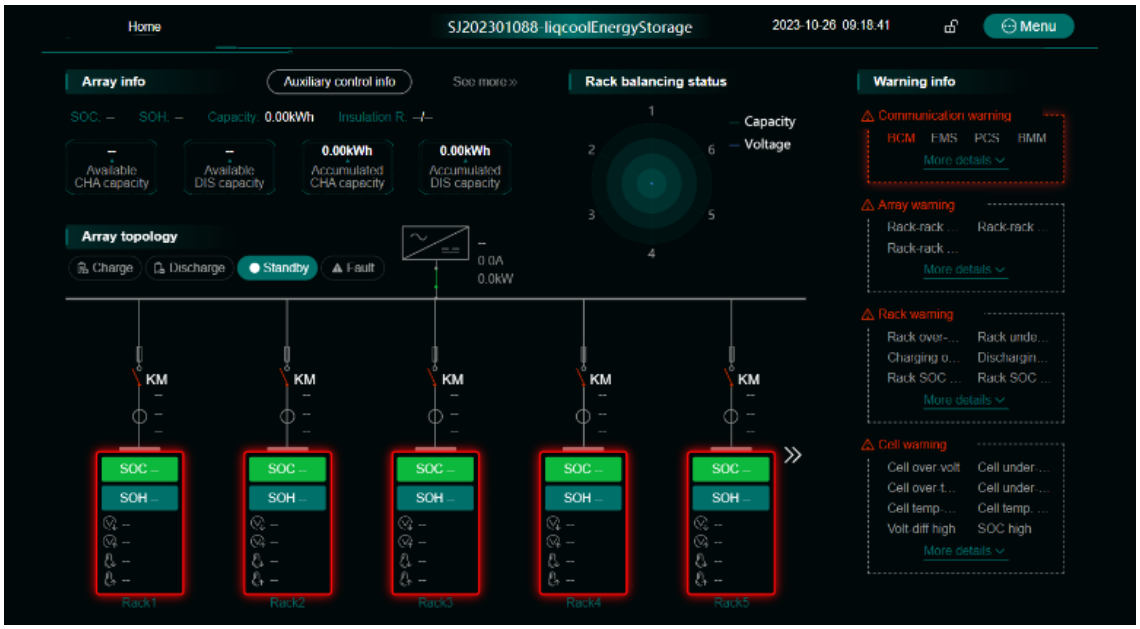


Figure 6- 3 Main Interface

2. Open “Array Info”, check the alarm history based on critical alarms and alarms that may not be sent to EMS. The alarm record interface is as follows:

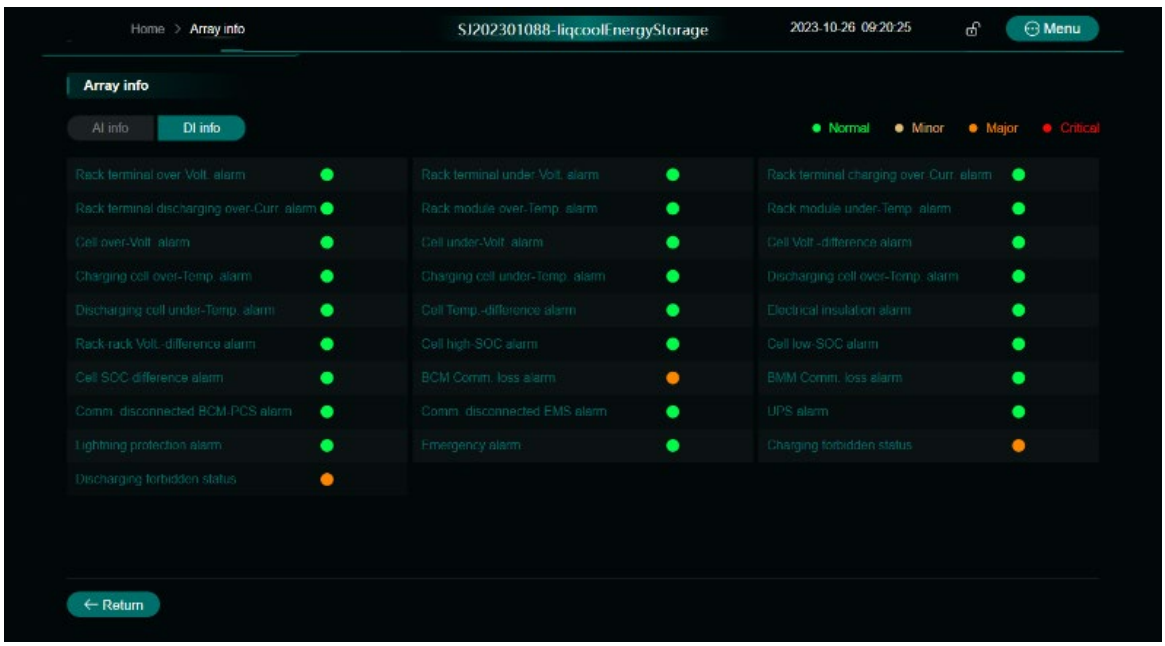
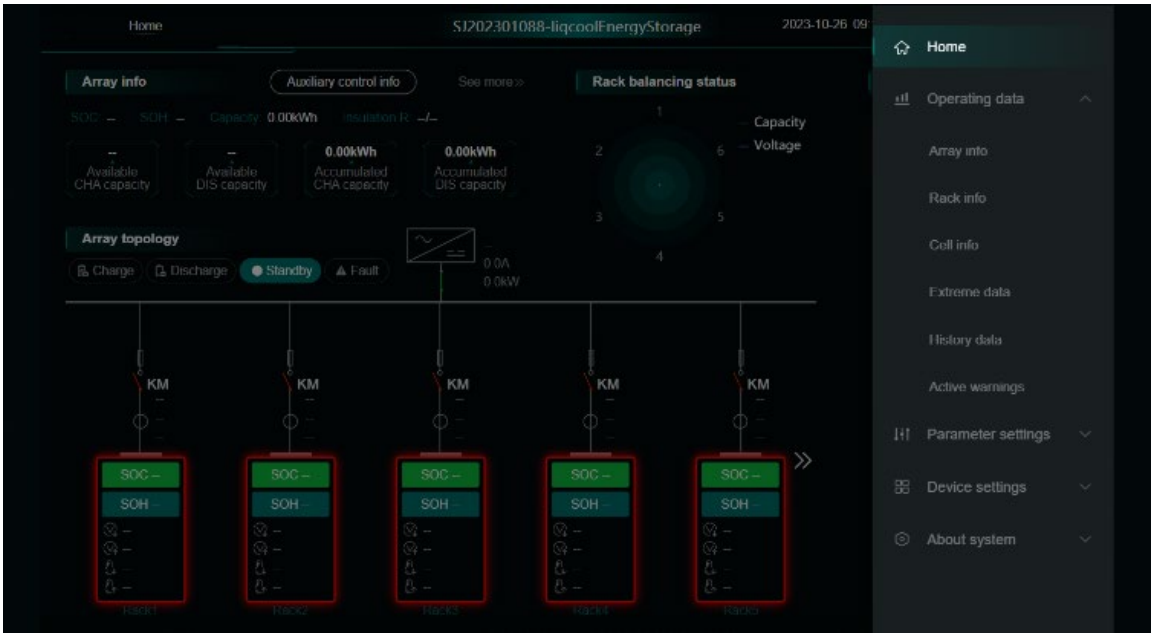


