GUIDANCE NOTES
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CHINA CLASSIFICATION SOCIETY

GUIDELINES FOR SURVEYS OF PURE BATTERY-POWERED SHIPS

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CONTENTS

CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 Application

1.1.1.1 The *Guidelines for Surveys of Pure Battery-Powered Ships* (hereinafter referred to as "the Guidelines") apply to the design, construction and survey of ships that use batteries as propulsion power supply as well as test and survey of the batteries and the associated battery management system(BMS). For hybrid powered electric ships, the applicable parts of the Guidelines may also be referred to.

1.1.1.2 Batteries mentioned in the Guidelines include lithium-ion batteries and high energy density super-capacitors, which could be used as propulsion power supply, main power supply, emergency power supply, backup power supply, starting power supply and other auxiliary power supply.

1.1.1.3 The Guidelines are applicable to ships the hull of which is constructed with steel or aluminium alloy materials.

1.1.1.4 Battery management system mentioned in the Guidelines includes capacitor management system.

1.1.1.5 Those that are not covered in the Guidelines are to meet relevant requirements in corresponding CCS rules.

Section 2 CLASS NOTATIONS

1.2.1 Class notations

1.2.1.1 Where only batteries are used as propulsion power during ship's normal operation and relevant requirements in the Guidelines are complied with, the following class notation may be assigned upon the request of the ship owners:

Battery (Power)

Section 3 DEFINITIONS

1.3.1 Definitions and terms

1.3.1.1 For definitions of terms such as product survey, approval, type test, sample, unit/ batch survey, see 3.1.2 of Chapter 3 of PART ONE of CCS *Rules for Classification of Sea-Going Steel Ships*.

1.3.1.2 Batch: Specifically refers to products with the same specification produced with the same production technology in the same production line by the same manufacturer.

1.3.1.3 Definitions and terms included in the Guidelines are as follows:

(1) Lithium-ion Battery means the batteries that use lithium-ion as conductive ion, which moves between positive and negative poles. Their charge and discharge are realized through mutual

transformation of chemical energy and electric energy.

(2) High Energy Density Supercapacitor means the capacitor mainly used for high energy input and output, combining double electric layers and redox reaction in positive pole and/or negative pole to realize energy storage, characterized by high energy density.

(3) Battery cell means the smallest structural unit in one battery, as a basic unit device that directly turns chemical energy into electric energy, including electrodes, diaphragm, electrolyte, shell and terminals (also called pole terminals).

(4) Battery module means the combination unit where more than one battery cells are combined in series connection, parallel connection or series-parallel mixed connection. This connection unit only has one pair of positive and negative pole output terminals, and is used as power supply.

(5) Battery pack is made up of one or more battery cells or battery modules in series or parallel connection as per voltage or power requirement. Battery pack is to include monitor circuit that provides information (such as voltage, temperature, etc) for the battery system.

(6) Battery management system (BMS) means the electric device that controls or manages battery system's electric or thermal performance.

(7) Battery system means energy storage devices, including integration of battery modules or battery packs, battery management system, high voltage circuit, low voltage circuit, cooling devices(if applicable) and mechanical assembly.

(8) Battery Capacity (C) means the capacity of battery's stored electric quantity. Rated battery capacity normally is battery capacity provided by the companies (Under room temperature, when storage battery discharges at constant current I_X(A), it could continuously work for X hours).

(9) State of health (SOH): The degree of deviation of battery's current performance from normal design index.

(10) State-of-charge (SOC): The percentage of the capacity allowed to be released as per discharge condition stipulated by the manufacturers to the actual capacity of current battery cell, module, battery pack or system, also called remaining capacity.

(11) Thermal runaway: The phenomenon of chain reaction of uncontrollable rising of temperature of batteries trigged by battery cell's heat release.

(12) Thermal runaway propagation: The phenomenon of one battery cell's thermal runaway causing remaining battery cells to also have thermal runaway in a row inside battery pack or system.

(13) Room temperature (RT): 25℃±2℃.

(14) Failure Mode & Effects Analysis (FMEA): A systematic program that analyzes the system to identify potential failure modes, failure causes and their effects on system performance (including component, system or process performance).

Section 4 PLANS AND DOCUMENTS

1.4.1 Plans and documents needed for battery cell survey

1.4.1.1 When approving battery cells, the following plans and documents are to be submitted to CCS for approval:

(1) General plan;

(2) Detailed drawings of main parts, including: enclosures, pole plates, etc;

(3) Product technical conditions or technical specifications;
(4) Type test program.

1.4.1.2 When approving battery cells, the following plans and documents are to be submitted to CCS for information:
(1) Main raw material list;
(2) Summary of key production processes;
(3) Operation and maintenance instructions for the products;
(4) Risk assessment report of batteries.

1.4.2 Plans and documents needed for battery module/battery pack survey

1.4.2.1 When approving battery module/ battery pack, the following plans and documents are to be submitted for CCS approval:
(1) General plan;
(2) Electrical schematic diagram;
(3) Arrangement plan of monitor sensor;
(4) External interface plan;
(5) Type test program;
(6) Product technical conditions or technical specifications.

1.4.2.2 When approving modules(battery packs), the following plans and documents are to be submitted to CCS for information:
(1) List of main parts;
(2) Temperature monitor analysis and test verification report(if applicable);
(3) Operation and maintenance instructions for the products.

1.4.3 Plans and documents needed for battery management system(BMS) survey

1.4.3.1 When approving battery management system(BMS), the following plans and documents are to be submitted to CCS for approval:
(1) BMS system general plan;
(2) BMS principle diagram;
(3) BMS enclosure and assembly;
(4) Type test program
(5) BMS product technical conditions or technical specifications.

1.4.3.2 When approving BMS, the following plans and documents are to be submitted to CCS for information:
(1) BMS main parts and material list;
(2) BMS product operation and maintenance instructions.

1.4.4 Plans and documents needed for battery system survey

1.4.4.1 When surveying battery system, the following plans and documents are to be submitted to CCS for approval:
(1) Battery system schematic diagram;
(2) Battery system connection diagram;
(3) Battery system equipment front panel arrangement plan;
(4) Battery system various protection device and protection device setting parameter plan;

(5) Battery system wiring diagram;
(6) Battery system test program.
1.4.4.2 When surveying battery system, the following plans and documents are to be submitted to CCS for information:
(1) Battery system equipment dimension diagram;
(2) Battery system operation and maintenance instructions.

1.4.5 Plans and documents needed for direct current busbar system
1.4.5.1 In addition to the plans and documents to be submitted as per the requirements of relevant CCS rules, the following plans and documents are also to be submitted to CCS for approval:
(1) Short-circuit current calculation and protection coordination analysis of direct current busbar system(applicable to ships whose converter's total power is over 200kW when connected by energy storage systems possibly in the network simultaneously);
(2) Short-circuit test report of direct current busbar system. Verification and analysis of equipment and component's short-circuit current bearing capacity are to be included in the test report (applicable to ships required by 1.4.5.1(1));
(3) Single line diagram of direct current busbar system;
(4) Safety assessment of direct current busbar system.
1.4.5.2 The following plans and documents are to be submitted to CCS for information:
(1) Function description of direct current busbar system;
(2) Operation manual of direct current busbar system.

1.4.6 Plans and documents needed for ship survey
1.4.6.1 In addition to the plans required by relevant CCS rules, for pure battery-powered ships, the following plans are also to be submitted to CCS for examination:
(1) Power system diagram (including circuit system diagram consisted of battery, BMS and switchboard);
(2) Electric power equipment layout (including installation location of battery, switchboard and other equipment);
(3) Electrical load calculation;
(4) Arrangement diagram of battery cabins (rooms) , battery box(cabinet) ;
(5) Ventilation system diagram and calculation of battery cabins (rooms) , battery box(cabinet) (if applicable);
(6) Fire prevention plan of battery cabins (rooms) ;
(7) Fixed fire detection and fire alarm system diagram, arrangement diagram of battery cabins (rooms) (which may be combined with ship's fixed fire detection and fire alarm system diagram, arrangement diagram);
(8) Fire extinguishing system arrangement diagram and extinguishing medium calculation of battery cabins (rooms).

