



China Classification Society

**Rules for Ships Applying Battery as
a Power**

2023

Beijing

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CHAPTER 1 GENERAL

Section 1 GENERAL PROVISIONS

1.1.1 APPLICATION

1.1.1.1 The Rules for Ships Applying Battery as a Power (hereinafter referred to as “the Rules”) apply to the design, construction and survey of ships that use batteries as part of or all power sources as well as test and survey of batteries and the associated Battery Management System (BMS).

1.1.1.2 The batteries referred to in the Rules include lithium-ion batteries and high energy density super-capacitors.

1.1.1.3 The battery management system referred to in the Rules includes battery management system of lithium-ion batteries and capacity management system of high energy density super-capacitors.

1.1.1.4 Except as specified in 1.1.1.5, the Rules are applicable to ships the hull of which is constructed with steel or aluminum alloy materials.

1.1.1.5 The Rules are applicable to fiber reinforced plastic ships of less than 20m in length. For fiber reinforced plastic ships of 20 m and over in length, they are to be approved through tests and / or other means in addition to meeting the applicable requirements of the Rules. The ship's safety level, in addition to meeting the goal and functional requirements of 1.1.2 and 1.1.3, is to consider the following measures:

- (1) Taking corresponding operational restrictions on the safety risks caused by the application of storage batteries on ships;
- (2) Taking corresponding fire safety measures for the fire safety risk caused by the application of storage batteries on ships;
- (3) Taking corresponding safety evacuation measures for the relevant danger caused by the application of storage batteries on ships.

1.1.1.6 The Rules are not applicable to high-speed craft.

1.1.1.7 Those that are not covered in the Rules are to meet relevant requirements in corresponding CCS rules.

1.1.2 GOAL

1.1.2.1 The goal of the Rules is to achieve battery-powered ships' safety and reliability under the following conditions by putting forward product quality requirements, health requirements, safe technology requirements, ship arrangement requirements, fire-fighting requirements, survey and test requirements of batteries involved in battery-powered ships:

- (1) Navigation;
- (2) Entering and leaving ports;
- (3) Docking and undocking;
- (4) Operation;
- (5) Berthing;
- (6) Emergency;

- (7) Charging;
- (8) Maintenance.

1.1.3 FUNCTION

1.1.3.1 In order to achieve the goal of 1.1.2.1, battery-powered ships are to meet the functions of 1.1.3.2 to 1.1.3.5.

1.1.3.2 The battery system is to be able to communicate effectively with the ship management system, accept its management, and upload important parameters.

1.1.3.3 The electric power propulsion system is to be able to ensure the normal propulsion of the ship, and is to have the following functions:

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

1.1.3.4 The fire protection system is to be able to contain, control and suppress the battery fire and explosion in the compartment of origin.

1.1.3.5 Battery powered ship classed with CCS is to be able to transmit key parameters of battery power system to CCS survey and verification platform for battery-powered ships.

1.1.4 SAFETY CLASSIFICATION

1.1.4.1 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. Safety classification is to be completed during the battery cell survey stage.

1.1.4.2 For batteries applicable to 1.1.1.1, risk assessment report must be provided. The report needs to reflect various elements included in safety classification in Table 1.1.4.6 and present judgement result. All judgement needs to be based on theoretical analysis and test data.

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

1.1.4.4 Batteries that have not passed the thermal runaway propagation test are forbidden onboard. The thermal runaway propagation test is to meet the corresponding requirements of CCS survey guidelines for marine lithium-ion battery products.

1.1.4.5 Batteries that have not passed the thermal runaway propagation test are forbidden onboard. The thermal runaway propagation test is to meet the corresponding requirements of CCS survey guidelines for marine lithium-ion battery products, and the test results are to meet the requirements of 6.3.4.3.

1.1.4.6 Batteries are classified as per Table 1.1.4.6. Safety level gradually increases from level 1 to level 2. Batteries with safety level 1 can be used onboard after strict protection is provided; batteries with safety level 2 can be used onboard after universal safety measures are adopted.

List of safety levels

Table 1.1.4.6

Safety Level	Thermal runaway		Combustion (explosion) risks
	Releases oxygen	Releases toxic, flammable gas	
1	√	√	Relatively high
2		√	Relatively low

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

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

1.1.4.9 The batteries of passenger ships over 50 meters in length or carrying over 150 passengers, and all ships carrying dangerous goods (including in bulk and in packaged form), oil tankers and liquefied gas carriers are to be safety level 2, and the protection level of the battery pack is not to be lower than IP67. The temperature regulation measures and fire prevention and control measures are to meet the requirements of 6.4.3.4 and 6.4.3.5.

1.1.4.10 The batteries of fibre reinforced plastic ships are to be safety level 2, and the protection level of the battery pack is not to be lower than IP67. The temperature regulation measures and fire prevention and control measures are to meet the requirements of 6.4.3.4 and 6.4.3.5.

1.1.5 CLASS NOTATIONS

1.1.5.1 Where only batteries are used as propulsion power during ship's normal operation and compliance with relevant requirements of the Rules is confirmed, the following class notation may be assigned upon the request of the ship owner or the shipyard/the designer and subject to CCS plan approval and survey:

Battery (Power)

1.1.5.2 Where batteries are used as partial propulsion power or energy storage source during ship's normal operation and compliance with relevant requirements of the Rules and the Guidelines for Survey of Hybrid Ship is confirmed, the following class notation may be assigned upon the request of the ship owner or the shipyard/the designer and subject to CCS plan approval and survey:

Battery (Power-h)

1.1.5.3 Where the ship is capable of sending the parameters of its battery power system, distribution system and electrical propulsion system to the CCS survey and verification platform for battery powered ships, and compliance with relevant requirements of the Rules is confirmed, the following class notation may be assigned upon the request of the ship owner or the shipyard/the designer and subject to CCS plan approval and survey:

Power-R

1.1.6 DEFINITIONS

1.1.6.1 Definitions and terms included in the Rules 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, 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 system that monitors the status of the battery (temperature, voltage, state of charge, etc.), provides communication, safety, battery cell balance and management control, and provides communication interface with the application equipment.

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

(8) Ship management system can be power management system (PMS) and/or energy management system (EMS) and/or alarming and monitoring system(AMS).

(9) 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).

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

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

(12) Depth of Discharge (DoD) means the percentage of the discharged capacity of the battery in its nominal capacity during use.

(13) Thermal runaway means the phenomenon of chain reaction of uncontrollable rising of temperature of batteries triggered by battery cell's heat release.

(14) Thermal runaway propagation means 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.

(15) 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).

1.1.7 PLANS AND DOCUMENTS

1.1.7.1 For ship survey, in addition to the plans required by relevant CCS rules, for battery-powered ships, the following plans and documents are to be submitted to CCS for approval:

(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) Short-circuit current calculation and protection coordination analysis of direct current busbar system^①(applicable to ships whose converter's total power is over 200kW when connected by energy storage systems possibly in the network simultaneously);
- (5) Arrangement diagram of battery cabins, battery box(cabinet);
- (6) Ventilation system(including emergency exhaust system) diagram and calculation of battery cabin, battery box(cabinet) (if applicable);
- (7) Temperature regulation device diagram and calculation of battery cabin, battery box (cabinet) (if applicable);
- (8) Fire prevention plan of battery cabins;
- (9) Fixed fire detection and fire alarm system diagram, arrangement diagram of battery cabins (which may be combined with ship's fixed fire detection and fire alarm system diagram, arrangement diagram);
- (10) Fire extinguishing system arrangement diagram and extinguishing medium calculation of battery cabins;
- (11) Combustible gas detection system diagram and arrangement diagram;
- (12) Temperature monitoring and alarm system diagram and arrangement diagram.

1.1.7.2 Risk assessment of battery-powered ships is to be completed by battery manufacturers, battery system set makers, and ship design companies respectively based on its intended usage, and provided to CCS for information. 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 Rules are complied with, and all potential hazard represented by the battery type(chemical) intended to be used, and is to at least include the following:
 - 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.

^①For the calculation of short-circuit current and selective protection analysis of DC busbar system, please refer to the relevant requirements in Section 4 of Chapter 3 of the Guidelines for Survey of DC Integrated Electrical Systems of Ships.

Section 2 BATTERY AND SYSTEM RELIABILITY REQUIREMENTS

1.2.1 BATTERY RELIABILITY REQUIREMENTS

1.2.1.1 The reliability of the battery is, in addition to satisfying the requirements of the corresponding international and domestic standards^①, to satisfy the quality, health and safety requirements of the corresponding sections in Chapter 6 of the Rules.

1.2.2 BATTERY SYSTEM RELIABILITY REQUIREMENTS

1.2.2.1 The reliability of the battery system with a system power of less than 100kWh is to satisfy the relevant requirements of the national standard GB 38031 "Safety Requirements for Power Battery for Electric Vehicles" or equivalent standard.

1.2.2.2 The reliability of the battery system with a system power greater than or equal to 100kWh is to satisfy the relevant requirements of the national standard GB/T36276 "Lithium-ion Battery for Electric Energy Storage" or equivalent standard.

1.2.3 EQUIPMENT OF BATTERIES

1.2.3.1 For ships that have batteries provided for main power supply and propulsion power respectively, batteries are to meet the following conditions respectively:

(1) At least two sets of independent batteries are to be equipped for main power supply, the electricity quantity 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 electricity quantity 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 inland waterways ships of less than 20 m in length, the main source of electrical power is to be provided in accordance with the requirements of the Rules for Construction of Inland Waterways Boats and corresponding regulations. For sea-going ships of less than 20 m in length, the main source of electrical power is to be provided in accordance with the requirements of the Rules for Classification of Sea-going Boats and corresponding regulations. For yachts, the main source of electrical power is to be provided in accordance with relevant rules and regulations.

(2) For electric propulsion power supply, at least two independent set of batteries are to be provided, the design power of each battery set is to be similar, and the total capacity is enough for electric power needed for ship's voyage. In case of failure of any set of batteries, the capacity of the remaining battery set can sustain the ship to reach the nearest port.

1.2.3.2 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) The outfitting, function and total capacity of batteries are to meet the provisions of

^①Such as GB38031-2020 (safety requirements for power batteries for electric vehicles), GB / T36276-2018 (lithium-ion batteries for electric energy storage) or related standards.

1.2.3.1;

(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) The main busbar is divided into at least two sections and set in one of the following ways:

① No connection between the sections, and separate power supply is implemented;

② Bus protection device is to be connected between the sections. In case of short circuit or similar failure in the main busbar, the bus-tie protection device is to be the first to operate to ensure the normal power supply on the non-failure side. The solid state switch is preferably used for the bus-tie protection device. When other types of protection devices are used, documents are to be submitted stating that the protection device can achieve the same selectivity under any working condition.

(4) The battery sets, propulsion system equipment and other equipment are to be equally connected to the main busbar section;

(5) At least one battery set is to be connected to each section of the main busbar. When any section of the battery set is not working, the battery sets of the remaining sections are to sustain the effective propulsion and steering of the ship by the propulsion system and equivalent steering equipment, and the electricity utilization of other equipment. At the same time, a certain speed is to be maintained until the ship reaches the nearest port.

(6) Effective measures are to be taken to avoid the power loss of the whole ship due to a single failure.

(7) Effective measures are to be taken to prevent multiple insulation resistance monitoring devices from working at the same time.

1.2.3.3 The battery capacity of the battery system of hybrid powered ships may not have to meet the requirements of 1.2.3.1 and 1.2.3.2.

1.2.3.4 The requirement of battery system main busbar section of hybrid powered ships may not have to meet the requirements of 1.2.3.2.