Figure 6- 4 Alarm Record Interface

3. Check the protection threshold parameter settings according to Table 5- 3 Protection Thresholds (Reference) to ensure consistency. Click the “Parameter settings” to check the settings:



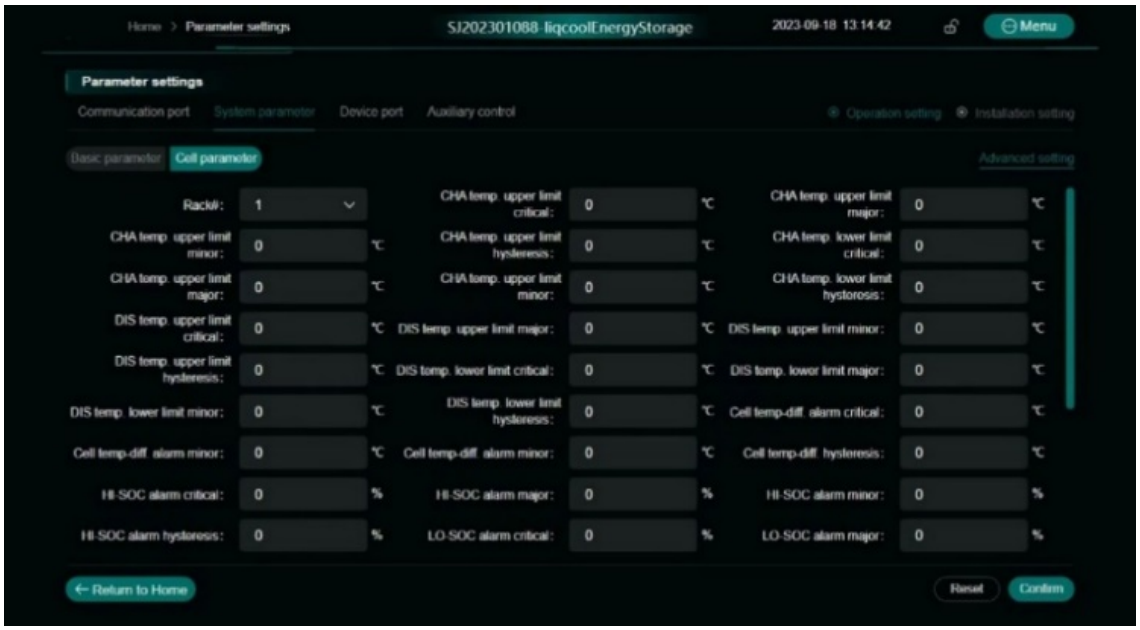


Figure 6- 5 Protection Threshold Parameter Settings

4. Check the interface with thermal management system for communication, operation state, temperature range and other faults. The interface is as follows (for reference):

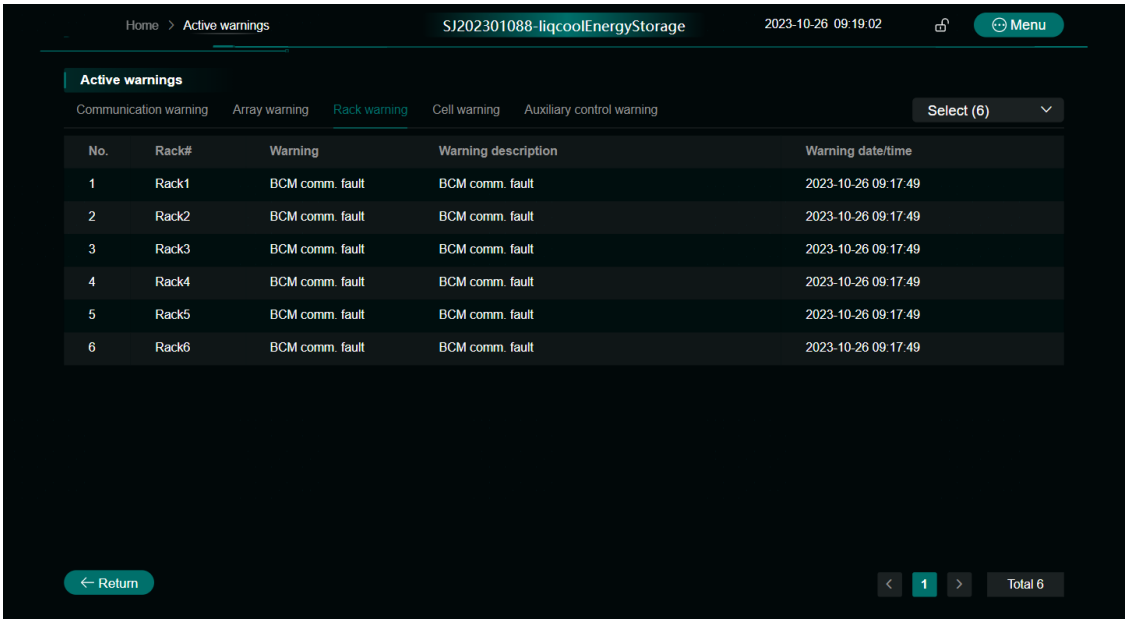


Figure 6- 6 Active Warnings

6.2.2. Automatic Calibration of BMS

The SOC of the battery system needs to be calibrated during maintenance. This calibration requires a full-charge and full-discharge process, and is an automatic process.

Full-charge process:

- When the maximum voltage in the battery PACK reaches the fully charged condition, the error judgment and correction of all individual SOC are performed by combining the current voltage distribution with charging rate and temperature. As the operating years increase and the consistency of the battery system changes, the range of set will also change accordingly.

Full-discharge process:

- When the minimum voltage in the battery PACK reaches the fully discharge condition, the error judgment and correction of all individual SOC are performed by combining the current voltage distribution with charging rate and temperature. As the operating years increase and the consistency of the battery system changes, the range of set will also change accordingly.

6.3. BMS System Test

The parameters of BMS Test may vary depending on the project.

The following tests shall be carried out once every year.