1.4.7 Documents to be provided for risk assessment
1.4.7.1 For pure battery-powered ships, risk assessment documents are to be provided to CCS for information. Based on its intended usage, risk assessment is to be completed by battery manufacturers, battery system set makers, and ship design companies respectively. The following

contents are to be included in risk assessment:

(1) Hazard identification(list of all possible potential hazard);

(2) Risk assessment(risk factor assessment);

(3) Risk control option(design measures to control and reduce identification risk);

(4) Measures that must be taken;

(5) Description of whether relevant requirements of the Guidelines are complied with, and all potential hazard represented by the battery type(chemical) intended to be used, and the following is at least to be included:

① Chemical reaction equations of main raw materials and list of gas composition that could be released under battery's normal working and thermal runaway conditions;

② Gas spread risk(toxic, flammable, corrosive);

③ Fire risk;

④ Explosion risk;

⑤ Necessary detection and alarm system(gas detection, fire detection, etc) and ventilation;

⑥ External risk(fire, water intrusion, etc);

⑦ Propulsion or auxiliary power loss of primary or essential services.

CHAPTER 2 GOALS, FUNCTIONAL REQUIREMENTS AND SAFETY CLASSIFICATION

Section 1 GENERAL GOAL

2.1.1 General goal

2.1.1.1 The goal of the Guidelines is to achieve pure battery-powered ships' safety and reliability under the following conditions by putting forward safe technology requirements, ship arrangement requirements, fire-fighting requirements, survey and test requirements of key elements(battery, electric propulsion technology, etc) involved in pure battery-powered ships:

(1) Navigation;
(2) Entering and leaving ports;
(3) Docking;
(4) Operation;
(5) Berthing;
(6) Emergency;
(7) Charging;
(8) Maintenance.

2.1.2 Functional goals

2.1.2.1 To realize the goal in 2.1.1.1, pure battery-powered ships are to meet functional goals of 2.1.2.2~2.1.2.4.

2.1.2.2 Battery system is to be able to operate safely and reliably during ship's whole life cycle, including: charging, discharging, storing and other processes. Battery's key parameters are to be fed back to ship's power station power management system (PMS), energy management system(EMS) or monitoring and alarm system(IAS).

2.1.2.3 Electric power propulsion system is to be able to ensure ship's normal propulsion, and is to have the following functions corresponding to its automation level:

(1) Propulsion equipment control and protection;
(2) System monitor and alarm.

2.1.2.4 Fire-fighting is to be able to suppress, control and extinguish battery fire and explosion within the cabin on fire.

Section 2 SAFETY CLASSIFICATION

2.2.1 Objective

2.2.1.1 The objective of safety classification is to ensure all onboard batteries' safe use based on their own characteristics after corresponding protective measures are taken as per their safety levels.

2.2.2 General requirements

2.2.2.1 For batteries applicable to 1.1.1.1 of the Guidelines, risk assessment report must be provided. The report needs to reflect various elements included in safety classification in Table 2.2.3.1 and present judgement result. All judgement needs to be based on theoretical analysis and test data.

2.2.2.2 The use of batteries with potential hazard in safety, which could release toxic and flammable gas or have risks of explosion, bloating and liquid leakage during normal use are forbidden onboard.

2.2.2.3 The use of batteries failed to pass thermal runaway propagation test are forbidden onboard. Thermal runaway propagation test needs to meet the requirements of 3.2.2.6 and Table 7.2.2.2.

2.2.2.4 Batteries with safety level 1 could be used onboard after strict protection is provided.

2.2.2.5 Batteries with safety level 2 could be used onboard after universal safety measures are adopted.

2.2.3 Safety classification

2.2.3.1 Batteries are classified as per Table 2.2.3.1. Safety level gradually increases from level 1 to level 2. Level 1 poses the greatest hazard.

List of safety levels Table 2.2.3.1

Safety rank	Thermal runaway test		combustion (explosion) risks
	Releases oxygen	Releases toxic, flammable gas	
1	√	√	Relatively high
2		√	Relatively low

2.2.3.2 Batteries that release oxygen and toxic and flammable gas, and have relatively high combustion (explosion) risks under thermal runaway condition are categorized into safety level 1.

2.2.3.3 Batteries that only release toxic, flammable gas and have relatively low combustion (explosion) risks under thermal runaway condition are of safety level 2.

2.2.3.4 Thermal runaway test needs to meet the requirements of Table 7.2.1.2.

CHAPTER 3 TECHNICAL REQUIREMENTS FOR BATTERIES USED ONBOARD

Section 1 GENERAL PROVISIONS

3.1.1 General requirements

3.1.1.1 The design and manufacture of batteries and associated equipment of their systems are to meet relevant provisions of relevant CCS rules, the *Guidelines for Type Approval Test of Electric and Electronic Products* and relevant provisions in Chapter 7 of the Guidelines.

3.1.1.2 Battery systems are to possess necessary electromagnetic compatibility[①].

3.1.1.3 Batteries are to be equipped with battery management system (BMS).

3.1.1.4 Batteries are to be installed inside a battery cabin (room) and/or battery box (cabinet) with a controllable environment.

3.1.1.5 Batteries are to be able to withstand ship's sway and vibration.

3.1.1.6 The arrangement of batteries and connection cables is to minimize stray magnetic field as much as possible.

3.1.1.7 The maintenance of batteries is to be carried out as per the document provided by manufacturers.

3.1.2 Equipment and capacity of batteries

3.1.2.1 For ships that have batteries provided for main power supply and propulsion power respectively, capacity of batteries is to meet the following conditions respectively:

(1) At least two sets of independent batteries are to be equipped for main power supply, the capacity of each is to be enough to supply power within suitable time range during the whole voyage to equipment that are necessary to guarantee ship's normal navigation, ship safety and refrigerated cargoes. At the same time, lowest comfortable accommodation condition is also to be ensured. Power supply to appropriate cooking, food refrigeration, mechanical ventilation, hygiene and fresh water equipment are at least to be ensured. The capacity of each set of battery is to at least be able to maintain power supply for 4h to electric equipment that are necessary for ship safety.

For ships engaged on inland waterways at a length of not more than 10 m, if lighting is the main purpose of electric power supply, the main power supply may have only one battery pack, the capacity of which is to be able to meet the demand of electric equipment's from port of departure to terminal port.

(2) For electric propulsion power supply, at least two independent set of batteries are to be provided, the design of which is to ensure that their total capacity is enough for electric power needed for ship's voyage.

3.1.2.2 If the public power station is used as main power supply and power supply for electric propulsion simultaneously, the following provisions are to be met:

① Refer to IEC60533 publication: *Electromagnetic Compatibility of Electrical and Electronic Installations in Ships* or corresponding standards.

(1) The outfitting, function and total capacity of batteries are to meet the provisions of the above-mentioned 3.1.2.1;

(2) Control system of power station is to ensure safe distribution of electric power between propulsion and routine load. If necessary, unimportant loads could be removed and/or propulsion power could be lowered;

(3) At least one set of battery is to be connected to busbar's port/starboard subsection. In case either of the subsection's battery is not working, battery set of the other subsection is to be able to supply power to all important equipment and commonly used equipment on board as well as to maintain effective propulsion at the same time.

3.1.2.3 Within the specified power supply time range, battery's final discharging voltage/electric quantity is to meet requirements in the Specifications provided by the manufacturer.

3.1.2.4 The provision and capacity of emergency power supply/temporary emergency power supply are to meet requirements of relevant rules and regulations.

Section 2 BASIC REQUIREMENTS

3.2.1 Battery cell

3.2.1.1 Battery cells with hard metal or plastic shell are to be equipped with safety valves or other explosion precautions.

3.2.1.2 For every battery cell with laminated composite metal foil shell (hereinafter referred to as pouch battery), when installed and used, a fixed bracket is to be provided externally to meet effective ventilation and other requirements.

3.2.2 Battery module/battery pack

3.2.2.1 Battery modules/battery packs are to be equipped with safety valves or other explosion precautions.

3.2.2.2 The shell of a battery module is to be flame retardant material, while the shell of the battery pack is to be non-combustible material.

3.2.2.3 A battery module/battery pack is to be equipped with temperature regulating measures. For pouch batteries and batteries with safety Level 1, their battery modules/battery packs are to be equipped with temperature regulating devices independent from battery cabins (rooms) / battery boxes (cabinets).