1.2.3.5 Within the specified power supply time range, battery's final discharging voltage, final discharging capacity (depth of discharge) are to meet requirements in the specifications provided by the manufacturer.

1.2.3.6 The total battery capacity of the ship is to consider the capacity fading of the battery in its service life.

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

Section 3 SURVEY

1.3.1 PRODUCT SURVEY

1.3.1.1 The battery enterprises applying for product survey (except for supercapacitors) are to at least meet the Standard Conditions of Lithium-ion Battery Industry (2021) and the Administrative Measures of Lithium-ion Battery Industry Standards Announcement (2021) issued by the Ministry of Industry and Information Technology.

1.3.1.2 Product survey is to satisfy the requirements of relevant CCS rules, regulations and

CCS survey guidelines for marine lithium-ion battery products for applying battery-powered ship related products.

1.3.1.3 Unless otherwise specified, the ship battery system and its components are to hold certificates as required in Table 1.3.1.3.

List of marine battery system certificates

Table 1.3.1.3

No.	Name of Product	Document		Approval Mode				Plan Approval
		C/E	W	DA	TA-B	TA-A	WA	PA
1	Battery system	X	—	—	—	—	—	X
1.1	Battery module/ battery pack	X	—	—	X	—	—	X
1.1.1	Battery cell	X	—	—	X	—	—	X
1.1.2	Battery management system(slave)	—	X	—	X	—	—	X
1.1.3	Sensor	—	X [±]	—	X ¹	—	—	X
1.1.4	Wire and cable	—	X	—	—	—	X	X
1.1.5	Fire prevention and control device (battery pack part, if equipped)	X	—	—	X	—	—	X
1.2	High voltage box (cabinet)	X	—	—	—	—	—	X
1.2.1	Battery management system (main control)	X	—	—	X	—	—	X
1.2.2	Circuit breaker	—	X	—	X	—	—	X
1.2.3	DC circuit breaker	—	X	—	X ³	—	—	X
1.2.4	Electrotechnical instrument	—	X	—	X	—	—	X
1.2.5	Contactor	—	X	—	X	—	—	X
1.2.6	Power conversion device (charger, frequency converter with 50kw and above, etc.)	X	—	—	X	—	—	X
1.2.7	Relay	—	X	—	X ³	—	—	X
1.2.8	Fuse	—	X	—	X ³	—	—	X
1.2.9	Display	—	X [±]	—	X ¹	—	—	X
1.2.10	Wire and cable	—	X	—	—	—	X	X
1.3	Wire and cable	X ²	—	—	—	—	X	X
1.4	Fire prevention and control device	X	—	—	X	—	—	X

Note:

1. If the certificate of the purchased parts cannot meet the requirements, the complete set of type test is to be carried out with the whole product;
2. It means wires and cables for external connection of battery pack / battery modules;
3. It is acceptable with the special consent of CCS.
4. Symbol description:
(1) C-Product Certificate; E-Equivalent document; W- Manufacturer's document.

(2) DA-Design approval; TA-Type approval; WA-Works approval; PA-Plan approval.

(3) X—Applicable; O—Optional; - —Not applicable.

(4) In case of no "C/E" requirement, the manufacturer is to provide a copy of the corresponding approval certificate along with the manufacturer's document (original) when supplying the products.

For the battery system components required by the product certificate in the Table above, if manufactured by the battery system manufacturer and used only for such products, they are to be inspected in accordance with CCS requirements and the product certificate may not be issued separately.

1.3.2 SHIP SURVEY

1.3.2.1 Survey procedures, survey methods, survey types, survey interval, survey conditions, the preparation before survey, survey, test requirements and the preservation requirements of ship plans, data, certificates, records and reports are to be carried out according to relevant CCS Rules.

1.3.2.2 Survey during construction

1) The surveyor is to confirm that the battery system holds the corresponding certificate as required in Table 1.3.1.3. The battery system certificate is to indicate the safety level of the battery cell.

2) In addition to the requirements of mechanical and electrical equipment and structure division survey according to relevant CCS rules, the following items are to be added to survey during construction:

(1) Inspection of means of access to battery cabins;

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

(3) Inspection and functional test of battery cabin emergency exhaust system, battery box (cabinet) emergency exhaust system (if any);

(4) Inspection and functional test of the ventilation system of the battery cabin / battery box (cabinet);

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

(6) Inspection and functional test of fire detection and fire alarm system in battery cabins /battery boxes(cabinets);

(7) Inspection and functional test of flammable gas detection system in battery cabins /battery boxes(cabinets);

(8) Inspection and function test of fire-fighting equipment inside battery cabins /battery boxes(cabinets) (if any);

(9) Inspection and function test of cooling devices inside battery cabins / battery boxes (cabinets) (if any).

(10) Inspection of explosion-proof electrical equipment in the battery cabins (if needed);

(11) Installation survey of the battery system, including:

a) Visual inspection of each component of the battery system

b) To check whether the arrangement of batteries is easy for replacement, inspection, test and cleaning;

c) 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.

(12) Functional survey of the battery system, including:

- a) Functional test of battery's charging and discharging device;
- b) Functional test of battery management system's safety protection.

(13) Function test of DC power distribution system (see relevant requirements in the Guidelines for Survey of DC Integrated Electrical Systems of Ships for details);

(14) Function test of the electric propulsion system (see the requirements in the corresponding rules of CCS for details);

(15) Functional survey of data transmission between battery system and CCS survey and verification platform;

(16) Plans of containerized mobile power supply products submitted for review (if any);

(17) Onboard arrangement plan of containerized mobile power supply (if any);

(18) The containerized mobile power supply is to pass the battery swap operation test (if any);

(19) Survey of the equipment for transmitting signals externally inside the containerized mobile power supply (if any).

1.3.2.3 Survey after construction

1) Annual survey and intermediate survey: In addition to carrying out annual survey and intermediate survey of mechanical and electrical equipment according to relevant CCS rules requirements(if applicable), the following items are also to be surveyed:

(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;

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

(3) Check whether temperature detection device of battery cells is working normally;

(4) Check whether emergency exhaust system of battery cabins/battery boxes(cabinets) is working normally;

(5) Check whether ventilation system of battery cabins is working normally.

(6) Check whether cooling system of battery boxes(cabinets) is working normally;

(7) Check whether various functions of battery management system are working normally;

(8) Check the effectiveness of the data transmission function between the battery system and CCS survey and verification platform;

(9) Basic data analysis report during the containerized mobile power supply survey cycle (when applicable).

2) Special survey: In addition to meeting the relevant requirements of relevant CCS rules for special survey for mechanical and electrical equipment (if applicable) and subparagraph 1), it is to also include:

(1) Functional test of temperature monitoring system of battery boxes(cabinets);

(2) Functional test of emergency exhaust system(emergency exhaust system) of battery boxes(cabinets);

(3) Functional test of ventilation system of battery cabins;

(4) Functional test of battery management system;

(5) The containerized mobile power supply is to pass the battery swap operation test (when applicable).

1.3.3 ALTERNATIVE SURVEY

1.3.3.1 For ships applying for class notations as described in 1.1.5.3, the survey items described in 1.3.2.3 may be subject to equivalent alternative survey as appropriate, according to the evaluation of CCS.

CHAPTER 2 SHIP ARRANGEMENT

Section 1 GENERAL PROVISIONS

2.1.1 GENERAL REQUIREMENTS

Ship arrangement needs to consider battery weight's effect on ship structure and stability, and structural strength check is to be carried out as appropriate.

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

Section 2 REQUIREMENTS OF BATTERIES

2.2.1 GENERAL REQUIREMENTS

If the battery is used as a starter battery, emergency power supply or temporary emergency power supply, its arrangement and installation are to meet the relevant requirements of starting battery, emergency power supply or temporary emergency power supply in CCS "*Rules for Construction of Inland Steel Ship*" or "*Rules for Classification of Sea-Going Steel Ships*" and other relevant CCS rules.

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

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

(2) The batteries with total stored energy of or less than 20kWh 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 2kWh, 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.

Batteries are to be in areas behind collision bulkhead.

Batteries are not to be installed inside accommodation space.

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

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.

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

The door of cabin reserved for batteries and the outside of the battery box (cabinet) are to

have obvious "no smoking or open flames" signs.

Section 3 BATTERY BOX(CABINET)

2.3.1 GENERAL REQUIREMENTS

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

2.3.1.2 The battery box (cabinet) is to be provided with an independent temperature regulating device, which is to meet the relevant requirements of 2.3.3; or the temperature regulating device in the installation space is to be used for temperature adjustment. When using the temperature regulating device in the place where it is installed, the structure and enclosure protection type of the battery box (cabinet) are to ensure the effectiveness of temperature adjustment.

2.3.1.3 When the battery is installed in the battery box (cabinet) in the form of modules, the battery box (cabinet) is to meet the requirements of 6.4.3.11.

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

2.3.1.5 The battery box (cabinet) is to be made of steel the thickness of which is not to be less than 1mm, and each layer of battery inside the box (cabinet) is to be horizontally divided by steel. Horizontal projected area of any battery box (cabinet)' s minimum division unit is not to exceed 1m², but under the following condition, it is not to exceed 1.5m²:

- (1) High energy density supercapacitor, or
- (2) Vertical height of battery boxes (cabinets) is not higher than 1m.

2.3.2 ARRANGEMENT OF BATTERY BOXES(CABINETS)

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

- (1) Horizontal projected area of battery cabin doesn't exceed 1m², or
- (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).

2.3.2.2 For battery boxes (cabinets) arranged on open deck, necessary maintenance spaces and passages such as installation, commissioning, overhaul and replacement are to be considered.

2.3.2.3 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.

2.3.2.4 For the battery box (cabinet) arranged on the open deck, there is to be at least a 900mm distance between the side wall and the bulkhead of the passenger space (except that the battery box (cabinet) or the bulkhead of the passenger space meets the requirements of A-60 fire division), and the distance from openings or exits such as doors, windows, vents, etc. of passenger spaces is at least 1.5m.

2.3.2.5 Battery boxes (cabinets) arranged in enclosed spaces are to meet the requirements of 2.4.2.

2.3.3 COOLING OF BATTERY BOXES (CABINETS)

2.3.3.1 When the battery box (cabinet) is equipped with an independent temperature regulating device, mechanical ventilation or other temperature regulating devices are to be used to prevent the temperature in the battery box (cabinet) from being too high.

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

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

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 between battery boxes (cabinets) and outside air, °C;

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

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

2.3.4 EMERGENCY EXHAUST AND COMBUSTIBLE GAS DETECTION OF BATTERY BOX (CABINET)

2.3.4.1 Battery boxes (cabinets) with safety level 1 is to be equipped with independent non-spark type emergency exhaust system to directly discharge possible toxic/combustible 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.

2.3.4.2 When the protection level of the battery box (cabinet) with safety level 2 is not less than IP67, it is to meet the requirements of 2.3.4.1.

2.3.4.3 An independent combustible gas detection device is to be provided for the battery boxes (cabinets) with safety level 1. When it is detected that the concentration of combustible gas in the battery box (cabinet) is greater than 20% of its lower explosion limit (volume fraction), an audible and visual alarms are to be issued in local, bridge and other spaces on ship where crew are often on duty. At the same time, the emergency exhaust system is automatically activated, and all non-explosion-proof electrical equipment in the box (cabinet) is powered off.

2.3.4.4 The combustible gas detection device is to be compatible with the combustible gas composition generated by the battery in the state of thermal runaway. The number and arrangement of combustible gas detectors are to ensure that the generated combustible gas can be detected at any time.

2.3.4.5 The combustible gas detection device is to be powered by two circuits, one of which is to be powered by a power source other than the battery it serves, and the power supply time is to meet the requirements of corresponding rules for the power supply time of emergency power supply.