6.3.1. Communication and Control Function Test

Table 6- 1 Communication and Control Function Test

Test purpose:			
1. Normal communication between BMS and PCS, EMS shall be ensured. 2. BMS shall be able to open or close the contactor.			
Preconditions:			
Visual inspection of battery, PCS and HMI is completed.			
Test process:			
1. Check the HMI of PCS to confirm whether there is information from BMS. 2. Check the HMI of EMS to confirm whether there is information from BMS. 3. Connect all battery cluster communications in parallel to the display and control. 4. Disconnect the communication connection between battery cluster and display and control. 5. Please refer to the communication architecture diagram (Figure 3- 2).			
Test parameters:			
PCS, EMS and contactor shall provide normal response			
Test record:			
Category	**Test content**	**Test result (Pass √/Fail ×)**	**Remarks (If any)**
1	Communication between BMS and PCS		
2	Communication between BMS and EMS		
3	Connect all battery clusters in parallel to the display and control		
4	Disconnect the battery cluster from the display and control		

6.3.2. Parameter setting

Table 6- 2 Inspection of Parameter Setting

Test purpose:				
BMS parameter settings shall be correct.				
Preconditions:				
Communication and control function test has been completed.				
Test process:				
1. Check parameter settings on the HMI against the standard table. 2. Battery overvoltage protection threshold shall be 3.5V for primary level, 3.6V for secondary level, and 3.65V for tertiary level. 3. Total overvoltage protection threshold shall be 1456V for primary level, 1497.6V for secondary level, and 1518.4V for tertiary level. 4. Charge overtemperature protection threshold shall be 45°C for primary level, 50°C for secondary level and 55°C for tertiary level.				
Test parameters:				
Parameter setting on BMS				
Test record:				
Category	**Test content**	**Test data**	**Test result (Pass √/Fail ×)**	**Remarks (If any)**
1	Whether it has management authority to set parameters	**N/A**	**N/A**	
2	Setting of battery voltage protection threshold			
3	Setting of system total voltage protection threshold			
4	Setting of system charge over-temperature protection threshold			

6.3.3. Alarm and protection function test

Table 6- 3 Overvoltage Alarm and Protection Function Test

Test purpose:				
Make sure that BMS can realize the protection function in case of primary, secondary and tertiary overvoltage alarms.				
Preconditions:				
Monitoring function and accuracy test is completed				
Test process:				
1. Reset the voltage protection threshold so that the total voltage or unit voltage reaches primary, secondary and tertiary overvoltage alarms respectively. The default total primary overvoltage is 1456V, the default total secondary overvoltage is 1497.6V, and the default total tertiary overvoltage is 1518.4V. 2. An alarm shall be displayed on the display and control. 3. Check BMS for corresponding protection function.				
Test parameters:				
1. BMS shall notify PCS to reduce the operating power in case of primary overvoltage alarm. 2. BMS shall notify PCS to stop charging and discharging (with a current limit of 0) in case of secondary overvoltage alarm. 3. BMS will notify PCS to stop and disconnect the contactor with a delay of 3s in case of tertiary overvoltage alarm.				
Test record:				
Category	**Test content**	**Test data**	**Test result (Pass √/Fail ×)**	**Remarks (If any)**
1	Display and control alarm display	N/A		
2	With primary overvoltage alarm protection function			
3	With secondary overvoltage alarm protection function			
4	With tertiary overvoltage alarm protection function			

Table 6- 4 Undervoltage Alarm and Protection Function Test

Test purpose:				
Make sure that BMS can realize the protection function in case of primary, secondary and tertiary undervoltage alarms				
Preconditions:				
Monitoring function and accuracy test is completed				
Test process:				
1. Reset the voltage protection threshold so that the total voltage or unit voltage reaches primary, secondary and tertiary undervoltage alarms respectively. The default total primary voltage is 1248V, the default total secondary voltage is 1164.8V, and the default total tertiary voltage is 1040V 2. An alarm shall be displayed on the display and control. 3. Check BMS for corresponding protection function.				
Test parameters:				
1. BMS shall notify PCS to reduce the operating power in case of primary undervoltage alarm. 2. BMS shall notify PCS to stop charging and discharging (with a current limit of 0) in case of secondary undervoltage alarm. 3. BMS shall notify PCS to stop and disconnect the contactor with a delay of 3s in case of tertiary undervoltage alarm.				
Test record:				
Category	**Test content**	**Test data**	**Test result (Pass √/Fail ×)**	**Remarks (If any)**
1	Display and control alarm display	N/A		
2	With primary undervoltage alarm protection function			
3	With secondary undervoltage alarm protection function			
4	With tertiary undervoltage alarm protection function			

Table 6- 5 Overcurrent Alarm and Protection Function Test

Test purpose:				
Make sure that BMS can realize the protection function in case of secondary and tertiary overcurrent alarms				
Preconditions:				
Monitoring function and accuracy test is completed				
Test process:				
1. Reset the current protection threshold so that the current reaches the secondary and tertiary overcurrent alarms respectively. The default primary overcharge current is 185A, the default secondary overcharge current is 195A and the default tertiary overcharge current is 205A. 2. An alarm shall be displayed on the display and control. 3. Check BMS for corresponding protection function.				
Test parameters:				
1. BMS shall notify PCS to stop charging and discharging (with a current limit of 0) in case of secondary overcurrent alarm. 2. BMS shall notify PCS to stop and disconnect the contactor with a delay of 3s in case of tertiary overcurrent alarm.				
Test record:				
Category	**Test content**	**Test data**	**Test result (Pass √/Fail ×)**	**Remarks (If any)**
1	Display and control alarm display	N/A		
2	Realization of secondary overcharge current alarm protection function			
3	Realization of tertiary overcharge current alarm protection function			

Table 6- 6 Over-temperature Alarm and Protection Function Test

Test purpose:				
Make sure that BMS can realize the protection function in case of primary, secondary and tertiary over-temperature alarms				
Preconditions:				
Monitoring function and accuracy test is completed				
Test process:				
1. Reset the temperature protection threshold so that the temperature reaches primary, secondary and tertiary overtemperature alarms respectively. The default primary overcharge temperature is 45°C, the default secondary overcharge temperature is 50°C, and the default tertiary overcharge temperature is 55°C. 2. An alarm shall be displayed on the display and control. 3. Check BMS for corresponding protection function.				
Test parameters:				
1. BMS shall notify PCS to reduce the operating power in case of primary over-temperature alarm. 2. BMS shall notify PCS to stop charging and discharging (with a current limit of 0) in case of secondary over-temperature alarm. 3. BMS will notify PCS to stop and disconnect the contactor with a delay of 5s in case of tertiary over-temperature alarm.				
Test record:				
Category	**Test content**	**Test data**	**Test result (Pass √/Fail ×)**	**Remarks (If any)**
1	Display and control alarm display	N/A		
2	Realization of the protection function in case of a primary over-temperature alarm		According to ambient temperature	
3	Realization of the protection function in case of a secondary over-temperature alarm		According to ambient temperature	
4	Realization of the protection function in case of a tertiary over-temperature alarm		According to ambient temperature	

7. Troubleshooting

- BESS is a HV DC system and can only be operated by qualified and authorized personnel!
- Make sure to check the inverter and all cables of BMS for correct connection and settings and check the BESS system for normal startup before checking for fault.