3.2.2.4 Inside battery packs, there is to be a monitor circuit that provides information (such as voltage, temperature, etc) for battery system.

3.2.2.5 If the system consists of battery modules, battery modules need to meet the requirement in 3.2.2.4.

3.2.2.6 When designing battery modules, it is to make sure that when thermal runaway occurs to any battery cell of the battery module, it won't trigger other cells' thermal runaway; or, if a battery pack consists of two or more battery modules, it is at least to be ensured that when thermal runaway occurs to a battery cell in the system, this may spread only within the module to which this cell belongs, but will not spread to other modules. Verification test is to be carried out using one of the following methods:

(1) Thermal runaway propagation among battery cells within the same module is prohibited, or

(2) Thermal runaway propagation among battery modules is prohibited.

3.2.2.7 Protection level of pouch battery's battery packs or battery packs with safety Level 1 is to at least be IP67. If thermal runaway propagation among battery cells is unavoidable, fire prevention and control measures independent from the fire-fighting arrangements for battery cabins (rooms) / battery boxes (cabinets) are to be provided. If fire prevention and control devices are installed as means of fire prevention and control, such devices are to be able to detect sources and signs of hazard of fire, release an alarm and automatically and/or manually start ejecting inhibitor medium. Test reports are to be provided to prove extinguishant's effectiveness in putting out battery fire.

3.2.2.8 Name plate is to be attached safely and securely on the shell of a battery module/battery pack, and the sign of the name plate is to at least include the following information:

Marine propulsion（main power supply or starting or lighting）xxx battery/high energy density supercapacitor

Cell type	
Cell parameter	Wh
Nominal voltage	V
Nominal power	KWh
Battery module/ battery pack weight	KG
Battery module/ battery pack type	
Product serial number	
Date of manufacture	Month Date Year

Of which, xxx means different types of lithium-ion batteries. For example: marine propulsion(or main power supply) lithium iron phosphate batteries.

3.2.2.9 Discernable code number is to be attached on battery module/battery pack to facilitate management, recycle and tracing. Refer to GB/T 34014-2017 Coding Regulation for Automotive Traction Battery for coding rules.

3.2.3 Battery system

3.2.3.1 The shell of battery system's relevant equipment is to be non-combustible material.

3.2.3.2 Refer to Section 3 of this Chapter for relevant technical requirement of battery system's control function.

3.2.3.3 For battery system with nominal energy of over 50kWh, independent emergency shut off device is to be set to break battery system's connection. The following requirements are to be met:

(1) Emergency shut off device is to be set in easily accessible locations outside navigation bridge and battery cabin, and is to give out visual and audio signals at the same time when in action.

(2) Emergency shut off function is to be carried out by hardware circuit, and be independent from control, display and alarm systems.

3.2.3.4 Main circuit of battery system is to be connected to distribution system busbar through disconnector or circuit breaker/switch without tripping mechanism to enable insulation during maintenance.

3.2.3.5 Battery system is to be connected to distribution system busbar through protective equipment with short circuit and overcurrent protection.

3.2.3.6 Pure battery-powered ships with battery as propulsion power are to be provided with the following documents onboard:

（1） Emergency operation description of battery system: It is to include the handling procedures when external fire and thermal runaway inside battery system occur.

（2） Description of battery system maintenance (including check) and function test: How professionals (normally battery manufacturer or its authorized personnel) test system and components, cycle of test and other details are to be described. Records are to be kept after maintenance/check; forms of record of maintenance cycle are to be made and updated, or in the case of remote data records, battery status records are to be kept for 60 days or more.

（3） Safety description of battery system: It is to include analysis of all potential hazards, and is to at least include the following contents:

①Possible leaks(toxic, combustible, corrosive, etc);

②Possible gases(toxic, combustible, corrosive, etc);

③Fire hazard;

④Explosion hazard, including description of battery releasing gas during ventilation and thermal runaway;

⑤Gas detection and alarm system of battery cabin/battery box(cabinet);

⑥Fire detection and alarm system of battery cabin;

⑦Ventilation rate of battery cabin;

⑧Recommended fire- fighting method;

⑨Battery internal breakdown/ thermal runaway;

⑩Battery internal and external short circuit;

⑪Overcurrent, overvoltage and low-voltage protection;

⑫External heat source/ fire;

⑬Safe charge/ discharge characteristics;

⑭Safety precaution measures to reduce risks.

Section 3 FUNCTIONAL REQUIREMENTS FOR BATTERY MANAGEMENT SYSTEM(BMS)

3.3.1 General requirements

3.3.1.1 BMS is to be powered by a source of power supply outside the battery monitored by it.

3.3.1.2 BMS is to be equipped with battery control unit and battery monitoring circuit according to battery layer.

3.3.1.3 The battery control unit is to be able to receive the information contained in the battery module/battery pack monitoring circuit (such as voltage, temperature, etc.).

3.3.1.4 BMS must be able to summarize the information from battery control unit of battery box (cabinet), and is to be able to feed the information listed in 3.3.2.2 back to the corresponding management system of the ship and be subject to its management. Management system can be the power management system (PMS) or the energy management system (EMS) or the monitoring and alarm system (IAS).

3.3.2 Basic functions

3.3.2.1 BMS is to be able to measure the following parameters (including but not limited to):

(1) Battery cell and system voltage;

(2) Battery cell temperature;

(3) Battery series loop current;

(4) Environment temperature;

(5) Battery system insulation resistance.

3.3.2.2 BMS is to display the following information locally and remotely (in the area on ship where the crew is on duty), including but not limited to:

(1) Battery system voltage;

(2) Battery cell voltage;

(3) Battery cell temperature;

(4) Battery series loop current;

(5) Environment temperature;

(6) Battery system insulation resistance;

(7) State of charge(SOC) of the batteries system;

(8) State of health(SOH) of the batteries system;

(9) Energy flow state of battery system (charge and discharge process);

3.3.2.3 BMS is to set the following visual and audible alarm locally and remotely (in the area on ship where the crew is on duty), and display the information remotely, including but not limited to:

(1) Over and under battery cell voltage;

(2) Overcurrent of battery series loop;

(3) High battery cell temperature;

(4) Environment temperature too high/too low;

(5) Low electrical insulation resistance;

(6) Low State of charge (SOC);

(7) Overcurrent protection;

(8) Over charge and over discharge protection;

(9) Over temperature protection;

(10) Battery pack / box (cabinet) thermal management (mechanical ventilation or other temperature regulating device) failure (if any);

(11) Battery box (cabinet) emergency exhaust failure (if any);

(12) Protection functional fault;

(13) Temperature detected fault;

(14) Charging fault;

(15) Voltage imbalance between the battery cells;

(16) Battery system stop running due to failure;

(17) Tripping of breakers/contactor;

(18) Communication failure between BMS and PMS/EMS/IAS;

3.3.2.4 When the SOC of the battery used for ship propulsion and/or main source reaches the minimum power required for normal operation of the ship, it is to send out visual and audible alarm signals. The alarm device of this alarm signal is to be independent of other alarm devices.

3.3.2.5 For battery failure that may cause the battery system (subsystem) to stop running (see

table 3.3.2.13 for details), a pre-warning is to be sent before it reaches the limit state.

3.3.2.6 BMS is to have at least the following control and safety protection functions:

(1) Control the charge, discharge and charging / discharging equipment of the battery;

(2) Control the balance between battery cells, and between battery modules;

(3) Overcurrent protection;

(4) Over charge and over discharge protection;

(5) Over heat protection (Environment temperature and cell temperature）;

(6) Fault protection of self-check function;

3.3.2.7 Charging equipment shall be able to communicate with BMS and operate under the conditions limited by BMS.

3.3.2.8 When overcurrent occurs, appropriate delay is to be applied to reduce or disconnect the load.

3.3.2.9 In case of over-charge and over-discharge, the charging and discharging device is to be disconnected.

3.3.2.10 Over heat protection is to be able to control the battery to a safe state, such as ventilation, reduced power, disconnect load, etc. Overheat protection is to be independent of other components for temperature indication, alarm and control functions.