2.3.4.6 If the battery box (cabinet) with safety level 2 is arranged in an enclosed space

outside the battery cabin, the requirements of 2.3.4.1 and 2.3.4.2 are to be met.

2.3.5 TEMPERATURE MONITORING AND ALARM OF BATTERY BOX (CABINET)

2.3.5.1 Battery boxes (cabinets) are to be installed with independent temperature monitoring devices., The number and location of temperature detectors are to take full account of the structure type of the box (cabinet). When the temperature in the battery box (cabinet) is higher than the set value, audible and visual alarms are to be sent out in spaces where crew are often on duty.

2.3.5.2 When the battery box (cabinet) is installed inside the battery cabin, and the temperature adjustment in the box (cabinet) is completed by means of the ventilation of the battery cabin or other temperature adjustment devices, the temperature monitoring and alarm of the battery cabin required in 2.4.5.1 can be used instead of the temperature monitoring and alarm in the battery box(cabinet) required in 2.3.5.1.

2.3.6 EQUIPMENT REQUIREMENTS IN BATTERY BOX (CABINET)

2.3.6.1 Heat source equipment unrelated to batteries are not to be installed inside the battery box (cabinet).

2.3.6.2 Installation of electrical equipment unrelated to batteries inside 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 boxes(cabinets) ' ventilation volume.

Section 4 BATTERY CABINS

2.4.1 GENERAL REQUIREMENTS

2.4.1.1 For ships of greater than 15 m 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.

2.4.1.2 The battery system subdivision arrangement requirements for hybrid powered electric ships may not be required to meet the requirements of 2.4.1.1. However, in the case that the ship is of greater than 15m in length, the battery system works independently under a specific operating condition of the ship, and other power sources cannot be immediately put into service in case of failure of the battery system, the batteries are to be subdivided.

2.4.1.3 Water is not to be the first choice for overall fire extinguishing of battery system in battery cabins. If water fire extinguishing system is used, corresponding protective measures are to be taken to prevent secondary disasters caused by water fire extinguishing.

2.4.2 ARRANGEMENT OF BATTERY CABINS

2.4.2.1 Battery cabins are not to be arranged adjacent to 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 requirements of 5.2.1.

2.4.2.2 The battery cabin door is not to be opened towards accommodation spaces.

2.4.2.3 When the battery box (cabinet) or battery pack arranged in the battery cabin is

ventilated and dissipated by means of the battery cabin, 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 and above in length, the net distance from the bulkhead is not to be less than 150mm, and the net distance from the bulkhead strengthening structure is not to be less than 100mm; The net distance from the upper deck is not to be less than 500mm, and the net distance from the upper deck strengthening structure is not to be less than 150mm. For ships less than 20m in length, the net distance from bulkhead and upper deck is not to be less than 150mm, and the net distance from bulkhead and upper deck strengthening structure is not to be less than 100mm.

2.4.2.4 Battery box(cabinet) and battery pack arranged in the battery cabin are to be fixed securely and be as far away from ship outboard side as possible to avoid impact of collision. The minimum horizontal distance from the battery box (cabinet) and battery pack to the hull outer plate and structure is not to be less than 500mm, and the minimum horizontal distance to the inner plate and structure of the catamaran hull is not to be less than 300mm. For ships less than 20m in length, the minimum horizontal distance to the outer plate and structure of the hull may be reduced to 300mm, and the minimum horizontal distance to the inner plate and structure of the catamaran hull may be reduced to 150mm.

2.4.2.5 The layout of the battery system related equipment arranged in the battery cabin is to consider the necessary maintenance space and access for installation, commissioning, overhaul, and replacement.

2.4.3 COOLING OF BATTERY CABINS

2.4.3.1 Battery cabins are to be equipped with mechanical ventilation or other temperature regulating device to prevent the ambient temperature of batteries from being too high. Battery cabins provided with mechanical ventilation are to meet the requirement of 5.2.2.1.

2.4.3.2 When mechanical ventilation is adopted, in addition to the normal ventilation of the battery cabins, 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:

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

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 between battery cabins and outside air, °C;

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

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

2.4.4 EMERGENCY EXHAUST AND FLAMMABLE GAS DETECTION OF BATTERY CABINS

2.4.4.1 Battery cabins installed with batteries of safety level 2 are to be installed with emergency exhaust system which meets the requirements of 5.2.2.2.

2.4.4.2 Battery cabins with batteries of safety level 2 inside are to be provided with independent flammable gas detection devices. When the concentration of flammable gas in the battery cabins is detected to be more than 20% of its lower explosion limit (volume fraction), audible and visual alarms are to be activated in local, navigation bridge and other spaces on ship where crew are often on duty, and the emergency exhaust system is to be activated automatically, and power off all non-explosion-proof electrical equipment in the battery cabin.

2.4.4.3 The flammable gas detection device is to meet the requirements of 2.3.4.4 and 2.3.4.5.

2.4.5 TEMPERATURE MONITORING AND ALARM OF BATTERY CABINS

2.4.5.1 Battery cabins are to be installed with independent temperature monitoring devices. The number and location of temperature detectors are to take full account of the type of locations. When the temperature in the battery cabin is higher than the set value, audible and visual alarms are to be sent out in places where crew are often on duty.

2.4.6 FIRE DETECTION AND ALARM OF BATTERY CABINS

2.4.6.1 The setting of battery cabin fire detection and alarm is to meet the requirements of 5.2.3.

2.4.7 EQUIPMENT REQUIREMENTS IN BATTERY CABINS

2.4.7.1 Heat source equipment and pipelines (vapor, liquid, etc.) unrelated to the battery are not to be installed in the battery cabins. When steam, liquid and other pressure pipelines must pass, it is to be forbidden to set up their flange joints in the battery cabins, or take reliable protective measures.

2.4.7.2 Installation of electrical equipment unrelated to the battery system in the battery cabin are to be avoided. If it must be installed, it is to be as far away from the batteries as possible, and its calorific value is to be included in the calculation of the ventilation volume of battery cabins' ventilation volume.

2.4.7.3 In the battery cabins, the electrical equipment that needs to be maintained in the state of thermal runaway of the battery is to be explosion-proof, such as fire detection equipment, fixed fire extinguishing agent release pre-alarm, flammable gas detection device and alarm, emergency exhaust system, etc. The specific explosion-proof requirements (explosion-proof type, explosion-proof category, temperature group) are to be determined according to the composition of the gas generated by the thermal runaway of different types of batteries, and can cut off the non-explosion-proof electrical equipment in the battery cabin that does not need to work.

CHAPTER 3 BATTERY POWER SYSTEM MONITORING, ALARMING AND CONTROL

Section 1 SHIP MANAGEMENT SYETEM

3.1.1 GENERAL REQUIREMENTS

3.1.1.1 The ship is to be provided with a ship management system for monitoring, alarming and control of the ship's power system (including battery system and other power equipment, power distribution system and propulsion system). The ship management system is to be arranged in the area on ship where the crew is on duty.

3.1.1.2 According to the difference of the total battery power of the ship, the ship management system can be the power management system (PMS) or the energy management system (EMS) or the monitoring and alarm system (AMS).

3.1.1.3 For battery-powered ships with total stored energy of greater than 100 kWh, the power management system (PMS) or energy management system (EMS) of the power station is to be set as the ship management system.

3.1.1.4 For battery-powered ships with total stored energy of less than or equal to 100kWh, monitoring and alarm system (AMS) is to be set as the ship management system.

3.1.1.5 The ship management system is to have the function of data storage, and the archive period of monitoring data is not to be less than the annual survey period.

3.1.1.6 The ship management system is to have the function of remote data transmission, and is to be able to transmit the data required by Section 5, Chapter 6 of the Rules from the BMS to the ship management system, the parameters of the ship's power distribution system required to be tested in the *Guidelines for Survey of DC Integrated Electrical Systems of Ships*, and the parameters of the electric propulsion system to be tested in the corresponding CCS rules to CCS survey and verification platform for battery-powered ships, so as to realize the monitoring and management of the battery power system by the CCS survey and verification platform for battery-powered ships.

3.1.1.7 When the communication is abnormal, the ship management system is to store the collected real-time data into the storage media, and the data is to be re-transmitted after the communication is restored.

3.1.1.8 If special equipment is used for data remote transmission, the relevant hardware and software of the computer system used by the special equipment are to meet the requirements of Class III computer system, and are to hold the marine product certificate or certificate of conformity or be approved by CCS.

3.1.2 POWER/ENERGY MANAGEMENT SYSTEM

3.1.2.1 The PMS or EMS of the ship's power station is to be able to collect and display important parameters of the battery system and the ship's power distribution system, including but not limited to the following:

- (1) The charging and discharging state of each battery system;
- (2) The state of charge (SOC) of each battery system;
- (3) The charging and discharging power of each battery system;
- (4) The total voltage and total current of each battery system;
- (5) The state of the breakers and busbar (isolation) switch, such as battery bank, propulsion system, daily load power converter;
- (6) Distribution board busbar voltage;
- (7) If AMS is provided, for all fault information of battery system, power distribution system and propulsion system, only serious fault information needs to be displayed;
- (8) The battery system can provide real-time information on how long or how far the vessel will remain underway with its remaining power.

3.1.2.2 PMS or EMS is to be able to control and deploy all power stations and energy storage systems of the ship, and provide sufficient power for the ship's electrical equipment under the ship's navigation, operation, berthing and other conditions to ensure the ship's safe navigation and normal operation.

3.1.2.3 The power station PMS or EMS is to include monitoring, alarming and protection functions for the battery system and the ship's power distribution system, and provide complete visualization functions for power/energy management.

3.1.2.4 PMS or EMS is to have but not limited to the following functions:

- (1) DC busbar precharge (if applicable)
- (2) Switching on/off of the battery system;
- (3) Automatic grid connection and load distribution of battery system;
- (4) Overload request (if applicable);
- (5) Automatically removes non-important loads or reduce the propulsion load to prevent battery from overloading;
- (6) Sequence start of important equipment (if applicable);
- (7) Reverse power protection, if the semiconductor converter can block any power feedback, it can be exempted;
- (8) Monitoring, alarming and protection of battery systems, power distribution systems and propulsion systems;
- (9) Able to transfer data to BMS.

3.1.2.5 The design of the PMS or EMS is to ensure that when the system fails, the wrong command signal will not be issued.

3.1.3 ALARMING AND MONITORING SYSTEM

3.1.3.1 The AMS is to be able to monitor and give alarm for the battery power system, and is to be arranged in the area on ship where the crew is on duty.

3.1.3.2 AMS is to be able to communicate with BMS, and to be able to accept and process battery system information collected and summarized by BMS.

3.1.3.3 The AMS is to be able to display all fault information of the battery system, power distribution system and propulsion system, and to give audible and visual alarms in the event of a fault.

Section 2 SHORE BASED SYSTEM

3.2.1 GENERAL REQUIREMENTS

3.2.1.1 The shore-based system of battery-powered ships mainly includes AC shore power source or DC charging device.

3.2.1.2 The monitoring, alarm and control of AC shore power supply are to meet the requirements of relevant CCS rules.

3.2.1.3 The monitoring, alarm and control of the DC shore-based charging device are to meet the relevant requirements of Section 7, Chapter 6 of the Rules.

Section 3 SHORE BASED MONITORING PLATFORM

3.3.1 GENERAL REQUIREMENTS

3.3.1.1 If the ship power system operation data is connected to CCS survey and verification platform for battery-powered ships through the shore-based monitoring platform, the shore-based monitoring platform is to be approved by CCS.