7.1. Troubleshooting of BMS

Table 7- 1 Faults and Solutions

No.	Faults	Solutions
1	The display and control cannot work normally after start-up	Record the fault and restart the power supply.
2	No data can be retrieved on the display and control screen	Check the BMS cable for proper connection and the battery cluster for correct IP address.
3	Contactors on the display and control interface fail to close	Check whether the voltage difference between battery clusters is greater than 5V, and BMS will start the protection program at this time.
4	Total voltage of a single battery cluster is too low, and ESBMM is disconnected	Check the 24V line of ESBMM for correct connection; replace the ESBMM module and check it for recovery to normal status.
5	Abnormal voltage sampling of battery cell	Remove the battery PACK and check whether the sampling fuse is blown; replace the ESBMM module and check it for recovery to normal status.
6	ESBMM does not perform balancing function	Remove the battery PACK and check whether the sampling fuse is blown; replace the ESBMM module and check it for recovery to normal status.
7	The ESMU shows that the total voltage of the cluster is normal, but there is no current or three times the current during charging and discharging	Check the cluster circuit for increased contact resistance; battery PACK for tightness; the fuse at DC confluence for damage; the battery PACK for increased internal resistance, and for voltage within the normal range.

7.2. Battery PACK Replacement

The following requirements must be met before battery PACK replacement:

- This battery system is a HV DC system and can only be operated by qualified and authorized personnel.
- Make sure to disconnect main circuit of the maintenance battery cluster before replacing the main components.
- All components can only be repaired and replaced by qualified personnel, and can only be replaced with approved materials, components and parts.

Please refer to the following steps for replacing battery PACK:

1. Disconnect the switch of PCS DC side;
2. Turn off the BMS system, disconnect the isolating switch and make sure that the high-voltage box is powered off (as shown in the figure below);