3.3.2.11 BMS is to have self-check function. BMS self-check function is at least to include SOC dynamic calibration and SOC shelf calibration at battery discharge terminals. Failure of self-check function includes but is not limited to: failure of protection function, failure of temperature detection, failure of cooling of battery pack/battery box(cabinet), and failure of charging. When the failure of protection function and temperature detection occurs, the battery system should stop running. When charging failure occurs, BMS should control charging equipment to stop charging.

3.3.2.12 As battery for propulsion power, BMS is to be able to monitor and control battery used on board during the whole life cycle of battery. During the period when the battery is not in operation, at least cell temperature and environment temperature are to be measured and displayed, and a visual and audible alarm is to be sent locally and remotely (in the area on ship where the crew is on duty) in case of abnormal temperature.

3.3.2.13 Functional requirements for BMS are shown in table 3.3.2.13.

List of functional requirements for BMS Table 3.3.2.13

NO.	Monitoring parameters	Display②	Alarm	Protection	Corresponding protection action
1	Battery system voltage	√			
2	Cell voltage	√	√	√	Equilibrium control
3	Battery series loop current	√	√	√	Power reduction③/ battery system (subsystem) stops running
4	Cell temperature①	√	√	√	Cooling/power reduction/ battery system (subsystem) stops running
5	Environment temperature	√	√	√	Temperature regulation
6	Electrical insulation	√	√	√	battery system

NO.	Monitoring parameters	Display②	Alarm	Protection	Corresponding protection action
	resistance				(subsystem) stops running
7	State of charge of the batteries (SOC)	√	√	√	Power reduction
8	State of health of the batteries (SOH)	√			
9	Battery energy flow state	√			
10	Overcurrent protection	√	√	√	Power reduction/ battery system (subsystem) stops running
11	Over charge and over discharge protection	√	√	√	Disconnect the charging and discharging device
12	Over heat protection （ Environment temperature and Cell temperature）	√	√	√	Cooling/power reduction/ battery system (subsystem) stops running
13	Battery pack/box (cabinet) thermal management failure(if any)	√	√		
14	Battery box (cabinet) emergency exhaust failure (if any)	√	√		
15	Protection function failure	√	√	√	Battery system (subsystem) stops running
16	Temperature detection failure	√	√	√	Battery system (subsystem) stops running
17	Charging fault	√	√	√	Power reduction/ Stop charging
18	Voltage imbalance between the cells	√	√	√	Start-up balancing control/ power reduction/ battery system (subsystem) stops running
19	Battery system stop running due to failure	√	√		
20	Tripping of breakers/contactor	√	√		
21	Communication failure between BMS and PMS/EMS/IAS	√	√		Battery system (subsystem) stops running

Notes:

① Cell temperature monitoring is to meet the requirements of 3.3.2.14.

② Display is to meet the requirements of 3.3.2.2 and 3.3.2.3.

③ Power reduction in this table is to be coordinated with 3.4.1.1, to provide power reduction protection on the premise of ensuring navigational safety.

3.3.2.14 BMS is to be able to monitor the temperature of each battery cell individually. If equivalent monitoring means are used, corresponding evidential documents are to be provided for CCS approval.

3.3.2.15 BMS independent power supply is to be capable of being displayed in the PMS/EMS/IAS and visual and audible alarms are to be released in the event of a fault.

Section 4 POWER/ENERGY MANAGEMENT SYSTEM

3.4.1 General requirements

3.4.1.1 If a pure battery propulsion powered ship is equipped with power management system (PMS) or energy management system (EMS), the management system is to have the following functions:

(1) Able to transfer data to BMS;

(2) Automatically removes non-important loads or reduces the power of the propulsion load to prevent the battery from overloading;

(3) Overloading request.

Section 5 CHARGING DEVICE

3.5.1 Charging device

3.5.1.1 A battery is to be equipped with a charging device with sufficient capacity. Charging devices are to be provided with measures to suppress radio interference.

3.5.1.2 Charging device is to be provided with overcurrent protection, including short circuit protection.

3.5.1.3 If the battery is charged through the DC bus, appropriate measures should be taken to avoid damage to the battery caused by the fault of the DC bus system.

3.5.1.4 Instruments are to be provided on or near the charging / discharging device to at least indicate charging and discharging current, voltage, SOC and other parameters.

3.5.1.5 Battery charging / discharging device should be used in combination with BMS and meet the requirements of 3.3.2.7.

3.5.1.6 If the charging shore power is connected to the charging equipment on board (including the shore power box) by charging connection device (such as charging gun, electric connector, etc.), the following requirements are to be satisfied:

(1) The charging connection device is to be equipped with mechanical interlocks to prevent the charging cable from falling off during the charging process;

(2) Under normal and failure conditions, the charging connection device are to be equipped with safety measures against electric shock;

(3) The charging connection device is to be so designed that it can be easily operated, special tools are not needed when being connected with the shore power device, and no live part will be touched.

3.5.1.7 The charging device is to be equipped with a temperature monitoring device, which is to be able to transmit corresponding signals to charging control system, for realizing the temperature monitoring and high temperature protection functions of the charging interface.

CHAPTER 4 SPECIAL REQUIREMENT FOR PURE BATTERY-POWER ELECTRIC PROPULSION TECHNOLOGY

Section 1 GENERAL PROVISIONS

4.1.1 General requirements

4.1.1.1 In addition to the Guidelines, a pure battery-powered ship is also to comply with the relevant requirements for electric propelled ships of CCS *Rules for Classification of Sea-going Steel Ships* or *Rules for Construction of Sea-going Ships* Engaged on Domestic Voyages or Rules for the Construction of Inland Waterways Steel Ships.

4.1.1.2 The electric propulsion system purely using battery is to be so designed and arranged that the safety and reliability of a pure battery-powered ship is not lower than that of the traditional ship.

4.1.1.3 In the event of fault condition, the electrical system and equipment should be properly protected to minimize the occurrence of the following conditions:

(1) The device itself is damaged;

(2) other equipment connected to the equipment is damaged;

(3) The crew and passengers were injured.

4.1.1.4 The voltage and frequency fluctuations of the electrical system are to comply with the requirements of the relevant regulations of CCS. If a higher level of fluctuation is intended, evidential documentation from the manufacturer is to be submitted indicating all of the equipment involved in the system are designed for being able to operate at a higher level of voltage and frequency fluctuation for a long time without any fault. This may be specially considered by CCS upon agreement by all the concerned parties.

4.1.1.5 The parameters of the components of the propulsion system are to be matched to ensure that the equipment can operate normally; at the speed state specified for the ship, each device is to be capable of stable operation at any speed within the designed speed range.

4.1.1.6 Adequate torque margin is to be provided in propulsion systems to guard against the motor from being pulled out of synchronism during rough weather or during turning in the case of multiple-screw ships, and to ensure a reliable start under all ambient conditions.

4.1.1.7 The lubrication of bearings of propulsion motors, gearing box and shafting is to be effective at all normal speeds from creep speed upwards, either ahead or astern(if any). The above shafts and bearings are not to be damaged by slow rotation caused by motor(s) or propeller(s) under all predictable oil temperature conditions.

4.1.1.8 Where fuses are used in the system, spare parts are to be stored on board, and appropriate labeling is to be provided detailing the type of replacement fuses to be fitted.

4.1.2 Special requirements for DC busbar systems

4.1.2.1 The safety and reliability of a vessel with DC busbar system is to be at the same level as a conventional vessel.

4.1.2.2 Protection equipment should provide overcurrent protection, including short circuits protection. The protective equipment used are to be fully selective and comply with the requirements of 3.2.3.5 of this Guideline.

4.1.2.3 Pure battery-powered ships using DC busbar systems are to have operating manuals on board. The manuals are to include the following information:

(1) Particulars and a description of the systems.

(2) Operating instructions for the equipment and systems.

(3) Maintenance instructions for the installed arrangements, including, but not limited to: procedures to prevent injury from electric shock and arc flash;

(4) Software configuration management procedures which are to include a list of all versions of the software installed in the system, and the settings, values of system or equipment specific configuration parameters.