3.3.1.2 The shore-based monitoring platform is to be set in battery companies, ship management companies or third-party institutions.

3.3.1.3 Shore-based monitoring platform is to monitor the running state of battery-powered ships in operation stage.

3.3.1.4 The monitoring data is to be archived for no less than the expected life cycle of the battery system.

3.3.1.5 The update of monitoring data is to meet the operational state monitoring requirements of the Rules. The collection, transmission, storage and other activities of monitoring data are to meet the relevant requirements of CCS *Guidelines for Verification of Digital Systems for Ships and Offshore Installations* to ensure the reliability, integrity and timeliness of the data. CCS regularly assesses the quality of the data retained by the shore-based monitoring platform, and the data quality is to meet the CCS *Guidelines for Data Quality Assessment*.

3.3.1.6 Monitoring data is to be stored within China in accordance with relevant laws and regulations. If such data needs to be provided abroad, it is to pass the data exit security assessment.

3.3.1.7 For the battery-powered ships applying for the class notation mentioned in 1.1.5.3, the relevant data is to be connected to CCS survey and verification platform for battery-powered ships in accordance with the requirements of the Rules.

3.3.2 MONITORING DATA MANAGEMENT REQUIREMENTS

3.3.2.1 The data during transmission between the ship power system operation data and the shore-based monitoring platform and CCS survey and verification platform for battery-powered ships is to be encrypted, and the encrypted data is to have confidentiality, integrity, accuracy, availability and tamper-proof modification.

3.3.2.2 TCP/IP network control protocol is to be used as the underlying communication bearer protocol for data transmission between ship operation data, shore-based monitoring

platform and CCS survey and verification platform for battery-powered ships. The data information is to be transmitted to CCS survey and verification platform for battery-powered ships in the manner required by *CCS Technical Guidelines for Digital Ship Survey Data Exchange*.

3.3.2.3 The transmission data package is to provide precise date and time, and the time error is to be within $\pm 5s$.

3.3.2.4 The ship operation data collected by shore-based monitoring platform is to be real-time data. The collection frequency of important monitoring data is to be no less than 1 time /s, and the collection frequency of other operation data is to be no less than 1 time /5min.

3.3.2.5 The shore-based monitoring platform is to keep the collected real-time data in the storage medium at intervals not exceeding 30s. When a serious alarm occurs in the ship's operation data (such as power reduction, power system stops running, overriding, etc.), the collected real-time data is to be kept in the internal storage medium at intervals not exceeding 1s.

3.3.2.6 The capacity of the ship-side data storage media is to be able to ensure that the data can be stored cyclically for at least 1 month. The capacity of the ship-side data storage media is not to be lower than the data requirements of the ship's expected life cycle.

3.3.2.7 When the shore-based monitoring platform is powered off and stops working, the data stored in the storage medium before power off is to be kept intact.

3.3.2.8 After the external power supply is disconnected, the shore-based monitoring platform is to ensure that it can still operate independently, and the capacity of the backup power supply can ensure that the collected data of the last 30 minutes can be transmitted to CCS survey and verification platform for battery-powered ships.

3.3.2.9 When the communication is abnormal, the shore-based monitoring platform is to store the collected real-time data in the storage medium. After the communication is restored, the data is to be reissued and transmitted to the CCS survey and verification platform for battery-powered ships.

3.3.2.10 The shore-based monitoring platform is to have a self-test function, and is to verify the received data to ensure the correctness of data information transmission and data format.

CHAPTER 4 BATTERY POWER DISTRIBUTION SYSTEMS

Section 1 GENERAL PROVISIONS

4.1.1 GENERAL REQUIREMENTS

4.1.1.1 In addition to the Rules, the power battery distribution system of the ship is also to comply with the relevant requirements for the ship's power distribution system of relevant CCS rules.

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

4.1.1.3 In the event of fault condition, the power battery distribution system and equipment of the ship are to 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 are injured.

4.1.1.4 The voltage and frequency fluctuations of the ship's power battery distribution system are to comply with the requirements of CCS rules. If a higher level of fluctuation is intended, 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 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.

4.1.1.6 A single fault in the cooling system serving the distribution system is not to result in a power failure throughout the entire ship.

Section 2 DC POWER DISTRIBUTION SYSTEMS

4.2.1 GENERAL REQUIREMENTS

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

4.2.1.2 Protection equipment is to provide overcurrent protection, including short circuits protection. The protection equipment used is to be fully selective and meet the relevant requirements of Chapter 3 of the *Guidelines for Survey of DC Integrated Electrical Systems of Ships* and the requirements of 6.6.1.4.

4.2.1.3 The electromagnetic compatibility (EMC) design of DC distribution system is to be analyzed and evaluated according to the standards accepted by CCS, including the impact of

external electromagnetic environment on the system and the mutual influence between strong and weak electrical equipment within the system (self-compatibility), which meets the relevant requirements of Chapter 5 of the *Guidelines for Survey of DC Integrated Electrical Systems of Ships*.

4.2.1.4 Battery-powered ships using DC bus 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.

4.2.1.5 The safety assessment of the DC bus 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 are to be considered;
- (3) Risk control measures;
- (4) Safety actions that need to be taken;
- (5) Electrical protection concept;
- (6) Software design and safety evaluation;
- (7) To form a FMEA report.

4.2.1.6 The DC bus system is to be provided with a functional description which is to 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.

4.2.1.7 The DC bus 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 are 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^① DC bus system is used in other ships, it is not necessary to test again, and only the first ship test report is needed.

Section 3 AC POWER DISTRIBUTION SYSTEMS

4.3.1 GENERAL REQUIREMENTS

4.3.1.1 When the ship sets up AC distribution system, the relevant technical requirements are to meet the requirements of the corresponding CCS rules.

^①The same type refers to the unprincipled change of the system topology, protection principle and control logic.

CHAPTER 5 FIRE PROTECTION

Section 1 GENERAL PROVISIONS

5.1.1 GENERAL REQUIREMENTS

5.1.1.1 In addition to meeting requirements in this Chapter, ship fire safety is also to meet corresponding CCS rules and relevant requirements of the Administration.

5.1.1.2 Fire safety systems and equipment required in this Chapter are to meet the requirements of the *International Code for Fire Safety Systems* (FSS CODE) or the Administration.

5.1.1.3 If the fire safety design and arrangements adopted are deviated from the requirements of this Chapter, it is to be verified by test or other methods that the design and arrangement have the same safety performance and functional requirements as the requirements of this Chapter (or is superior to the requirements of this Chapter), according to the procedures specified in *CCS Guidelines for Application of Alternative Design and Arrangements of Ships*.

Section 2 FIRE PREVENTION AND FIRE DETECTION

5.2.1 THERMAL AND STRUCTURAL SUBDIVISION

5.2.1.1 Bulkheads and decks between battery cabins and other adjacent spaces are to be "A-60" class divisions, but for open spaces and spaces having little or no fire risk such as voids, bathroom and similar spaces or open spaces (except for cargo spaces and ro-ro spaces), these above-mentioned divisions may be reduced to "A-0".

5.2.1.2 For passenger ships of 20m or more in length, bulkheads and decks between battery cabins and external means of escape are to be "A-60" divisions.

5.2.1.3 Battery cabins are to be isolated from fuel oil or lubricating oil tanks, and there is to be no common boundaries between them. The fuel tank with a flash point of no more than 60 °C is to be isolated from the battery cabin by a void of at least 900 mm.

5.2.1.4 5.2.1.1 and 5.2.1.2 are not applicable to fiber reinforced plastic ships.

5.2.2 VENTILATION SYSTEM

5.2.2.1 The mechanical ventilation system equipped in the battery cabins is to meet the following requirements:

- (1) Ventilation ducts are to be of steel or other equivalent materials;
- (2) The arrangement of ventilation system is to ensure that all spaces in battery cabins can be effectively ventilated;
- (3) The ventilation systems of each battery cabin are to be independent from each other and completely separated from the ventilation systems serving other spaces;
- (4) For ships of 20m and over in length, ventilation ducts for the battery cabins are not to pass through accommodation spaces, service spaces, control stations, machinery spaces, ro-ro

spaces, vehicle spaces, special category spaces or other battery cabins. If the requirements of 5.2.2.1 (6) are met, the ventilation ducts for the battery cabins can pass through accommodation spaces, service spaces (except kitchens), control stations, machinery spaces or other battery cabins;

(5) For ships of 20m and over in length, ventilation ducts for accommodation spaces, service spaces, control stations, machinery spaces, ro-ro spaces, vehicle spaces or special category spaces are also not to pass through battery cabins. If the requirements of 5.2.2.1 (6) are met, the ventilation ducts for accommodation spaces, service spaces (except kitchens), control stations or machinery spaces can pass through the battery cabins;

(6) The ducts permitted in (4) and (5) above are to be:

① The ducts are made of steel having a thickness of at least 3mm for ducts the widths or diameters of which are 300 mm and below, having a thickness of at least 5mm for ducts the widths or diameters of which are 760 mm 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 properly supported and reinforced;

③ Automatic fire damper is set near the boundary where the ducts pass through; and

④ Within the range of at least 5m from the boundary of the spaces serviced to each fire damper, the thermal insulation is "A-60" standard;

or

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

⑥ The ducts are properly supported and reinforced;

⑦ Ducts that pass through all spaces are insulated to "A-60" standard, except for the ducts passing through voids, toilets and similar spaces where there is little or no fire risk.

(7) 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;

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

(9) Control facility is to be provided to permit a shut down from a safe position outside the battery cabins.

5.2.2.2 For battery cabins with safety level 2, independent emergency exhaust systems are to be installed to timely discharge the flammable gas generated in case of thermal runaway of the battery. 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 system is to be automatically activated. The gas from the system is to be led directly to safe locations on open decks, away from inhabited or heat-containing spaces, and at least 3m away from the air inlet of other spaces. The volume of emergency exhaust is to be determined according to the air change rate of the spaces not less than 30 times/h. Emergency exhaust systems are to be of no-spark type. When emergency exhaust system is combined with the ventilation system described in 5.2.2.1, the ventilation system is to meet the requirements of this Paragraph at the same time.

5.2.2.3 The emergency exhaust system is to be powered by two power supplies, one of which is to be powered by other power supply system outside its service area. The power supply

time is to meet the requirements of corresponding rules for the power supply time of emergency power supply.

5.2.2.4 At least two control devices that can cut off the fan in the battery cabins are to be set, one of which must be set outside the outlet of the battery cabins.

5.2.3 FIRE DETECTION AND ALARM

5.2.3.1 A fixed fire detection and fire alarm system is to be installed in battery cabins. 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 and under battery's normal working conditions and ventilation changes needed by ambient temperature range. The battery cabins are not to be equipped with temperature detectors solely. The fire detector is to be applicable to the explosive gas environment formed by mixing the flammable gas generated in case of thermal runaway of the battery with the air.

5.2.3.2 The fixed fire detection and fire alarm system in battery cabins is to be capable of remotely and individually identifying each detector. When the system does not have the function of identifying a single detector, each detector is to be set as an independent loop.

5.2.3.3 The fixed fire detection and fire alarm system is to be powered by two power supplies, one of which is to be powered by other power supply system outside its service area, and the power supply time is to meet the requirements of corresponding specifications for the power supply time of emergency power supply.

Section 3 FIRE EXTINGUISHMENT

5.3.1 GENERAL REQUIREMENTS

5.3.1.1 For ships with water fire extinguishing system, at least 2 water nozzles of spout / spray type are to be equipped near the battery cabins or battery boxes (cabinets) on open deck. Measures are to be provided to ensure that the fire pumps can still work normally when any battery cabin or battery box (cabinet) is on fire. The fire hydrant is to be set at an appropriate position on the ship to avoid the fire in battery cabins or battery boxes (cabinets) making it inaccessible to the crew. The discharge of large amount of water for battery fire is to be fully considered to avoid affecting the stability of the ship.