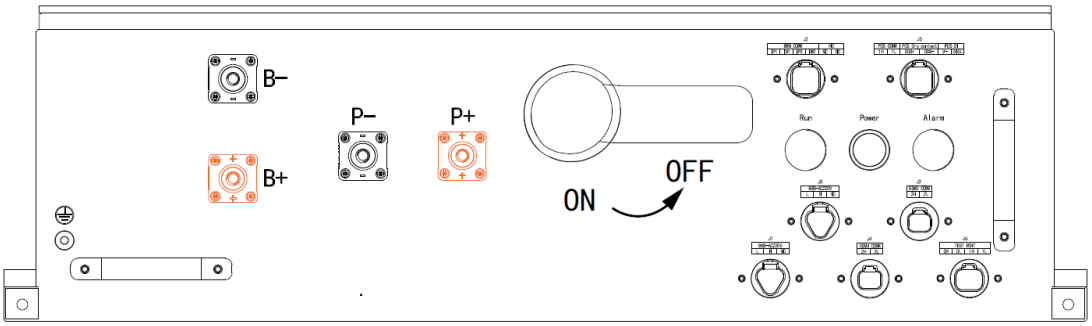


Figure 7- 1 Isolating switch

3. Find the faulty battery PACK, locate the faulty battery PACK and pull out the MSD (1). As shown below:

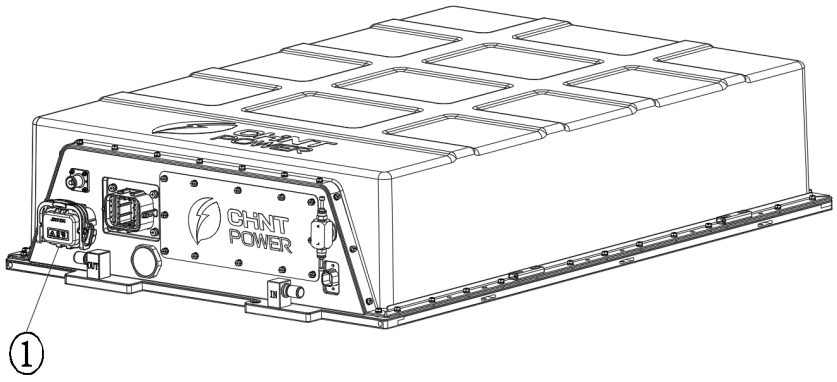


Figure 7- 2 MSD

4. Remove connecting cables (1, 2). As shown in the following figure:

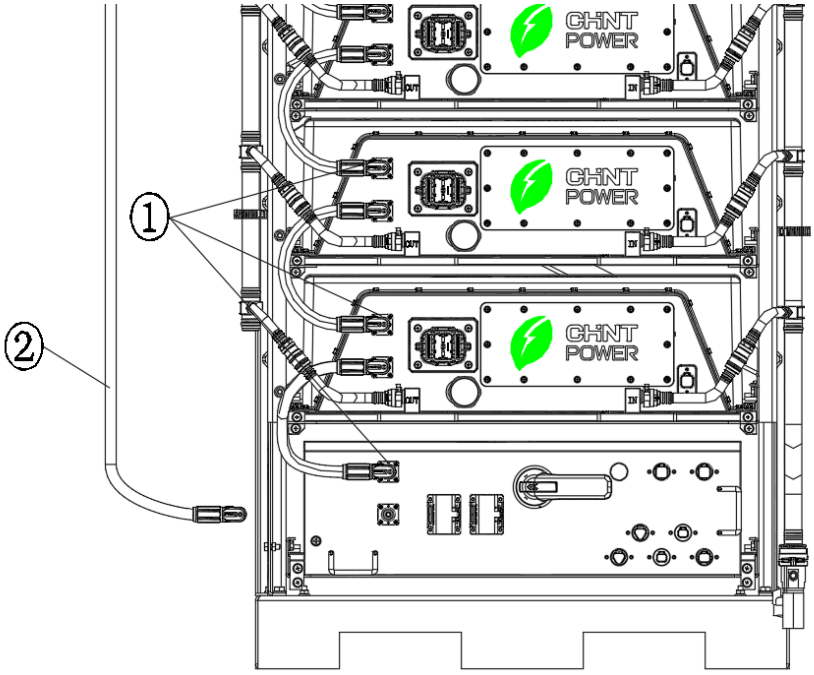


Figure 7- 3 Remove the connecting cable

5. Remove the communication harness;
6. Close the valve (1) on the Liquid cooling pipeline;

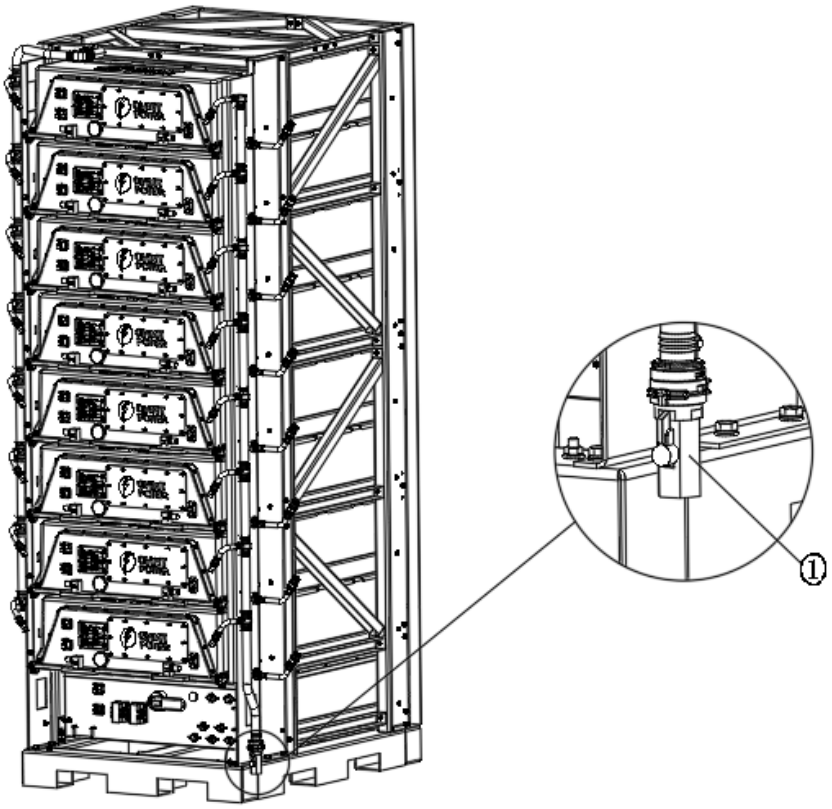


Figure 7- 4 Close the valve

7. Remove the coolant input pipeline (1) and output pipeline (2), drain the remain coolant in the pipelines, and place the disassembled components in designated positions.

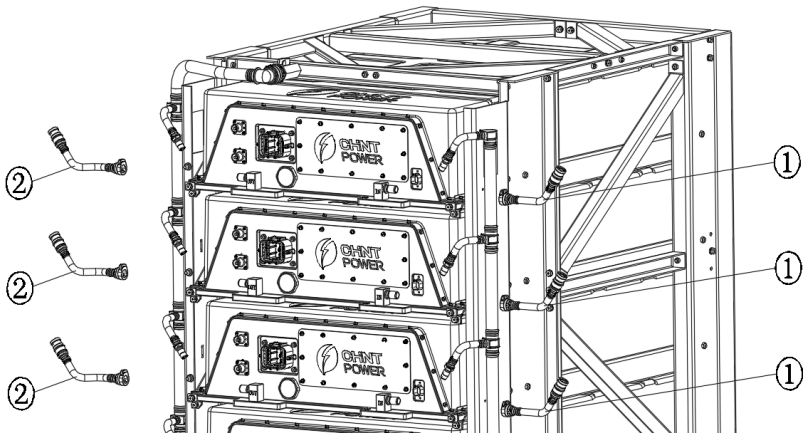


Figure 7- 5 Remove the coolant pipeline

8. Remove the 4 screws (1) fixed on the side beam of battery PACK, and place them in the specified position. As shown in the following figure:

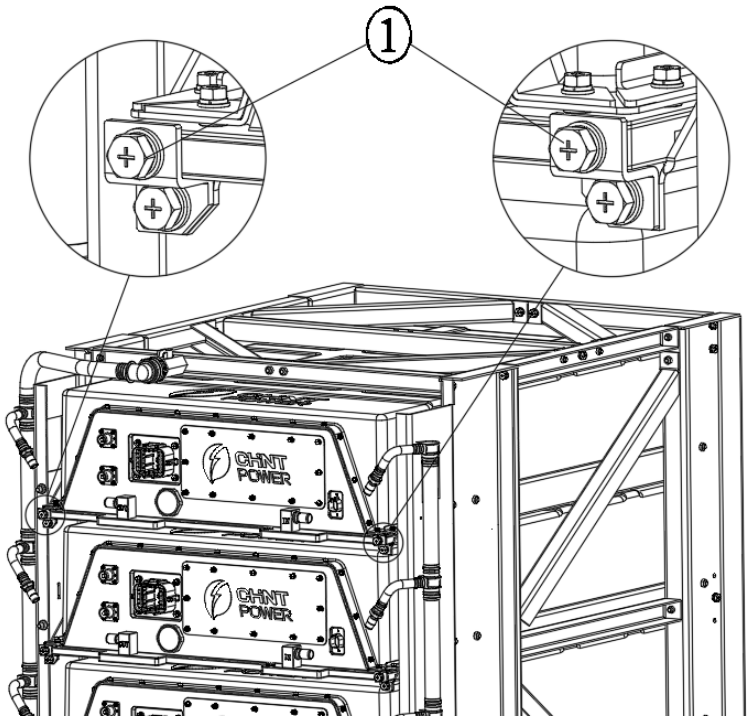


Figure 7- 6 Remove the screw

9. Remove the battery PACK from the battery rack: secure it on the threaded hole of the battery PACK side beam using a wristband or a special tool as shown in the figure, and pull it out to a distance of approximately 50cm. Protective measures shall be taken during handling to prevent falling of personnel or battery PACK. As shown in the following figure:

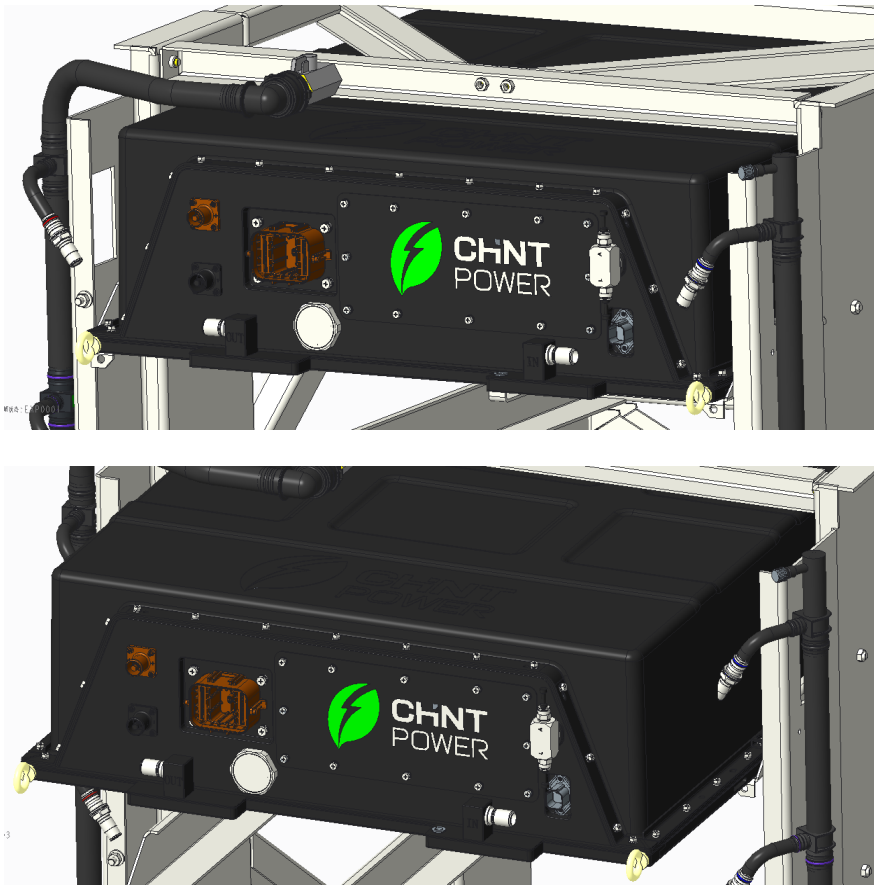


Figure 7- 7 Remove the battery PACK

10. Place the battery PACK on the lifting tool, move the special forklift with a roller worktable or platform to the bottom of the target battery PACK, move the battery PACK onto the platform, and completely pull it out from the rack. As shown in the following figure:

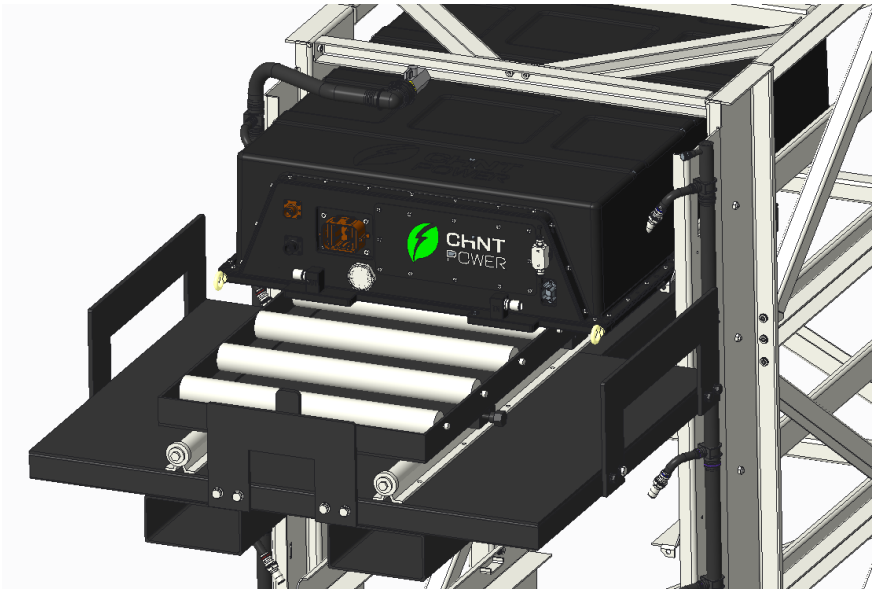


Figure 7- 8 Place the battery PACK on the lifting tool

Figure 7- 9 Forklift

11. Install a new battery PACK and reconnect the system according to the Installation Manual. Pay attention to the following when replacing with a new battery PACK:
    - Before installing the new battery PACK, please verify whether the capacity of the battery PACK matches the system: if they match, proceed with direct replacement; if they do not match, consult a battery PACK engineer.
    - After the installation of the new battery PACK, power on the system, and then confirm the status information of the target battery PACK through the display and control interface to determine if the fault has been resolved or proceed with the next step of operation. Please contact professionals or manufacturers for handling if there is any other abnormal information.

7.3. Troubleshooting of Liquid Cooling Unit

- The liquid cooling unit is a professional equipment and can only be operated by qualified and authorized personnel.
- The power supply and communication must be cut off before the replacement of main components.
- All components can only be repaired and replaced by qualified personnel, and can only be replaced with approved materials, components and parts.

Table 7- 2 Troubleshooting of liquid cooling unit

Fault	Possible Cause	Inspection Item or Treatment Method
The external circulation fan does not run	The water cooling unit is not powered on	Check whether the power input end of water cooling unit is energized.
	Circuit breaker is tripped due to lightning stroke	Check whether the circuit breaker inside the water cooling unit is closed.
	Abnormal power input is detected in the water cooling unit (such as overvoltage or undervoltage)	Confirm whether the water cooling unit has corresponding alarms, and if so, handle them according to the instructions of the water cooling unit.
	The fan is stuck	Check whether the fan is stuck by foreign matters.
	The terminal is loose	Check whether the butt terminal of fan is loose.
	Compressor is not started	Refer to the handling method for compressor not started in the instructions of water cooling unit
	Control panel fault	Replace the control panel according to the instructions of water cooling unit.
	Fan fault	Replace the fan, and replace the external circulation fan according to the instructions of water cooling unit
External circulation fan generates abnormal sound	The fan bearing is worn	Replace the fan, and replace the external circulation fan according to the instructions of water cooling unit
	The fan blade scratches other objects	Check for interference between cables and fan blades.
Compressor is not started	It is not powered on (in standby state)	Check the main power switch and the operation display interface to see whether the compressor is started.
	Circuit connection is loose	Tighten the circuit connector.
	Open or short circuit	Check the circuit for open or short circuit, and repair the main power supply.
	Converter fault	Replace the converter.

Fault	Possible Cause	Inspection Item or Treatment Method
	Control panel damage	Replace the control panel according to the instructions of water cooling unit.
	Compressor motor fault	Replace the compressor
The compressor does not work	There is no need for cooling	Check the output status of outlet liquid temperature compressor on the display screen interface. Check whether the operation interface is in cooling state.
	Shutdown delay	The compressor has the shortest shutdown time under normal conditions. If the temperature rises to the starting point again during this period, the compressor will still be started with a delay.
High exhaust pressure	The condenser is blocked by dirt	Clean the condenser with compressed air or a vacuum cleaner equipped with a brush head.
	The external circulation fan does not work	Refer to the above table.
Internal circulating water pump does not start	It is not powered on (in standby state)	Check the main power switch and the operation display interface to see whether the compressor is started.
	Circuit connection is loose	Tighten the circuit connector.
	Pump converter fault	Replace the pump converter.
	Pump is in a self-protection state due to no coolant	Check whether there is coolant in the circulation system. If not, replenish it.
	Pump body fault	Replace the water pump. Replace the pump according to the instructions of the water cooling unit.
The electric heating tube does not work	No heating demand is required	Check whether the outlet temperature and heating setpoint are reasonably set.
	Circuit connection is loose	Tighten the circuit connector.
	Overheating protection is activated	Wait for a period of time and restart the electric heater to observe whether it works normally.
	Electric heater fault	Replace the electric heater. Replace the heater and circulating water pump according to the instructions of the water cooling unit.
The automatic topping up pump does not work	Topping up pump fault	Replace the automatic topping up pump.
	The topping up pump is stuck.	Check whether there are foreign matters in the topping up pump, and remove them if any. Replace the topping up pump if it is damaged.
	The terminal is loose	Check whether the butt terminal of topping up pump is loose.