4.1.2.4 The safety assessment of the DC busbar system is to be carried out. The safety assessment is to include the following steps:

(1) To list all normal and possible accident (fault) causes and consequences, such as start-up, normal shutdown, non-use, and protection;

(2) To assess each risk factor, mechanical, electrical and human failures and misoperations other than design operating parameters shall be considered;

(3) Risk control measures;

(4) The safety actions that need to be taken;

(5) Electrical protection concept;

(6) Software design and safety evaluation;

(7) To form a FMEA report.

4.1.2.5 The DC busbar system is to be provided with a functional description which should include the following information:

(1) The composition of the electric propulsion system, including the main power equipment constituting the system;

(2) Installation and layout instructions, including the installation of the main power equipment of the system;

(3) The functional description, including compliance of the functions and performance of the system under normal conditions and foreseeable abnormal conditions, including but not limited to:

① Under abnormal conditions, operations in various degraded modes;

② Management and distribution of loads;

③ System grounding principle;

④ Electrical protection concept;

⑤ System stability;

⑥ Actions of converters and switchgear.

(4) Technical specifications, including system technical details such as voltage, current, power, etc.;

(5) Equipment outline drawings and dimensions;

(6) External wiring diagram of the equipment;

(7) Test report.

4.1.2.6 The DC busbar system is to be provided with a short-circuit test report. The verification and analysis of short-circuit current carrying capacity of the equipment and components is to be included in the test report. When it is not possible to provide a test report witnessed by the surveyor in site, corresponding tests are to be supplemented. These tests may be completed at the factory or after installation on board. When the same type DC busbar system is used in other ships, it is not necessary to test again, and only the first test report is needed.

CHAPTER 5 SHIP ARRANGEMENT

Section 1 GENERAL PROVISIONS

5.1.1 General requirements

5.1.1.1 Ship arrangement needs to consider battery weight's effect on ship structure and stability.

5.1.1.2 Ship arrangement needs to consider the difference between batteries of different safety levels.

Section 2 REQUIREMENTS OF BATTERIES

5.2.1 General requirements

5.2.1.1 In addition to the requirements of 5.1.3.1, 5.1.3.8 and 5.1.3.9 of PART THREE of CCS *Rules for Construction of Inland Steel Ships (2016)* or requirements of 2.11.1.10 to 12 of PART FOUR of *the Rules for Classification of Sea-Going Steel Ships*, the arrangement and installation of batteries onboard are still to meet requirements of this Section.

5.2.1.2 When arranging batteries, batteries' total stored energy is to be considered(stored energy is the product of battery's rated capacity and rated voltage):

(1) The batteries with total stored energy greater than 20 kWh are to be installed inside battery cabins (rooms) or inside battery boxes (cabinets) on open deck;

(2) The batteries with total stored energy of or less than 20 kWh but greater than 2 kWh may be installed inside a battery box(cabinet), which may be placed inside the engine room when service environment of the box(cabinet) can be ensured;

(3) For the batteries with the total stored energy of or less than 2 kWh, steel shell battery pack may be adopted, which may be installed in locations that are decently ventilated when service environment inside the pack is ensured.

5.2.1.3 Batteries are to be in areas behind collision bulkhead.

5.2.1.4 Batteries are not to be installed inside accommodation space.

5.2.1.5 Batteries' arrangement is to facilitate replacement, check, test and cleaning. For ships at a length of or less than 20m, any battery's minimum detachable unit weight is to be no heavier than 130kg.

5.2.1.6 Batteries are not to be installed in locations where overheat, over cooling, splash, steam and other factors would damage their performance or accelerate their performance deterioration. Their arrangement is to prevent fire, explosion caused by their abuse from endangering personnel and damaging equipment

5.2.1.7 In the areas related to battery arrangement, safety warning signs and sings showing prohibition of entry of unrelated personnel are to be posted.

Section 3 REQUIREMENTS FOR BATTERY CABINS (ROOMS), BATTERY BOX(CABINET)

5.3.1 General requirements

5.3.1.1 For ships of 15m above in length, when propulsion batteries are arranged inside cabins, they are to be set up separately in at least 2 dedicated cabins. The total energy of batteries stored in each dedicated cabin is not to be greater than 2000kWh.

5.3.1.2 Protection level of battery boxes(cabinets) needs to meet the requirement of corresponding location, but is not to be lower than IP22.

5.3.1.3 Battery boxes(cabinets) are to be equipped with temperature regulating measures.

5.3.1.4 When battery brackets are installed, brackets are to be made of steel materials.

5.3.2 Arrangement of battery cabins (rooms) and/or battery boxes(cabinets)

5.3.2.1 A battery box(cabinet) is to be made of steel the thickness of which is not to be less than 1 mm and each layer of battery inside the box is to be horizontally divided by steel. Horizontal projected area of any battery box(cabinet) 's minimum division unit is not to exceed $1m^2$, but under the following condition, it is not to exceed $1.5m^2$:

(1) High energy density supercapacitor, or

(2) Vertical height of battery boxes (cabinets) is not higher than 1m.

5.3.2.2 For batteries with safety level 2 arranged in battery cabins (chambers), battery boxes (cabinets) are not required under the following situations:

(1) Horizontal projected area of battery cabin doesn't exceed $1m^2$;

(2) Installed on the bracket in the form of a battery pack, and the battery pack meets the requirements of the corresponding safety level battery box (cabinet).

5.3.2.3 If batteries with safety level 2 are installed inside battery boxes (cabinets) in the form of modules, the battery boxes (cabinets) also need to meet the requirement of battery pack of the corresponding safety level at the same time.

5.3.2.4 Pouch batteries and batteries of safety level 1 must be installed inside battery boxes(cabinets) in the form of battery pack. For battery cabins (rooms) with batteries of safety level 1 inside, their protection level is to be at least IP67.

5.3.2.5 For battery cabins with batteries of safety level 2 inside, gratings or similar arrangements are to be appropriately provided for the battery box(cabinet) /battery pack to facilitate ventilation, thermal dissipation and fire fighting. Exceptions could be granted if temperature regulating device and fire prevention measure are provided separately.

5.3.2.6 There is to be sufficient space between battery box(cabinet) or battery pack inside battery cabin and the bulkhead and the upper deck to facilitate the ventilation and dissipation of the battery. For ships of 20m above in length, the distance between the bulkhead and battery should be not less than 150 mm, the distance between the upper deck and battery should be not less than 500 mm. For ships less than 20m in length, the distance between the battery and the bulkhead and the upper deck should not be less than 150 mm.

5.3.2.7 Battery box(cabinet) and battery pack are to be fixed securely and be as far away from ship outboard side as possible to avoid impact of collision. The horizontal distance between the

battery box (cabinet) and the battery pack to the hull outer plate should be no less than 500 mm. For ships less than 20m in length, the distance may be reduced to 300 mm.

5.3.2.8 Battery cabins are to be arranged far away from accommodation spaces. If they really need to be arranged adjacently, their shared boundary is to be minimized and the insulation divisions are to comply with the requirement of 6.2.1.1.

5.3.2.9 Means of access for the ship crew to easily reach battery boxes(cabinets) on open deck is to be provided. For passenger ships, such access is to be independent from means of escape for passengers.

5.3.3 Cooling of battery cabins (rooms) and/or battery boxes (cabinets)

5.3.3.1 Battery cabins (rooms) and battery boxes (cabinets) installed on the deck are to be equipped mechanical ventilation or other temperature regulating device to prevent the ambient temperature of batteries from being too high. Battery cabins (rooms) provided with mechanical ventilation are to meet the requirement of 6.2.2.1.

5.3.3.2 When mechanical ventilation is adopted, in addition to the normal ventilation of the cabin, the mechanical ventilation calculation of the heat exchange of the battery is to be carried out according to the method provided by the manufacturer. If the calculation method is not provided by the manufacturer, the ventilation is to be calculated according to the following method.

Ventilation volume q' is not to be less than the value calculated from the equation below:

$$q' = k(nQ + Q_1)/(0.335\Delta t)\ \mathrm{m^3/h}$$

Where： Q ——Heat productivity generated by single battery module in operation itself ,W；

Q_1 ——Heat productivity of other heat sources, W；

n ——Total number of battery modules;

Δt ——Maximum temperature difference[②] between battery cabins (rooms) and outside air, ℃；

k ——Surplus constant of fans, to be taken between 1.5~2 when practically chosen.