5.3.1.2 For ships without water fire extinguishing system, at least two fire buckets with ropes of appropriate length are to be equipped near battery cabins or battery boxes (cabinets) on open deck. Ships that are already equipped with two fire buckets could be exempted.

5.3.2 FIXED FIRE EXTINGUISHING SYSTEM FOR BATTERY CABINS

5.3.2.1 Except for the high energy density super capacitor spaces, one of the following fixed fire extinguishing systems is to be set in the battery cabins for protection:

(1) Heptafluoropropane fire-extinguishing system ^①, the extinguishing design concentration of which is to be at least 9%. The system is to be equipped with the extinguishing agent with the same amount as that required as a standby, gas cylinders and

^①Refer to IMO's Revised Guidelines for the Approval of Equivalent Fixed Gas Fire Extinguishing Systems for Machinery Spaces and Cargo Pump Cabins (MSC/CIRC.848 circular) and its amendments or Section 8, Chapter 3, Part 5 of the Technical Rules for the Statutory Survey of Inland Ships (2019).

relevant pipeline accessories, so as to be ready for use at any time. If the battery pack is equipped with the device specified in 5.3.3 of this Section, it is not necessary to provide standby fire extinguishing agent;

(2) Carbon dioxide fire-extinguishing system, the quantity of extinguishing agent of which is to be designed according to at least 40% of the total volume of the space. The system is to be equipped with the extinguishing agent with the same amount as that required as a standby, gas cylinders and relevant pipeline accessories, so as to be ready for use at any time. If the battery pack is equipped with the device specified in 5.3.3 of this Section, it is not necessary to provide standby fire extinguishing agent.

5.3.2.2 Fixed carbon dioxide fire-extinguishing system or heptafluoropropane fire-extinguishing system is to be set in the high energy density supercapacitor spaces, and the quantity of fire extinguishing agent required is to be designed according to at least 40% of the total volume of the space or at least 9% of the designed fire extinguishing concentration.

5.3.3 FIRE PREVENTION AND CONTROL DEVICE FOR BATTERY PACK

5.3.3.1 If the battery pack is equipped with a special fire prevention and control device, the device is to be able to detect the signs of hazard sources that may cause fire, release an alarm, and automatically and/or manually start to ejecting fire extinguishing media. The design, manufacture and test of such devices are to meet the requirements of recognized international or national standards or be agreed by CCS.

5.3.3.2 The fire prevention and control device of battery pack is at least to meet the following requirements:

- (1) It is suitable to the chemical characteristics of the battery used;
- (2) If gas extinguishing agent is used and the number of battery packs protected is more than 8, these battery packs are to be divided into different zones for control. The number of battery packs protected in each zone is not to exceed 8, and the total number of battery packs protected by each device is not to exceed 40;
- (3) When manual release is adopted, it is to be able to operate outside the protected cabin and at a position easily accessible to personnel while measures are to be provided to prevent misoperation.

5.3.4 PORTABLE FIRE EXTINGUISHER

5.3.4.1 For battery cabins with a deck area of 4m² or more, at least four portable heptafluoropropane fire extinguishers or other gas extinguishers are to be provided, and one of them is to be located near the entrance.

5.3.4.2 For battery cabins with a deck area of less than 4m², a sufficient number of portable heptafluoropropane fire extinguishers or other gas extinguishers may be used in place of the fixed fire-extinguishing systems required by 5.3.2. A hole is to be provided in the bulkhead of battery cabins to facilitate the use of fire extinguishers to release the agent into space.

5.3.4.3 Battery boxes (cabinets) placed on open decks or other locations are to be installed with at least four portable heptafluoropropane fire extinguishers or other gas extinguishers near them. For ships with a length of less than 20m, 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

5.4.1 ENTRANCE/EXIT AND MEANS OF ACCESS

5.4.1.1 The door of the battery cabin is to be kept closed. When it is opened, an alarm is to be released at the spaces where someone is on duty, or self-closing door is to be used. The door is to open outward.

5.4.1.2 For battery cabins that persons could enter, the means of escape are to be in accordance with the relevant regulations of the machinery spaces other than machinery spaces of Category A (sea-going ships) or other machinery spaces (inland waterways ships) of the Administration.

5.4.1.3 For battery cabins that persons could enter, where stairway is used as the escape passage, it is to be of steel material, and its angle of inclination is not to be greater than 65°. The clear width of the entrance and the stairway are to be at least 600 mm. For battery cabins of 2m or less in height, vertical ladders^① could be used.

Section 5 SPECIAL REQUIREMENTS FOR FIBER REINFORCED PLASTIC SHIPS

5.5.1 GENERAL REQUIREMENTS

5.5.1.1 Except as expressly stipulated by the flag State government, fiber reinforced plastic ships using lithium iron phosphate batteries are to meet the requirements of this Chapter and this Section.

5.5.2 STRUCTURAL MATERIALS

5.5.2.1 The hull, superstructure, structural bulkheads, decks, deckhouses and columns are to be constructed of incombustible or fire-retardant materials with adequate structural performance. Fire-retardant materials are to be determined by tests in accordance with Part 10 of Annex 1 of the *International Code for Application of Fire Test Procedures* (FTP Code).

5.5.3 FIRE DIVISION

5.5.3.1 The battery cabin is to be enclosed by fire retardant division. Its bulkheads and decks are to be tested in accordance with the requirements of Part 11 of Annex 1 of the FTP Code, and are to have a structural fire protection time of at least 60 minutes. It is also to have a bearing capacity, which can be confirmed by the test that the hull and superstructure will not collapse within this time. The thermal insulation material is to be laid on both sides of the division. However, if it can be confirmed that it is adjacent to the space without fire hazard (such as empty cabin and toilet), the thermal insulation material of bulkhead and deck could only be laid on the side facing the battery cabins. The structure in contact with water below the light load waterline may not be required, but the influence of heat transfer from the non-insulated structure in contact

^①Vertical ladders are to meet relevant national or industrial standards, such as Steel Vertical Ladders for Ships (GB 3892), CB/T81-1999, etc.

with water to the insulated structure above the water surface is to be considered.

5.5.4 OTHER

5.5.4.1 Open flame facilities or equipment for cooking or food heating with single power exceeding 5 kW are not to be provided on the ship.

CHAPTER 6 TECHNICAL REQUIREMENTS FOR BATTERIES USED ONBOARD

Section 1 GENERAL PROVISIONS

6.1.1 GENERAL REQUIREMENTS

6.1.1.1 The design, manufacture and survey of batteries and associated equipment of their systems are to meet relevant provisions of relevant CCS rules, CCS survey guidelines for marine lithium-ion battery products, the Guidelines for Type Approval Test of Electric and Electronic Products and relevant provisions of the Rules.

6.1.1.2 Battery systems are to possess necessary electromagnetic compatibility^①.

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

6.1.1.4 Batteries are to be installed in enclosed spaces such as battery cabin and/or battery box (cabinet) with controllable environment.

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

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

6.1.1.7 The auxiliary materials of battery products are to be flame retardant materials.

6.1.1.8 For the requirements of CCS survey in Sections 2 and 3 of this Chapter, if the on-site survey is infeasible, the survey may be completed by uploading relevant records to the CCS survey and verification platform for battery-powered ships.

Section 2 BATTERY CELL

6.2.1 GENERAL REQUIREMENTS FOR TECHNOLOGY OF BATTERY CELL PRODUCTION LINE

6.2.1.1 The main production process of battery cell is to generally include the preparation and mixing of positive and negative electrode materials, coating, rolling, cutting, winding or stacking, shell assembly, liquid injection, formation, semi-finished product testing, etc.

6.2.1.2 Considering the consistency requirements of battery cell, the main processes of battery cell production are to be completed by an automatic production line.

6.2.1.3 Key technologies such as weight before liquid injection, voltage, capacity, internal resistance and liquid injection volume are to be surveyed by CCS. If an enterprise can achieve capacity prediction, control non-outflow of capacity through process control and capacity prediction and has relevant accuracy basis, it can implement capacity sampling prediction.

6.2.1.4 Abnormal alarm data of production equipment is to be uploaded to CCS survey and verification platform for battery-powered ships. If this is difficult to achieve for some data, it is to

^① Refer to IEC60533 publication Electromagnetic Compatibility of Marine Electrical and Electronic Equipment or corresponding standards.

be recorded and saved locally for at least 15 years for traceability.

6.2.1.5 Dangerous operation procedures are to ensure the safety of on-site operation. Personnel entering and leaving the production line are to wear necessary protective equipment, protective shoes, etc.

6.2.2 REQUIREMENTS FOR ENVIRONMENTAL CONDITIONS OF BATTERY CELL PRODUCTION LINE

6.2.2.1 The ambient temperature of the battery cell production line is to be controllable, and the temperature control floating range of different processes is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.2.2 The ambient humidity of the battery cell production line is to be controllable, and the humidity control floating range of different processes is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.2.3 The dust concentration of the battery cell production line is to be controllable, and the floating range of dust control in different processes is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.2.4 Abnormal alarm data from the environment of battery cell production line is to be uploaded to CCS survey and verification platform for battery-powered ships. If it is difficult to achieve for some data, it is to be recorded and saved locally for at least 15 years for traceability.

6.2.3 REQUIREMENTS FOR BATTERY CELL

6.2.3.1 The preparation of positive and negative electrode materials is to meet the requirements of battery cell model, and the fineness of powder magnetic materials and slurry magnetic materials is to be surveyed by CCS.

6.2.3.2 During the fabrication of positive and negative electrode plates, the density deviation of electrode plate surface, cold pressing thickness deviation and length deviation of electrode plate (measured value - nominal value) are to be surveyed by CCS.

6.2.3.3 Processes such as die-cutting and slitting are to be surveyed by CCS. The vertical burrs beyond the surface of the electrode plate are to be less than 1/2 of the thickness of the diaphragm.

6.2.3.4 The thickness deviation and width deviation of single coiling core are to be surveyed by CCS.

6.2.3.5 Ultrasonic automatic welding is to be adopted for the welding of positive and negative electrode lugs. The welding mark is to be clear, and the electrode lugs are to be free of defects such as cold solder joint, over welding, lack of weld, and skewed electrode lugs.

6.2.3.6 The airtightness after welding of battery cell cover plate and sealing of liquid injection hole is to be surveyed by CCS.

6.2.3.7 After baking, the moisture content of electrode plate is to be surveyed by CCS, and the design value is to be uploaded to the CCS survey and verification platform for battery-powered ships. The moisture content is not to be higher than the design value.

6.2.3.8 The total liquid injection volume is to meet the requirements of the battery cell model. The deviation of the total liquid injection volume is to be surveyed by CCS, and the deviation floating range is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.3.9 The total weight of battery cell is to be surveyed by CCS, and the deviation floating range is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.4 QUALITY REQUIREMENTS FOR BATTERY CELL

6.2.4.1 The production quality of battery cell products of the same batch is to ensure good consistency.

6.2.4.2 For battery cell products produced in the same batch, main battery cell materials are to be consistent, such as the specifications and materials of shell, pole piece and diaphragm, positive and negative electrode materials and electrolyte ratio. Changes in the same production batch are to be recorded with traceability.

6.2.4.3 For battery cell products produced in the same batch, the mechanical property and environmental adaptability are to meet relevant standards accepted by CCS and have good consistency.