Fault	Possible Cause	Inspection Item or Treatment Method
Automatic topping up pump makes abnormal sounds during operation	Axial of topping up pump is worn	Replace the automatic topping up pump.
	Fixing screw of the topping up pump is loose	Tighten screws.

7.4. Spare Parts

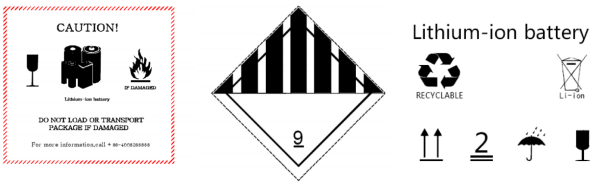
A list of spare parts shall be prepared during minor repairs and minor equipment maintenance in order to ensure daily operation and maintenance of the energy storage system. It is necessary to communicate with customers to clarify the list of spare parts in the early stage of the Project. Spare parts can be purchased by customers and kept in warehouse, which will not be listed in this Manual for the time being.

7.5. System Processing

The energy storage system shall be decommissioned and disposed of at the end of their service life in the manner determined by its Owner according to local regulations on or requirements for waste disposal or recycling.

Observe following instructions if the battery PACK is physically damaged, smoked, burnt out or expires:

- Keep the battery PACK still for 24 hours to prevent further danger;
- Make sure that the battery PACK temperature is not higher than the ambient temperature;
- Wear insulating gloves when handling the battery PACK;
- Provide external insulation to the battery PACK during transportation;
- Make sure that the disconnector of high-voltage box is turned off;
- Make sure that there is an original plastic cover at the battery PACK output terminal for protection/heat insulation;
- Pack the battery PACK into a plastic bag;
- Fix the battery PACK to avoid further vibration and impact;
- Prevent the battery PACK from being wetted by rain or water.



8. Performance Maintenance

- The operation and maintenance of battery PACKs, liquid cooling units and fire suppression systems must be carried out by qualified and authorized personnel.
- The system must be shut down before some maintenance items.

The system which has been running for more than six months or does not run for a long time shall receive a safety maintenance, and corresponding records shall be kept. The specific items are as follows:

1. Check whether the safety door, main door and battery cabinet door of the container can be opened normally to ensure a clean and tidy environment inside and outside the container;
2. Check whether the fire suppression system can give an alarm and start normally, and whether there is fire protection equipment around the container for emergency use in case of accidents;
3. Check whether each power line is insulated abnormally, whether the electrical safety clearance reaches the safety standard, and whether the wiring bolts are loose;
4. Check whether the electrical components are normal and whether the power supply doors can be disconnected effectively

8.1. Battery PACK Maintenance Procedure

Table 8- 1 Battery PACK Maintenance Procedure

Maintenance frequency	Category	Maintenance content	Remarks
Quarterly	Voltage inspection	Check the voltage of battery system with a monitoring system. Check for normal system voltage. For example, whether the voltage of a single battery PACK is too high or too low.	
	SOC inspection	Check the SOC of the battery system through the monitoring system. Check the battery PACK for normal SOC.	
	Cable inspection	Visually inspect all cables of the battery system. Check for broken, aged or loose cable.	
	Balance inspection	The battery PACK will be unbalanced after long-term incomplete charging. Solution: Balanced maintenance shall be carried out every 3 months (until the battery PACK is fully charged), which is completed automatically by the communication between the system and external equipment under normal circumstances.	
	Output relay inspection	The output relay is turned off and on under low load conditions (low current), and the relay can be disconnected and connected normally if a click sound is heard.	
	Inspection of historical records	Analyze the historical records, check for accident (alarm and protection), and analyze its cause.	

Maintenance frequency	Category	Maintenance content	Remarks
Semi-annually	Dust inspection	Keep the battery cabinet clean.	
	Temperature	Measure and record the ambient temperature in the battery cabinet.	
	Appearance	Check the appearance cleanliness of each battery PACK; check terminals and terminal covers for damage or overheating.	
	Voltage	Check the voltage of battery system with a monitoring system. Check for normal system voltage. For example, whether the voltage of a single battery PACK is too high or too low.	
	Shutdown and maintenance	It is necessary to maintain some system functions every 6 months during the restart of network management.	
Annually	Repeat	Repeat the quarterly maintenance and inspection.	
	Tightness inspection	Check each cable connector for looseness every year and tighten the loose ones.	
	Discharge test	Perform discharge test once a year under accurate load, and the discharge capacity is 30-40% of the rated capacity. Carry out the 80% DOD capacity test once a year after three-year's operation. The BESS system shall be fully charged prior to the discharge test.	

Table 8- 2 Record of capacity test results

No.	Discharge current	Discharge time	System capacity	SOH

8.2. Maintenance Procedure for Liquid Cooling Unit

Table 8- 3 Maintenance Procedure for Liquid Cooling Unit

Frequency	Category	Maintenance standard	Test method	Treatment
Quarterly	Appearance of unit	The unit is clean and free of dust and dirt;	Visual inspection	Remove dust and dirt from the unit with a brush or cotton cloth 10 minutes after power failure.
	Reliability of fan operation	The fan is free from dust, and there are no obstructions at the air outlet.	Visual inspection	Clean the dust on the fan with a brush 10 minutes after power failure. Clear the obstacles at the air outlet.
	Condenser cleaning	The condenser is not blocked by dust and foreign matters	Visual inspection	Clean the condenser with compressed air or a vacuum cleaner equipped with a brush 10 minutes after power failure.
		The fin is free of serious bending deformation.	Visual inspection	Correct with tools such as fin comb 10 minutes after power failure.
Semi-annually	Reliability of power cables and terminals on the wiring panel	Electrical cables and wiring terminals are not loose.	Visual inspection	Tighten the loose cable with a screwdriver 10 minutes after power failure.
		Electrical cables are free of aging, damage, abnormal heating and other abnormalities.	Visual inspection	Replace the power cable 10 minutes after power failure.
		Wiring panel is free of dust	Visual inspection	Clean the dust with a brush 10 minutes after power failure.
	Reliable operation of fan	The fan blades are not damaged, and the fan rotates smoothly without abnormal sound.	Visual inspection	Tighten the fan 10 minutes after power failure, and check whether there are internal cables interfering with the rotation of the fan. If the fan fails, replace it.
	Coolant	1. The concentration meets the range requirements 2. PH and electrolyte concentrations meet the requirements 3. No dirt, sediment and algae is detected	1. Coolant detector 2. Visual inspection	Replace the coolant 10 minutes after power failure.