5.3.3.3 When other temperature regulating devices (such as air conditioners) are used, the heat of the battery and other heat sources should be fully considered.

5.3.4 Emergency ventilation / emergency exhaust of battery cabins (rooms) and/or battery boxes (cabinets)

5.3.4.1 Batteries with safety level 1 is to be equipped with independent non-spark type emergency exhaust system to directly emit possible toxic/inflammable gas. The emergency exhaust system is to take the environment inside battery box(cabinet) as protection area, and emergency exhaust system’s exhaust pipe needs to lead to safety location on open deck and be away from places where people live or have heat sources, and is at least 3 meters away from the air inlet of other places.

5.3.4.2 Battery cabins (rooms) with batteries of safety level 2 inside are to meet the requirements

②Highest environment temperature possible for the ship’s navigation area is taken as highest temperature, but it is not to exceed 45° C.

of 6.2.2.2 of the Guidelines on emergency ventilation.

5.3.5 Temperature monitoring and alarm of battery cabins (rooms) and/or battery boxes (cabinets)

5.3.5.1 Battery cabins (rooms) and/or battery boxes(cabinets) are to be installed with independent temperature monitoring devices. The number and location of temperature detectors should take full account of the type of locations. When the temperature in the battery cabin, box or cabinet is higher than the set value, audible and visual alarms are to be sent out in places where crew are often on duty.

5.3.6 Equipment requirement

5.3.6.1 Heat source equipment unrelated to batteries are not to be installed inside battery cabins (rooms) and/or battery boxes (cabinets).

5.3.6.2 Installation of electrical equipment other than the battery system inside battery cabins (rooms) and/or battery boxes (cabinets) is to be avoided. If it must be installed, it is to be as far away from batteries as possible, and its calorific value is to be included in the calculation of battery cabins (rooms) and battery boxes(cabinets) ' ventilation volume.

5.3.6.3 Battery boxes (cabinets) with batteries of safety level 1 inside are to be provided with independent flammable gas detection devices. When the concentration of flammable gas in the battery box (cabinet) is detected to be more than 20% of its lower explosion limit (volume fraction), an alarm is to be released in the navigation bridge and the emergency exhaust system is to be activated.

5.3.6.4 Battery cabins (rooms) with batteries of safety level 2 inside are to be provided independent flammable gas detection devices. The flammable gas detection device is to be capable of releasing an alarm in the navigation bridge when the gas in the battery cabins (rooms) is abnormal, and at the same time starting the emergency exhaust fans.

CHAPTER 6 FIRE PROTECTION

Section 1 GENERAL PROVISIONS

6.1.1 General requirements

6.1.1.1 This Chapter applies to batteries used for propulsion and/or main power supply, while batteries used for other purpose are to meet applicable requirements.

6.1.1.2 In addition to meeting special requirements of battery cabins (rooms) and/or battery boxes (cabinets) in this Chapter, ship fire safety is still to meet applicable standards of corresponding navigation waters.

6.1.2 Functional requirements

6.1.2.1 To prevent the occurrence of battery's fire or explosion, and to contain, control and suppress battery's fire and explosion in the cabins (rooms) of origin, the following functional requirements are to be met:

(1) Temperature of battery cabins (rooms) and/or battery boxes (cabinets) are to be restricted;

(2) Ignition sources of battery cabins (rooms) and/or battery boxes (cabinets) are to be restricted;

(3) Thermal insulation of battery cabins (rooms) boundaries is to fully consider the fire risk of the space and adjacent spaces;

(4) Fixed fire detection and fire alarm system devices are to be suitable for the properties of battery cabins (rooms), fire growth potential and potential generation of smoke and gas;

(5) Fire extinguishing device of battery cabins (rooms) is to be suitable for battery's fire characteristics;

(6) Safe escape routes are to be provided for personnel in battery cabins (rooms) .

Section 2 FIRE PREVENTION AND FIRE DETECTION

6.2.1 Thermal and structural subdivision

6.2.1.1 Bulkheads and decks between battery cabins (rooms) and other adjacent spaces are to be "A-60" class divisions, but for spaces having no fire risk such as voids, bathroom, etc, above-mentioned, these divisions may be reduced to "A-0".

6.2.2 Ventilation system

6.2.2.1 Where battery cabins (rooms) are to be equipped with mechanical ventilation system, the system is to meet the following requirements:

(1) Ventilation ducts are to be of steel or equivalent materials;

(2) The arrangement of ventilation pipes is to ensure that all spaces in battery cabins (rooms) can be effectively ventilated;

(3) The ventilation systems for battery cabins (rooms) are to be completely separated from the ventilation systems serving other spaces;

(4) For ships of 20m or more in length, ventilation ducts for battery cabins (rooms) are not to pass through accommodation spaces, service spaces and control stations. Ventilation ducts for accommodation spaces, service spaces and control stations are also not to pass through battery cabins (rooms) unless they comply with the conditions below:

① The ducts are made of steel having a thickness of at least 3mm for ducts the widths or diameters of which are 300mm and below, having a thickness of at least 5mm for ducts the widths or diameters of which are 760mm and above, or having a thickness obtained by interpolation for ducts the widths or diameters of which are between 300mm and 760mm;

② The ducts are to be suitably supported and stiffened;

③ Ducts that pass through accommodation spaces, service spaces and control stations, and pipes that pass through battery cabins (rooms), are insulated to "A-60" standard.

(5) Measures that prevent water and flame from entering are to be provided at ventilation openings and air inlets are to be far away from air outlet;

(6) Means are to be provided on the navigation bridge to indicate any loss of the required ventilating capacity;

(7) Control facility is to be provided to permit a shutdown from outside the battery cabins (rooms) in case of fire.

6.2.2.2 For cabins (rooms) of battery with safety level 2, independent emergency exhaust fans are to be installed to timely discharge the flammable gas generated in case of thermal runaway of the battery. The emergency exhaust fan is to be interlocked with the flammable gas detection device installed in the space. When it is detected that the concentration of combustible gas in the space is greater than 20% of its lower explosion limit (volume fraction), the emergency exhaust fan is to be automatically activated. The gas from the fan should be led directly to safe locations on open decks and away from inhabited or heat-containing spaces. The volume of emergency air exhaust should be determined according to the assessment, but should not be less than 10 times per hour. Fans should be of no-spark type. When emergency ventilation is combined with the ventilation system described in 6.2.2.1, the ventilation system is to meet the requirements of this paragraph at the same time.

6.2.3 Fire detection and alarm

6.2.3.1 A fixed automatic fire detection and fire alarm system is to be installed in battery cabins (rooms). The design of this system and installation of detectors are to quickly detect fire signs at the very beginning of fire in any part of battery cabins (rooms) and under battery's normal working conditions and ventilation changes needed by ambient temperature range. Smoke detectors or combined smoke and temperature detectors should be used.

Section 3 FIRE EXTINGUISHMENT

6.3.1 General requirements

6.3.1.1 For ships with water fire extinguishing system, a fire hydrant is to be set near the entrance of battery cabins (rooms). Fire nozzles should be of spout / spray type.

6.3.1.2 For ships without water fire extinguishing system, at least two fire buckets with ropes of appropriate length are to be equipped near battery cabins (rooms) or battery boxes (cabinets).

Ships that are already equipped with two fire buckets could be exempted.

6.3.1.3 For battery cabins (rooms) installed with a fixed water-based fire-fighting system, the bilge water system or drain holes at each side are to be capable of draining not less than 125% of the combined capacity of the supply pumps of water-based fire-fighting system and of the required number of fire nozzles.

6.3.2 Fixed fire extinguishing system

6.3.2.1 Battery cabins (rooms) of safety level 2 are to be protected by one of the following fixed fire-extinguishing systems:

(1) Heptafluoropropane fire-extinguishing system, the capacity of which is designed to be 9% of the total volume of the space;

(2) Carbon dioxide fire-extinguishing system, the capacity of which is to be designed according to 40% of the total volume of the space (applicable only to energy type supercapacitor spaces);

(3) Water-based fire-extinguishing system, the water output rate of which is designed to be at least $5L/m^2$•min; the distance between the nozzle and the top of the battery should not be less than 0.5m, and the system can be connected with the fire main pipeline onboard.