6.2.4.4 For battery cell products produced in the same batch, basic electrical performance parameters, including battery cell capacity, voltage and impedance, safety performance, including charge-discharge and short circuit characteristics of battery cell, are to meet relevant standards accepted by CCS and have good consistency.

6.2.4.5 For battery cell products produced in the same batch, the temperature rise, capacity attenuation, and cycle trend during the cycle are to be consistent.

6.2.4.6 For battery cell products produced in the same batch, full inspection is to be carried out to the voltage, AC impedance, capacity, appearance of the battery cell. Periodic tests on battery quality are to be carried out at least every year. The test items include but are not limited to: high temperature, low temperature, vibration and self-discharge rate tests. Each test item is not to be carried out on less than 2 battery cells. Test data is to be uploaded to the CCS survey and verification platform for battery-powered ships. If an enterprise can achieve capacity prediction, control non-outflow of capacity through process control and capacity prediction and has relevant accuracy basis, it can implement capacity sampling prediction.

6.2.4.7 The capacity of finished battery cell is not to be lower than the rated capacity, and the capacity deviation of battery cells produced in the same batch is to be within the given range. The deviation floating range is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.4.8 The AC impedance deviation of battery cells produced in the same batch is to be within the given range. The deviation floating range is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.4.9 The dimension deviation of length, width and height of battery cells produced in the same batch is to be within the given range. The deviation floating range is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.4.10 Each battery cell is to be subjected to performance test when leaving the factory. The corresponding voltage, AC impedance (ACR), total battery weight, battery size parameters and battery cell code number are to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.2.4.11 The pass rate of battery cell product is to be evaluated according to the calculation method provided by the manufacturer, and the pass rate is not to be lower than 94%. If the manufacturer does not provide a formula for calculating the pass rate, the following method is to

be used to calculate the pass rate: pass rate=work order output/work order input.

6.2.4.12 The surface of the battery cell is to be free of electrolyte pollution, shell deformation, pits, damage, bursting diaphragm damage, poor welding and other undesirable conditions.

6.2.5 HEALTH REQUIREMENTS FOR BATTERY CELL

6.2.5.1 The energy retention at the end of the service life of battery cell is not to be less than 80% of the initial value.

6.2.5.2 When the battery cell (except high energy density supercapacitor) conducts 100% DoD cycle at room temperature and reaches 80% SOH of battery cell, the cycle life is not to be less than 4000 times.

6.2.5.3 The energy density of high energy density supercapacitor is not to be less than 85Wh/kg, and the power density is not to be less than 10000W/kg. If it conducts 100% DoD cycle at room temperature and reaches 80% SOH of battery cell, the cycle life is not to be less than 10000 times. If it conducts 80% DoD cycle at room temperature and reaches 80% SOH of battery cell, the cycle life is not to be less than 50000 times.

6.2.5.4 In addition to the requirements of 6.2.5.5, having been stored at room temperature for 28 days under 100% SOC, the charge retention rate of battery cell is not to be less than 95%, and the capacity recovery rate of battery cell is not to be less than 96%. Having been stored for 7 days at high temperature ($55 \pm 2^{\circ}\text{C}$) under 100% SOC, the charge retention rate of battery cell is not to be less than 95%, and the capacity recovery rate of battery cell is not to be less than 96%.

6.2.5.5 The voltage at both ends of the high energy density supercapacitor is not to be less than 98% of rated voltage after it has been opened for 72 hours at room temperature at rated voltage.

6.2.5.6 The operating ambient temperature of the battery cell is to be controlled within the nominal operating temperature range of the battery.

6.2.5.7 Identifiable product code number is to be attached to the battery cell to facilitate management, recovery and traceability. The product coding rules are to be implemented in accordance with GB/T 34014-2017 Coding Rules for Automotive Power Batteries.

6.2.6 SAFETY REQUIREMENTS FOR BATTERY CELL

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

6.2.6.2 When the battery (hereinafter referred to as "soft pack battery") with the battery shell made of composite film and connecting elements (electrodes) is installed and used, the external of each battery cell is to be equipped with a fixed bracket to meet the requirements of effective ventilation, strength, etc.

Section 3 BATTERY MODULE

6.3.1 GENERAL REQUIREMENTS FOR TECHNOLOGY OF BATTERY MODULE PRODUCTION LINE

6.3.1.1 The process capability index of welding drawing force of the battery module is to be

surveyed by CCS, and the process capability index of welding drawing force is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.3.1.2 Abnormal alarm data of key production equipment is to be uploaded to the CCS survey and verification platform for battery-powered ships. Maintenance, replacement and other data are to be recorded and archived for at least 15 years for traceability.

6.3.2 QUALITY REQUIREMENTS FOR BATTERY MODULE

6.3.2.1 The range of battery cell capacity (maximum battery cell capacity-minimum battery cell capacity) in the same battery module is to be within the given range. The range of range fluctuation is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.3.2.2 Under static condition, the static voltage range of battery cell in the same battery module under the state of SOC30%~40% is to be within the given range. The range of range fluctuation is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.3.2.3 The internal resistance range between battery cells in the same battery module is to be within the given range. The range of range fluctuation is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.3.2.4 The external surface of the battery module is to be flat without obvious scratch, deformation and other defects.

6.3.2.5 If the battery module adopts the form of bottom heat dissipation, the bottom flatness deviation is not to be greater than 0.5mm, except for those filled with thermal conductive adhesive.

6.3.2.6 The components of the battery module are to be fastened reliably and free of rust, burrs, cracks and other defects and injuries.

6.3.2.7 The identification contents of battery module are correct, complete and clear.

6.3.3 HEALTH REQUIREMENTS FOR BATTERY MODULE

6.3.3.1 The battery module is to be used under the monitoring circuit of the battery system to provide information (such as voltage, temperature, etc.).

6.3.3.2 The battery module is to be attached with an identifiable code number for management, recycling and traceability. The coding rules are to refer to GB/T 34014-2017 Coding Rules for Automotive Power Batteries.

6.3.3.3 When battery module is discharged at 1C under a high temperature of $55 \pm 2^\circ\text{C}$ and any single voltage reaches 2.5V, the capacity retention rate is not to be less than 95%. When battery module is discharged at 1C under a low temperature of $-20 \pm 2^\circ\text{C}$ and any single voltage reaches 2.0V, the capacity retention rate is not to be less than 70%.

6.3.4 SAFETY REQUIREMENTS FOR BATTERY MODULE

6.3.4.1 The auxiliary material of the battery module is to be flame retarding material.

6.3.4.2 The battery cell is to be firmly fixed in the battery module. The battery module is to have sufficient preload to prevent deformation or cracking caused by the battery cells.

6.3.4.3 The battery pack consists of a battery module. The design of battery modules is to make sure that when thermal runaway occurs to any battery cell of the battery module, it is not to

trigger thermal runaway of other battery cells; or, if a battery pack consists of two or more battery modules, the design is at least to ensure that when thermal runaway occurs to a battery cell, 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 in accordance with one of the following methods:

(1) Thermal runaway propagation among battery cells within the same module is not to happen, or

(2) Thermal runaway propagation among battery modules is not to happen.

Among them, the maximum electric energy of a single module with thermal runaway propagation among battery cells in the same module is not to exceed 4kWh.

Section 4 BATTERY PACK

6.4.1 QUALITY REQUIREMENTS FOR BATTERY PACK

6.4.1.1 The range of battery cell capacity in the same battery pack and the range of battery pack capacity are to be within the given range. The range of range fluctuation is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.4.1.2 The AC impedance range among battery cells within the battery pack is to be within the given range. The range of range fluctuation is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.4.1.3 The external surface of the battery pack is to be flat without obvious scratch, deformation and other defects.

6.4.1.4 The components of the battery pack are to be fastened reliably and free of rust, burrs, cracks and other defects and injuries.

6.4.1.5 The identification contents of battery pack are to be correct, complete and clear.

6.4.2 HEALTH REQUIREMENTS FOR BATTERY PACK

6.4.2.1 The SOC of battery cells in the battery pack is to be kept above 20% as far as possible. If it is lower than this value, the battery pack is to be charged, except for high energy density supercapacitor.

6.4.2.2 When the voltage range of battery cells exceeds the limit value, balance control is to be carried out at the battery pack level.

6.4.2.3 If the operating ambient temperature of battery pack is 0°C and below, heating device is to be arranged based on the charging and discharging capacity of the battery. When the temperature of battery cells reaches the set temperature (the recommended value is 10°C), the heating device is to stop heating.

6.4.2.4 The battery pack is to contain monitoring circuits that provide information (such as voltage, temperature, etc.) for the battery system.

6.4.3 SAFETY REQUIREMENTS FOR BATTERY PACK

6.4.3.1 Battery packs are to be equipped with safety valves or other explosion precautions.

6.4.3.2 The shell of the battery pack is to be non-combustible material.

6.4.3.3 For design of battery pack, thermal runaway propagation is to meet the requirements of 6.3.4.3.

6.4.3.4 A battery pack is to be equipped with temperature regulating measures. IP67 battery pack is to be equipped with a temperature regulating device independent of battery cabins or battery boxes (cabinets). When the battery pack adjusts temperature by means of the temperature regulating device of battery cabins or battery boxes (cabinets) where it is located, the shell protection class of the battery pack is to ensure the effectiveness of temperature regulation.

6.4.3.5 The protection level of battery packs of soft pack battery or battery packs with safety level 1 is not to be lower than IP67. If thermal runaway propagation among battery cells is unavoidable, fire prevention and control measures independent from the fire-fighting arrangements for battery cabins / battery boxes (cabinets) are to be provided for battery packs. 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 fire, release visual and audible alarms, and automatically and/or manually start ejecting inhibitor medium. Test report is to be provided to prove the effectiveness of the fire extinguishing agent used for extinguishing battery fire.

6.4.3.6 Except for soft pack battery, the protection level of the battery pack with safety level 2 is to be at least IP22. When the battery pack uses the fire extinguishing medium of battery cabin or battery box (cabinet) where it is located to extinguish the fire, and its designed IP level is not conducive to the entry of external fire-fighting media, if thermal runaway propagation among battery cells is unavoidable, the fire prevention and control measures required in 6.4.3.5 are to be arranged for battery packs.

6.4.3.7 Soft pack batteries and batteries of safety level 1 must be installed inside battery boxes (cabinets) in the form of battery pack. For battery boxes (cabinets) with batteries of safety level 1 inside, their protection level is not to be lower than IP67.

6.4.3.8 The IP67 battery pack is to be able to withstand the high temperature and pressure generated by thermal runaway of battery cells without any damage (except for the explosion proof devices of battery pack).

6.4.3.9 Clear identification is to be provided for battery pack's sockets. In addition, positive and negative poles are to be equipped with fool-proofing connectors.

6.4.3.10 The battery pack is to be provided with an effective grounding device. The shell of external connector is to be made of flame retardant materials. The connecting cables among battery packs are to meet flame retardant requirements.

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

6.4.4 NAMEPLATE AND LABEL OF BATTERY PACK

6.4.4.1 A nameplate is to be attached safely and securely on the shell of battery pack, and the sign of the nameplate is to at least include the following information:

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

model of battery cell	
voltage of battery cell	V
capacity of battery cell	Ah
nominal voltage of battery module/battery pack	V
nominal electric energy of	kWh

battery module/battery pack	
weight of battery module/battery pack	kg
model of battery module/battery pack	
product code	
date of manufacture	year/month/day

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

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

Section 5 BATTERY MANAGEMENT SYSTEM (BMS)

6.5.1 GENERAL REQUIREMENTS

6.5.1.1 BMS is to be powered by two power sources, one of which is to be powered by the power system other than the one monitoring battery.