8.3. Fire Protection Maintenance Procedure

Table 8- 4 Fire Protection Maintenance Procedure

Frequency	Category	Maintenance content	Remarks
Daily	Signboard inspection	Check warning signs in the protection area, including those of manual starter, emergency stop switch and manual/automatic change-over switch (emergency service switch), to confirm that all of them are in their original positions, installed firmly, and not damaged.	
	Control panel	Check the control panel and confirm that it works normally. If there is a fault signal on the control panel, notify the professional company in charge of maintenance for inspection.	
	Control switch	Check whether the manual starter, emergency stop switch and manual/automatic change-over switch are in their original positions and in normal working conditions.	
	Gas extinguishing cylinder	Check the electromagnetic starter of selector valve, starter connector and emergency mechanical starter for normal operating conditions; Check the pressure switch for secure installation and normal operating conditions; Check whether the pressure gauge of each cylinder is within the green normal pressure range; Check the electromagnetic starter, starter connector and emergency mechanical starter of each active cylinder for normal operating conditions.	
Monthly	Repeat	Repeat the routine maintenance and inspection.	
	Equipment tightness	Check whether all equipment that keeps the tightness of protection area is intact. Fire damper and other linkage equipment shall be subject to a linkage test every six months.	
	Cylinder	Use a pressure gauge to test the cylinder pressure every six months to check whether indication of the pressure gauge on the cylinder head valve is accurate; Remove the electromagnetic starter, emergency mechanical starter and high-pressure release hose from the cylinder head valve before pressure measurement; Re-install them to the cylinder head valve after the pressure measurement if it is confirmed that the control panel works normally.	

Frequency	Category	Maintenance content	Remarks
Annually	Repeat	Repeat the monthly maintenance and inspection.	
	Integrity of protection area	Investigate whether the protection area is consistent with the originally designed system protection area and whether the integrity of the protection area is damaged.	
	Sprinkler/nozzle	Check all nozzles to confirm that they are in the original positions, and the pressure relief device is in the original position and its size and opening diameter is the same as that originally designed. Check the nozzle for corrosion and damage, and confirm that the nozzle is not blocked inside or outside.	
	Pipeline	Check condition of the pipe network, confirm that the pipe network is fastened on the support, and all pipe fittings and fasteners are connected firmly, and prepare a pipeline purging scheme according to the actual situation on site.	
	Cylinder support	Check all cylinder supports and confirm that all cylinders are installed firmly on the supports. Check for corroded, damaged or missing parts.	
	High-pressure release hose	Check the condition of all cylinder high-pressure release hoses. Look for signs of structural issues such as wear or aging, and verify that all hose connections are secure and in good condition.	
	Starter	Check the electromagnetic starter and mechanical starter for complete functions.	
	Control panel	Check the control panel for changes, corrosion or damage. Test the control panel according to the corresponding control panel operation manual.	
	Detector	Check all detectors to confirm that they are in place, clean and undamaged. Test all detectors in accordance with debugging requirements. Test the sensitivity of each detector according to the procedures of the detector manufacturer if necessary.	
	Warning indicator	Check each buzzer, flashing light and alarm bell. Check the alarm condition and verify that it can operate correctly when being energized. Reset the alarm circuit after each alarm device is tested.	
	Operating mode	Perform a simulation test on the overall system in three operating modes, and make sure that all tests meet the system debugging requirements.	

Table 8- 5 Fire Protection Maintenance Records

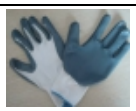
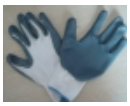
No.	Equipment name	Description	Maintenance personnel	Maintenance date

Annex 1 Safety Training Record Form

Customer name		Training place	
Training purpose		Contact number	
Trainer		Training time	
Training contents			
Basic requirements	• Wear PPE before entering the site. • Installation personnel on site shall not use metal accessories (i.e. watches and necklaces). • Special types of construction projects must be carried out by the holder within his/her scope of work.		
Battery PACK handling	• Do not make the battery PACK short-circuited. • Do not use the wire rope as a means of transportation. • Do not pull the battery PACK terminal forcibly. • Handle with care. Avoid the strong impact and vibration. Do not place the battery PACK upside down. Do not throw the battery PACK. Do not expose the battery to the sun and rain.		
Battery PACK installation	• Check each battery PACK visually and find defects in time. • Place the battery PACK in strict accordance with the supervisor's instructions. Note the terminal position. • Handle with care to ensure the personal safety and not damage the battery PACK.		
Battery PACK connection	• Insulate the wrench and other metal tools to prevent short circuit when falling. • The supervisor should pay strict attention to the battery PACK connection to avoid short circuit. • Make sure that all the bolts on the battery PACK are tightened.		
Overall	• Install a protective cover on the cable in time. • Clearly mark on the battery: Electrified Equipment • Do not construct around the battery PACK. If it is inevitable, wrap the battery PACK with the insulating plastic cloth before construction, so as not to damage it.		
Signature:			
If the above requirements can be met, please sign here:			

Note: If an accident occurs due to improper operations, the company does not assume any responsibility.

Annex 2 List of Personal Protective Equipment (PPE)

Category	Sample	Qty.	Requirements	Remarks
Safety helmet			Your hard hats must meet one of the two types: • TYPE I: Protects the top of the head; • TYPE 2: Protects both the top and the sides of the head. Your hard hats must meet with one of the three classes: • CLASS G: These are general hard hats rated for 2,200 volts. • CLASS E: These are electrical hard hats rated for 20,000 volts. • CLASS C: These are conductive hard hats, and they do not offer electrical protection at all	
Electrician's clothes			Service personnel on site shall wear electrician's clothes.	
Protective shoes			Wear protective shoes during battery PACK transportation and installation. Service personnel on site shall wear protective shoes.	
Insulating gloves	 		Maintenance personnel on site shall wear insulating gloves.	Grid: 480V
Insulating gloves			Maintenance personnel on site shall wear insulating gloves.	Battery: 1500V
Masks			Service personnel on site shall wear masks	

Note: Other types of PPE and their corresponding quantity depend on the requirements on site.

Annex 3 List of Tools

S/N	Name	Material	Specification	Sample	Qty.	Remarks	Calibration date	Term of validity
1	Laptop	/	/		2	Important tools		
2	Tape measure	Steel	5m		1	Important tools		
3	Wrench (Insulation)	Stainless steel	1 complete set		1	Important tools		
4	Socket wrench (Insulation)	Stainless steel	1 complete set		1	Important tools		
5	Insulation torque Wrench	Stainless steel	1 complete set		2	Important tools		
6	Screwdriver	Stainless steel	1 complete set		1	Important tools		
7	Gradiometer (Gradienter)	Aluminum alloy	1000mm		1	Important tools		
8	Electric wrench				1	Important tools		
9	Electric drill				1	Important tools		
10	Multimeter DC 2000V				1	Important tools		
11	Battery tester		HIOKI 3564		1			
12	Lift truck							

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