6.3.2.2 Battery cabins (rooms) with of safety level 1 are to be protected by one of the following fixed fire-extinguishing systems:

(1) Water-based fire-extinguishing system, the water output rate of which is designed to be at least $5L/m^2$•min, the distance between the nozzle and the top of the battery should not be less than 0.5m, and the system can be connected with the fire main pipeline onboard;

(2) Heptafluoropropane fire-extinguishing system, but the fire extinguishing agent quantity and control system are to ensure that the system can be released again when the battery is re-ignited, and the capacity of each release is designed according to 9% of the total volume of the space. If the battery box (cabinet) or the battery pack is separately provided with a built-in fire extinguishing device, it is acceptable that the fire extinguishing agent quantity required for the space can be released only one time.

6.3.3 Portable fire extinguisher

6.3.3.1 For battery cabins (rooms) with a deck area of $4m^2$ or more, at least four portable heptafluoropropane fire extinguishers are to be provided, and one of them is to be located near the entrance.

6.3.3.2 For battery cabins (rooms) with a deck area of less than $4m^2$, a sufficient number of portable heptafluoropropane fire extinguishers may be used in place of the fixed fire-extinguishing systems required by 6.3.2.1 and 6.3.2.2. For energy-type supercapacitor locations, portable carbon dioxide fire extinguishers can be used instead. A hole is to be provided in the bulkhead of battery cabins (rooms) to facilitate the use of fire extinguishers to release the agent into the space. An opening or fire hose connector may also be provided for the purpose of facilitating the use of fire water.

6.3.3.3 Battery boxes (cabinets) placed on open decks or other locations are to be installed with at least four portable heptafluoropropane fire extinguishers near them. For ships with a length of less than 20 m, two portable heptafluoropropane fire extinguishers may be installed. A hole is to be provided on the battery box (cabinet) to facilitate the use of fire extinguishers to release the agent into it.

Section 4 MEANS of ESCAPE

6.4.1 Entrance/exit and means of access

6.4.1.1 The entrance/exit of battery cabins (rooms) accessible for persons is to directly lead to open deck. Doors or other openings that directly lead to battery cabins (rooms) are not to be provided in accommodation spaces.

6.4.1.2 For battery cabins (rooms) that persons could enter, at least one means of escape is to be provided. Where stairway is used, it is to be of steel material, and its angle of inclination is not to be greater than 65°. For battery cabins (rooms) of 2m or less in height, vertical ladders could be used.

CHAPTER 7 TECHNICAL REQUIREMENTS OF SURVEY AND TEST

Section 1 GENERAL PROVISIONS

7.1.1 General provisions

7.1.1.1 In addition to ship survey items provided in relevant CCS rules, the survey of pure battery-powered ships is to include battery product survey, and ship battery system surveys during construction and after construction.

7.1.1.2 Battery products of pure battery-powered ships include: battery cell, battery module/battery pack, battery management system and battery system. Battery cell, battery module/battery pack and battery management system are to be subject to CCS type approval. Battery system is to be subject to CCS product survey and acquire product certification.

Section 2 PRODUCT SURVEY

7.2.1 Requirement of survey(type test)of battery cell

7.2.1.1 Performance test of battery and its battery management system is to meet standards accepted by CCS.

7.2.1.2 Safety test of battery is to be carried out as per specific requirements and test requirements of Section 7 in IEC62619-2017 *Secondary Batteries Containing Alkaline or Other Non-acid Electrolytes-Safety Requirements for Secondary Lithium Cells and Batteries for Use In Industrial Application*; environment adaptability test of battery is to meet relevant requirements in *CCS Guidelines for Type Approval Test of Electric and Electronic Products* (Hereinafter referred to as "Type Approval Test Guidelines"). See Table 7.2.1.2 for details.

Battery cell survey items (type test) Table 7.2.1.2

	No.	Survey item	Reference standard for test method
Safety survey	1	Mechanical shock	6.2.2 in IEC 62660-2：2018
	2	Extrusion	5.2.3.4 and Appendix A.2.15 in GB/T36276：2018
	3	High temperature teat	7.2.4 in IEC 62619：2017
	4	External short circuit	6.4.1 in IEC 62660-2：2018
	5	Over-charge	7.2.5 in IEC 62619：2017
	6	Over-discharge	7.2.6 in IEC 62619：2017
	7	Thermal runaway	5.2.3.8 and Appendix A.2.19 in GB/T36276：2018
Environment Adaptability survey	1	Appearance inspection	2.1 in Type Approval Test Guidelines
	2	Performance test	2.2 in Type Approval Test Guidelines（GBT_31484-2015_, GBT_31486-2015_）
	3	Insulation resistance measurement	2.3 in Type Approval Test Guidelines

	4	Vibration test	2.7 in Type Approval Test Guidelines（according to Standard IEC60068-2-6publication,Test Fc）
	5	Cyclic damp heat test	2.10 in Type Approval Test Guidelines（according to Standard IEC60068-2-30 publication, Test D*b*）
	6	Steady damp heat test	2.11 in Type Approval Test Guidelines（according to Standard IEC60068-2-3 publication, Test C*ab*）
	7	Salt spray test Kb①	2.12 in Type Approval Test Guidelines（according to Standard IEC60068-2-52 publication, Test Kb）
	8	Flame retarding test（plastic shell only）	2.16 in Type Approval Test Guidelines（according to Standard IEC60092-101 publication）

Note: ① Only applicable to batteries cell installed on open deck.

7.2.2 Type test requirement of battery module and/or battery pack

7.2.2.1 Performance test of battery module and/or battery pack is to meet standards accepted by CCS.

7.2.2.2 Safety test and environment adaptability test of battery module and/or battery pack are to meet the requirements in Table 7.2.2.2.

Battery module and/or battery pack survey items (type test) Table 7.2.2.2

	No.	Survey item	Reference standard for test method
Safety survey	1	Mechanical shock	6.2.3 in ISO 6469-1：2019
	2	Extrusion	5.3.3.4 and A.3.16 in GB/T36276：2018
	3	Temperature cycle	6.3.1 in ISO 6469-1：2019
	4	External short circuit	5.3.3.3 and A.3.15 in GB/T36276：2018
	5	Over-charge	5.3.3.1 and A.3.13 in GB/T36276：2018
	6	Over-discharge	5.3.3.2 and A.3.14 in GB/T36276：2018
	7	Thermal runaway propagation	5.3.3.7 and Appendix A.3.19 in GB/T36276：2018
Environment Adaptability survey	1	Appearance inspection	2.1 in Type Approval Test Guidelines
	2	Performance test	2.2 in Type Approval Test Guidelines（GBT_31484-2015_, GBT_31486-2015_）
	3	Insulation resistance measurement	2.3 in Type Approval Test Guidelines
	4	Vibration test	2.7 in Type Approval Test Guidelines（according to Standard IEC60068-2-6publication,Test Fc）
	5	Cyclic damp heat test	2.10 in Type Approval Test Guidelines（according to Standard IEC60068-2-30 publication, Test Db）
	6	Steady damp heat test	2.11 in Type Approval Test Guidelines（according to Standard IEC60068-2-78 publication, Test C*ab*）
	7	Salt spray test Kb①	2.12 in Type Approval Test Guidelines（according to Standard IEC60068-2-52 publication, Test Kb）
	8	Flame retarding test（plastic shell only）	2.16 in Type Approval Test Guidelines（according to Standard IEC60092-101 publication or IEC60695-11-5 publication）

Note: ①Only applicable to battery packs and/or battery module installed on open deck.

7.2.3 Test requirement for battery system

7.2.3.1 Performance test of battery system is to meet the requirements of standards accepted by CCS or technical specifications of manufacturers.

7.2.3.2 Battery system's safety protection test could be appropriately adjusted as per the technical plans of various system integrators, but at least the following items are to be included:

(1) Over-high temperature protection;

(2) Overcurrent protection;

(3) External short circuit protection;

(4) Over-charge protection;

(5) Over-discharge protection.

7.2.4 Test requirement of battery management system

7.2.4.1 Functional requirements of battery management system are given in relevant requirements in Section 3 of Chapter 3 of the Guidelines. For environment adaptability test and electromagnetic compatibility test, please refer to relevant requirements in the CCS Guidelines for Type Approval Test of Electric and Electronic Products. See Table 7.2.4.1 for details.