6.5.1.2 BMS is to be equipped with battery control unit and battery monitoring circuit based on the battery layer.

6.5.1.3 The battery control unit is to be able to receive the information collected by monitoring circuit (such as voltage, temperature, etc.) within battery module/battery pack.

6.5.1.4 BMS must be able to summarize the information from battery control unit of battery system. BMS is to have a data transmission interface with ship management system, through which the information listed in 6.5.2.1~6.5.2.4 can be fed back to ship management system for management. Remote (the spaces on ship where the crew are often on duty) display and alarm function of the BMS may be realized through the ship management system.

6.5.2 BASIC FUNCTION

6.5.2.1 BMS is to be able to monitor the following items, and display the following information (including but not limited to) locally and remotely (spaces on ship where the crew are often on duty):

- (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 battery system;
- (8) State of health (SOH) of the battery system;
- (9) Energy flow state of battery system (charge and discharge process).

6.5.2.2 BMS is to be able to arrange the following separate visual and audible alarms (including but not limited to) locally and remotely (spaces on ship where the crew are often on duty):

- (1) Over and under voltage of battery cell;
- (2) Overcurrent of battery series loop;
- (3) High temperature of battery cell;
- (4) Excessive high/low environment temperature;
- (5) Low electrical insulation resistance;
- (6) Low state of charge (SOC);
- (7) Overcurrent protection;
- (8) Over charge and over discharge protection;
- (9) Over heat 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 failure;
- (13) Temperature detection failure;
- (14) Charging failure;
- (15) Voltage or SOC imbalance between battery cells or battery modules;
- (16) Battery system stops running due to failure;
- (17) Abnormal operations of breakers/relays;
- (18) Communication failure between BMS and PMS/EMS/AMS.

6.5.2.3 The battery failure (see Table 6.5.2.14 for details) that may cause the battery system (subsystem) to stop running is to give a pre-alarm before it reaches the limit state.

6.5.2.4 BMS is to have at least the following control and safety protection functions. In addition to (1) and (2), visual and audible alarms are to be issued when the corresponding protective actions are performed:

- (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.

6.5.2.5 BMS is to be able to communicate with charging equipment and meet the requirements of 6.7.1.6. BMS is to detect the temperature of battery side of the charging socket to realize the temperature monitoring and over heat protection functions of the charging interface.

6.5.2.6 In case of overcurrent, BMS is to send out power reduction signal or stop battery system (subsystem).

6.5.2.7 In case of over-charge, the charging device is to be disconnected. In case of over-discharge, BMS is to be able to stop the battery system (subsystem).

6.5.2.8 BMS is to set low temperature charging limit.

6.5.2.9 Over heat protection is to be able to control the battery to a safe state, such as ventilation, power reduction, shutoff of battery system, etc. Over heat protection is to be independent of other components for temperature indication, alarm and control

functions(including sensors, circuits, monitoring and control components, etc.).

6.5.2.10 BMS is to have calibration function. The calibration function is to at least include SOC dynamic calibration and SOC shelving calibration at the end of battery charging.

6.5.2.11 BMS is to have communication continuity detection function.

6.5.2.12 BMS is to have self-check function. Failure of self-check function includes but is not limited to: failure of protection function, failure of voltage detection, failure of temperature detection, cooling failure of battery pack/battery box (cabinet) (if any), and failure of charging. When the failure of protection function and temperature detection occurs, the battery system is to stop running. When charging failure occurs, BMS is to control charging equipment to stop charging.

6.5.2.13 As the battery for propulsion power, BMS is to be able to monitor and control the battery used on board during the whole life cycle of battery. During the period when the battery is not in operation, at least battery cell temperature and environment temperature are to be measured and displayed, and visual and audible alarms are to be sent locally and remotely (in the spaces on ship where the crew are often on duty through the ship management system) in case of abnormal temperature. 24V and 48V replaceable mobile power batteries with smaller electric energy (within 10kWh) may only send visual and audible alarms locally.

6.5.2.14 Functional requirements for BMS are shown in Table 6.5.2.14.

List of BMS functional requirements

Table: 6.5.2.14

NO.	Monitoring parameters	Display ^②	Alarm	Protection	Corresponding protection measure ^③
1	Battery system voltage	√			
2	Battery cell voltage	√	√	√	Equilibrium control Power reduction ^③ / battery system (subsystem) stops running
3	Battery series loop current	√	√	√	Power reduction ^③ / battery system (subsystem) stops running
4	Battery cell temperature ^①	√	√	√	Temperature regulation/power reduction/ battery system (subsystem) stops running
5	Environment temperature	√	√	√	Temperature regulation and power reduction
6	Electrical insulation resistance	√	√	√	battery system (subsystem) stops running
7	State of charge of the batteries (SOC)	√	√	√	Power reduction/battery system (subsystem) stops running
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 device/ battery system (subsystem) stops running
12	Over heat protection (battery cell temperature)	√	√	√	Temperature regulation and power reduction/ battery system (subsystem) stops running
13	Over heat protection (Environment temperature)	√	√	√	Temperature regulation and power reduction/ battery system (subsystem) stops running
14	Thermal management failure of battery pack/box (cabinet) (if any)	√	√		
15	Emergency exhaust failure of battery box (cabinet) (if any)	√	√		
16	Protection function failure	√	√	√	Battery system (subsystem) stops running
17	Temperature detection failure	√	√	√	Battery system (subsystem) stops running
18	Charging failure	√	√	√	Stop charging
19	Voltage or SOC imbalance between the modules	√	√	√	Start-up balancing control and power reduction/ battery system (subsystem) stops running
20	Battery system stops running due to failure	√	√		
21	Abnormal operation of breakers/relay	√	√		
22	Communication failure between BMS and PMS/EMS/AMS	√	√	√	Power reduction/ Battery system (subsystem) stops running
23	BMS power indication and failure	√	√		

Notes:

- ① Cell temperature monitoring is to meet the requirements of 6.5.2.15.
- ② The requirements of 6.5.2.1~6.5.2.4 are to be met.
- ③ The power reduction in this Table is to be coordinated with the power/energy management system in Chapter 3, and power reduction protection is to be implemented under the premise of ensuring the safety of navigation.
- ④ The set values of alarm and protection measures are to be carried out in stages, and the set values of different protection measures in the corresponding protection measures are also to be carried out in stages, among which temperature regulation and power reduction may be of the same stage. For power reduction, BMS sends a power reduction signal to PMS/EMS/AMS; for temperature regulation, BMS starts the temperature regulation device in the battery system (if equipped) or sends the starting signal to the temperature regulation device (fan, air conditioner, etc.) in the battery installation space.

6.5.2.15 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.

6.5.2.16 The state of BMS power supply is to be capable of being displayed in the PMS/EMS/AMS, and visual and audible alarms are to be issued in the spaces on ship where the crew is often on duty in the event of a fault.

Section 6 BATTERY SYSTEM

6.6.1 GENERAL REQUIREMENTS

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

6.6.1.2 Refer to Section 5 of this Chapter for relevant technical requirement for control function of battery system.

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

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

6.6.1.5 A single failure of the battery system is not to cause a power blackout to the whole ship.

6.6.1.6 The recommended value of the best charging and discharging rate is to be set in accordance with the charging and discharging characteristics of the battery. The number of times of high charging and discharging rate of the battery system is to be reduced. Relevant data is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.6.1.7 The SOC range of battery system is to be controlled between 20% and 80% as far as possible. When it is lower than 20%, the system is to be charged in time, except for high energy density supercapacitor.

6.6.1.8 The SOC data of battery system is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.6.1.9 The SOH data of battery system is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.6.1.10 Protection measures are to be provided between battery subsystems (minimum independent power supply unit) directly connected in parallel to prevent internal circulation.

6.6.1.11 The battery subsystem is to be able to continuously monitor insulation resistance online, meet the requirements of 1.2.3.2(7), and avoid interference caused by multiple insulation resistance monitors working at the same time.

6.6.2 EMERGENCY SHUTDOWN DEVICE

6.6.2.1 For battery system with nominal electric energy of over 50kWh, independent emergency shutdown device is to be set to break the connection of battery system. The following requirements are to be met:

- (1) Emergency shutdown device is to be arranged in locations easily accessible outside

the bridge and battery cabin, and is to give out visual and audio signals at the same time when in action.

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

6.6.3 MINIMUM ELECTRIC ENERGY ALARM DEVICE

6.6.3.1 When the total SOC of battery system used for ship propulsion and/or main source reaches the minimum electric energy required for normal operation of the ship, visual and audible alarm signals are to be sent out. The alarm device of this alarm signal is to be independent from other alarm devices. This alarm signal is to be distinguished from the discharge termination electric energy (minimum electric energy recommended by the manufacturer) of a single battery system, and is to be issued by the ship management system.

6.6.4 DOCUMENTATION REQUIREMENTS ON BOARD

6.6.4.1 Battery powered ships with battery as propulsion power are to be provided with the following documents onboard:

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

(2) Descriptions of battery system maintenance (including check) and function test: The test of system and components carried out by professionals (normally battery manufacturer or its authorized personnel), cycle of test and other details are to be described. Records are to be kept after maintenance/check. Records of maintenance cycle are to be updated. In the case of remote data records, battery status records are to be kept for 60 days or more.

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

- ① Possible leaks (toxic, combustible, corrosive, etc);
- ② Possible gases (toxic, combustible, corrosive, etc);
- ③ Fire hazard;
- ④ Explosion hazard, including description of battery releasing gas during ventilation and thermal runaway;
- ⑤ Gas detection and alarm system of battery cabin/battery box (cabinet);
- ⑥ Fire detection and alarm system of battery cabin;
- ⑦ Ventilation rate of battery cabin;
- ⑧ Recommended fire-fighting method;
- ⑨ Breakdown/thermal runaway within the battery;
- ⑩ Internal and external short circuit of battery;
- ⑪ Overcurrent, overvoltage and undervoltage protection;
- ⑫ External heat source/ fire;
- ⑬ Safe charge/discharge characteristics;
- ⑭ Safety precaution measures to reduce risks.

Section 7 CHARGING DEVICE

6.7.1 GENERAL REQUIREMENTS

6.7.1.1 The battery system is to be equipped with charging devices with sufficient capacity. Charging devices are to be provided with measures to suppress radio interference.

6.7.1.2 Charging devices are to be provided with overcurrent protection, including short circuit protection.

6.7.1.3 Instruments are to be provided at least on or near the charging device and in spaces where the crew are often on duty to indicate charging and discharging current, voltage, temperature, SOC and other parameters. Relevant data is to be transmitted to the ship management system, and the corresponding alarm information is to be uploaded to the CCS survey and verification platform for battery-powered ships.

6.7.1.4 The charging device of battery system is to have an interface with BMS and operate under the conditions defined by BMS.

6.7.1.5 If the charging shore power is connected to the charging equipment on board (including shore power box) by charging connection device (such as charging gun, charging electric connector), 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 is 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 for connection with the shore power device, and no live part will be touched.

6.7.1.6 The charging device is to be equipped with temperature monitoring device, which is to be able to transmit corresponding signals to charging control system for temperature monitoring and over heat protection functions of the charging gun.

6.7.1.7 No flammable materials are to be arranged near the charging device.

6.7.2 SPECIAL REQUIREMENTS FOR DC BUS SYSTEMS

6.7.2.1 If the battery system is charged through the DC bus, appropriate measures are to be provided to avoid damages to the battery caused by the failure of DC bus system.

CHAPTER 7 SUPPLEMENTARY PROVISIONS FOR THE APPLICATION OF CONTAINERIZED MOBILE POWER SUPPLY TO SHIPS

Section 1 GENERAL PROVISIONS

7.1.1 APPLICATION

7.1.1.1 This Chapter applies to the design, construction and survey of marine containerized mobile power supplies (hereinafter referred to as " containerized power ").