Battery management system survey items (type test) Table 7.2.4.1

No.	Survey item	Reference standard for test method
1	Appearance inspection	2.1 in Type Approval Test Guidelines
2	Performance test	2.2（QC/T 897-2011中4.2.3~4.2.7、4.2.12、4.2.16）in approved test guide
3	Insulation resistance measurement	2.3 in Type Approval Test Guidelines
4	Energy fluctuation test	2.4 in Type Approval Test Guidelines
5	Energy failure test	2.5 in Type Approval Test Guidelines
6	Vibration test	2.7 in Type Approval Test Guidelines（according to Standard IEC60068-2-6publication,Test *Fc*）
7	High temperature test	2.8 in Type Approval Test Guidelines（according to Standard IEC60068-2-2 publication, Test B_b）
8	Low temperature test	2.9 in Type Approval Test Guidelines（according to Standard IEC60068-2-1publication, Test A_b）
9	Cyclic damp heat test	2.10 in Type Approval Test Guidelines（according to Standard IEC60068-2-30 publication, Test D_b）
10	Steady damp heat test	2.11 in Type Approval Test Guidelines（according to Standard IEC60068-2-78 publication, Test *Ca*）
11	Salt spray test Kb①	2.12 in Type Approval Test Guidelines（according to Standard IEC60068-2-52 publication, Test *Kb*）
12	Voltage resistance test	2.14 in Type Approval Test Guidelines
13	Shell protection test	2.15 in Type Approval Test Guidelines（according to Standard IEC60529 publication）
14	Flame retarding test（when	2.16 in Type Approval Test Guidelines（according to Standard

	plastic components are present）	IEC60092-101 publication and/pr IEC60092-101 publication）
15	Electromagnetic compatibility test	Chapter 3 in Type Approval Test Guidelines

Note: ① Only applicable to BMS installed on open deck.

Section 3 SURVEY DURING CONSTRUCTION

7.3.1 Product certification

7.3.1.1 Surveyors are to ensure that various main components of battery system are all provided with corresponding certificate according to the requirements of 7.1.1.2. Battery's safety level is to be indicated in the battery cell certificate.

7.3.2 Battery cabins (rooms)/battery boxes(cabinets)

7.3.2.1 Inspection of means of access to battery cabins (rooms);

7.3.2.2 Inspection of equipment inside battery cabins (rooms) /battery boxes(cabinets) ;

7.3.2.3 Test and inspection of emergency exhaust system of battery cabins (rooms), emergency exhaust fans of battery boxes(cabinets)(if any) ;

7.3.2.4 Test and inspection of ventilation system of battery cabins (rooms)/ battery boxes(cabinets) ;

7.3.2.5 Inspection of fire division between battery cabins (rooms) and other cabins;

7.3.2.6 Inspection of fire detection and fire alarm system in battery cabins (rooms)/battery boxes(cabinets);

7.3.2.7 Inspection of flammable gas detection system in battery cabins (rooms)/battery boxes(cabinets);

7.3.2.8 Inspection of fire-fighting equipment inside battery cabins (rooms)/battery boxes(cabinets);

7.3.2.9 Survey and test of temperature inspection device inside battery cabins (rooms), battery boxes(cabinets) .

7.3.3 Installation survey

7.3.3.1 To check whether the arrangement of batteries are easy for replacement, inspection, test and cleaning;

7.3.3.2 To check whether batteries are installed in locations where overheat, over cooling, splash, vapor and other factors may damage their performance or accelerate deterioration of their performance.

7.3.4 Functional survey

7.3.4.1 Functional test of battery's charging and discharging device;

7.3.4.2 Functional test of battery management system's safety protection;

7.3.4.3 Functional tests of DC busbar system.

Section 4 SURVEY AFTER CONSTRUCTION

7.4.1 Annual survey, intermediate survey

7.4.1.1 Check operation records of batteries and battery management system. Batteries are to be replaced when service life provided by the manufacturer is reached or they are damaged;

7.4.1.2 Check whether heat source equipment is added inside battery cabins (rooms)/battery boxes(cabinets) ;

7.4.1.3 Check whether temperature detection device is working normally;

7.4.1.4 Check whether emergency exhaust system(emergency exhaust fan) is working normally;

7.4.1.5 Check whether ventilation system is working normally.

7.4.2 Special survey

7.4.2.1 Annual survey and intermediate survey items;

7.4.2.2 Functional test of temperature monitoring system;

7.4.2.3 Functional test of emergency exhaust system(emergency exhaust fan);

7.4.2.4 Functional test of ventilation system;

7.4.2.5 Functional test of battery management system.

CHAPTER 8 SUPPLEMENTARY PROVISIONS FOR CONTAINERIZED MOBILE POWER SUPPLY

Section 1 GENERAL PROVISIONS

8.1.1 Application

8.1.1.1 This section applies to the design, construction and survey of marine containerized mobile power supplies (hereinafter referred to as "Containerized Power").

8.1.1.2 In addition to the special provisions of this section, the requirements for the arrangement, installation, ventilation, fire protection, etc. of batteries in the Containerized Power are to be consistent with the requirements of the marine main source of power supply and/or propulsion source of power supply for the batteries and associated cabins (rooms).

8.1.2 Definition

8.1.2.1 Containerized mobile power supply refers to the battery power system using the container as the battery installation platform.

8.1.3 Submission of plans

8.1.3.1 The following plans of containerized power are to be submitted to CCS for examination during product survey, including but not limited to:

(1) Instruction manual of Containerized Power;

(2) Structural calculations of Containerized Power;

(3) Structure (including fire structures) arrangement of Containerized Power;

(4) Containerized Power lifting equipment arrangement;

(5) Containerized Power internal ventilation (air conditioning) system diagram and calculations;

(6) Fire extinguishing equipment arrangement;

(7) Power system diagram of Containerized Power (including the circuit diagram of battery, BMS system, and high-voltage circuit, low-voltage circuit);

(8) Power equipment arrangement of Containerized Power supply (including the installation locations of battery, BMS system, and high-voltage circuit, low-voltage circuit);

8.1.4 Testing items

(1) Structural strength and tightness of Containerized Power;

(2) Shell fireproof separation of Containerized Power;

(3) Battery arrangement in the container;

(4) Means of access and battery ambient temperature regulating system in the container;

(5) Ambient temperature monitoring and alarming system in the container;

(6) Fire detection system and fire extinguishing system in the container;

(7) Survey of electrical performance (including insulation monitoring, BMS function, charging and discharging performance, line protection, interface with ship system, etc.)

Section 2 TECHNICAL REQUIREMENTS OF CONTAINERIZED MOBILE POWER SUPPLY

8.2.1 General provisions

8.2.1.1 Containerized Power is to be furnished with marine product certification.

8.2.1.2 Containerized Power interface should consider plugging loss and electrical protection.

8.2.1.3 The container material and welding, structural strength and arrangement, test methods, inspection requirements, etc. of the Containerized Power are to meet the requirements of the applicable provisions for common containers in the *Rules for Surveys of Container* provided that the requirements in 8.1.1.2 are complied with.

8.2.1.4 Containerized Power is to be provided with securing means and is to be able to withstand the adverse weather conditions encountered during ship's navigation.

8.2.1.5 The protection level of the Containerized Power is to meet the requirements for the space where the power is located.

8.2.1.6 The distance between the battery box(cabinet)/battery pack and the bulkhead and the upper deck of the Containerized Power is to be at least 150mm for ventilation and heat dissipation.

8.2.1.7 The walkway is to be provided inside the Containerized Power to facilitate maintenance by personnel.

8.2.1.8 The layout of Containerized Power should consider the impact force on the battery during the lifting process.

8.2.1.9 The Containerized Power is to be as far as possible from the outer side of the ship to avoid the impact of collision. The horizontal distance from it to the side is to be not less than 500 mm.

8.2.1.10 The ship structural strength in way of the Containerized Power arrangement is to meet the load requirements.

8.2.1.11 The Containerized Power is to be arranged as far as possible from the living quarters and personnel activity areas.

8.2.1.12 The space where the Containerized Power is installed is to be free from the impact of deck water on the battery.