7.1.1.2 The battery system and corresponding products in containerized power supply are to comply with the certification requirements of 1.3.1.3, and other system supporting products are to comply with the certification requirements of relevant CCS rules.

7.1.1.3 Containerized power is to be furnished with marine product certification.

7.1.2 DEFINITIONS

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

7.1.2.2 Battery swap refers to the process of quickly replacing the containerized power supply with special devices or artificial assistance to realize the power supply of battery-powered ships.

7.1.2.3 Battery swap connector means the connection device located on the containerized power, used to connect the containerized power to the ship system or the shore-based system, and to transmit electrical energy, electrical signals, communication data and thermal energy medium (generally including electrical interface, as well as cooling interface for transmitting cooling medium, fire interface for transmitting fire extinguishing medium and other interfaces that need to be connected between the ship and the containerized power).

7.1.2.4 Containerized mobile power supply junction box means the connection device located at ends of ship, used to connect the containerized power to the ship system, and to transmit electrical energy, electrical signals, communication data and thermal energy medium (generally including electrical interfaces, as well as cooling interfaces for transmitting cooling medium, fire interface for transmitting fire extinguishing medium, and other interfaces that need to be connected between the ship and the containerized power).

7.1.2.5 Ship battery swap system means a system composed of components and equipment used for ship battery swap operations or related to battery swap functions, referred to as battery swap system. It can include a battery swap interface, a containerized power junction box, and the connection between the two, as well as auxiliary electrical devices with functions such as position monitoring.

Section 2 TECHNICAL REQUIREMENTS FOR CONTAINERIZED POWER

7.2.1 GENERAL REQUIREMENTS

7.2.1.1 In addition to the special provisions of this Section, the requirements for the arrangement, installation, and ventilation 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.

7.2.1.2 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 *CCS Rules for Surveys of Container* provided that the requirements in this Chapter are complied with.

7.2.1.3 Water fire extinguishing (except high-pressure water mist) is not to be the first choice for the overall fire extinguishing of the battery system in the containerized power. If a water fire extinguishing system is used, corresponding protective measures are to be taken to prevent secondary disasters caused by water fire extinguishing.

7.2.1.4 Protective measures are to be provided between the battery subsystems (minimum independent power supply units) directly connected in parallel in the containerized power to prevent internal circulation.

7.2.1.5 In the battery compartment of the containerized power, the electrical equipment that needs to be maintained in the state of thermal runaway of the battery is to be an explosion-proof type, such as fire detection equipment, fixed fire extinguishing agent release pre-alarm device, flammable gas detection and alarm device, emergency exhaust system etc., the specific explosion-proof requirements (explosion-proof type, explosion-proof category, temperature group) are to be determined according to the composition of the gas generated by the thermal runaway of different types of batteries. And the non-explosion-proof electrical equipment that does not need to work in the battery compartment can be automatically cut off.

7.2.1.6 The protection level of the battery pack in the containerized power is to be not less than IP67, and the temperature adjustment measures and fire prevention and control measures are to meet the requirements of 6.4.3.4 and 6.4.3.5.

7.2.1.7 The containerized power is to be able to measure and display the battery cell temperature and ambient temperature during hoisting, transportation, shore-based charging and storage, and be able to issue visual and audible alarms locally and on the remote shore-based monitoring platform when the temperature is abnormal.

7.2.2 CONTAINERIZED POWER CONTAINER

7.2.2.1 The containerized power is to adopt a specially designed container suitable for it.

7.2.2.2 The influence of local stress caused by the fixed bracket in the container under various working conditions is to be considered for the structure of the containerized power container.

7.2.2.3 The containerized power is generally to comply with the salt spray-proof requirements of the relevant CCS rules for electrical equipment.

7.2.2.4 Anti-condensation design is to be considered for the containerized power container.

7.2.2.5 The containerized power container is to comply with the weathertight requirements.

7.2.3 INTERNAL ARRANGEMENT OF CONTAINERIZED POWER

7.2.3.1 All equipment in the containerized power is to be effectively fixed, including but not limited to battery box (cabinet)/battery pack, combiner cabinet, high-voltage box, fire-fighting device, etc.

7.2.3.2 Under various working conditions of the containerized power, the structural strength of the battery box (cabinet) in the containerized power is to be able to withstand the corresponding impact.

7.2.3.3 If the battery box (cabinet) or battery pack arranged in the containerized power is ventilated and dissipated by means of the public space, the clear distance between the battery box (cabinet)/battery pack in the containerized power and the internal bulkhead is not to be less than 150mm.

7.2.3.4 The distance between the battery box (cabinet)/battery pack in the containerized power is not to be less than 150mm from the box wall and box top, and the clear distance from the box wall and box top reinforcement structure is not to be less than 100mm, so as to reduce the risk of collision during the hoisting process.

7.2.3.5 The design of the containerized power is to be such as to facilitate the maintenance of the battery system related equipment. If the onboard maintenance is not considered for the design, an explosion-proof camera is to be provided in the containerized power compartment to facilitate internal debugging and inspection, and at the same time, it is to be able to display on the spot, navigation bridge and remote shore-based monitoring platforms(if any).

7.2.3.6 The battery system in the containerized power is not to be located in the same space with the switchboard.

7.2.3.7 The fixed fire detection and fire alarm system, flammable gas detection device, emergency exhaust system and BMS of the containerized power are to be powered by two independent power sources, one of which is to be powered by other power supply systems on board except the main power source, and the power supply time meets the requirements of relevant rules for the emergency power supply. BMS power supply is to meet the longest waiting time that the containerized power may exist, whichever is greater.

7.2.3.8 The strong current wiring harness in the containerized power is to be kept away from the communication cable as far as possible.

7.2.3.9 The power distribution room in the containerized power is to be provided with smoke detection and alarm devices.

Section 3 ONBOARD ARRANGEMENT OF CONTAINERIZED POWER

7.3.1 GENERAL REQUIREMENTS

7.3.1.1 The containerized power is not to be placed in hazardous areas.

7.3.1.2 The containerized power is not to be placed in the same cargo area with the cargo.

7.3.1.3 The containerized power is to be as far away as possible from the outer side of the ship to avoid the impact of collision. The horizontal distance from it to the side is not to be less than 500 mm.

7.3.1.4 The collision impact of other facilities on the ship and the cargo container (if any) during the hoisting process is to be considered for the arrangement of the containerized power.

7.3.1.5 The containerized power is to be arranged as far away as possible from the accommodation space and areas traversed by personnel. Corresponding measures are to be taken in the area to prohibit unprofessional personnel from approaching the containerized power. At the same time, the containerized power container is to be provided with high-voltage danger signs and no entry signs for unprofessional personnel.

7.3.1.6 The containerized power is to be kept as far away as possible from the emergency power supply room.

7.3.1.7 The area where the containerized power is located is to be provided with means of access for professional personnel to carry out the inspection, maintenance and emergency handling.

7.3.1.8 If the containerized power is placed on the open deck, lightning protection measures are to be taken to avoid the failure of containerized power.

7.3.1.9 The 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.

7.3.1.10 The exhaust duct of the emergency exhaust system of the containerized power is to lead to a safe place on the open deck, and be far away from the spaces inhabited or containing heat sources, and at least 3 meters away from the air inlets of other spaces.

7.3.1.11 The air inlet of the containerized power is to be as far away as possible from the air outlet of the paint room and the battery room, and avoid dangerous areas.

7.3.1.12 If the containerized power is adjacent to an ordinary cargo container, the distance from the cargo container is not to be less than 600mm. If the emergency exhaust vent faces the cargo container, the danger of combustible gas is also to be considered.

7.3.1.13 The spacing between the side wall of the containerized power and the bulkhead of the passenger space (except that the bulkhead of the passenger space adjacent to the side wall of the containerized power is of "A-60" class division structure) is to be at least 900mm. The distance from openings or exits such as doors, windows and ventilation openings in passenger spaces is to be at least 1.5m.

7.3.1.14 The ship structural strength in way of the containerized power arrangement is to meet the load requirements. The structural strength is to be checked according to the situation.

7.3.1.15 The space where the containerized power is installed is to be free from the impact of deck water on the battery.

7.3.1.16 An obvious "No Fire" sign is to be provided outside the containerized power.

7.3.1.17 A hydrant is to be located near the containerized power, and at least 2 water jet/mist dual type water guns are to be provided.

7.3.1.18 At least 4 portable heptafluoropropane or other gas fire extinguishers are to be provided near the containerized power.

Section 4 THE BATTERY SWAP REQUIREMENTS OF CONTAINERIZED POWER

7.4.1 GENERAL REQUIREMENTS

7.4.1.1 Each time the containerized power is swapped, there is to be a corresponding inspection process to prevent the use of damaged containers.

7.4.2 SHIP BATTERY SWAP SYSTEM

7.4.2.1 The design and manufacture of the ship battery swap system are to meet the requirements of safe, fast and reliable replacement of the containerized power.

7.4.2.2 The ship battery swap system is to have electrical, communication, thermal management and other functions that meet the interoperability during the design life cycle.

7.4.2.3 The containerized power is to be kept in a normal position through mechanical devices or electrical monitoring devices on the ship. Electrical signals such as the position of the containerized power, the connection status of the ship battery swap system or electrical interface can be used to detect the looseness and accident unlock of the containerized power.

7.4.2.4 If there are consumable parts in the ship battery swap system, the scope, maintenance and replacement requirements of the consumable parts are to be given in the containerized power maintenance manual.

7.4.2.5 The ship battery swap system is to have both the automatic unlocking function and the manual unlocking function of the special device. Two or more steps are to be used to unlock, and the process is to be continuous and reliable to avoid misoperation. The operation of turning the thread with a tool is regarded as a multi-step unlocking.

7.4.3 BATTERY SWAP INTERFACE/ CONTAINERIZED POWER JUNCTION BOX

7.4.3.1 There are to be no burrs, foreign objects, overlaps and similar sharp edges on the surface of the battery swap interface/containerized power junction box.

7.4.3.2 The electrical interface is to have the correct electrical connection and power-off sequence to avoid unexpected high and low-voltage circuit conduction during the battery swap process.

7.4.3.3 Accidental leakage of coolant from the cooling interface (if any) is not to cause electrical interface insulation failures and other safety hazards.

7.4.3.4 Accidental leakage of water from fire water connections (if any) is not to cause electrical connection insulation failures and other safety hazards.

7.4.3.5 The protection level of the electrical interface in the battery swap interface/containerized power junction box is to meet the protection level of the electrical equipment in the corresponding space. The battery swap interface is to be convenient for replacement and maintenance.

7.4.3.6 The connectors of the battery swap interface/containerized power junction box is to be of a structure or design that prevents incorrect coupling, and can be firmly connected to prevent loosening.

Section 5 FIRE PROTECTION

7.5.1 GENERAL REQUIREMENTS

7.5.1.1 In addition to the provisions of this Section, the fire protection of the containerized power is to meet the relevant requirements of 5.2.2, 5.2.3, 5.3.2, 5.3.3 and 5.4.1.

7.5.2 STRUCTURE

7.5.2.1 The container (including doors or other openings) is to be made of steel.

7.5.2.2 The fire integrity of the boundary of the enclosure space where the battery is located is to be insulated to A-60 class standard. Insulation material is to be non-combustible material.

7.5.3 EMERGENCY EXHAUST

7.5.3.1 The emergency exhaust vent of the containerized power is to be provided with a fire damper and have a self-closing function. If it is not possible, the emergency vent of the containerized power is to be open to the outside of the vessel and be protected against rain and wave injection.

7.5.4 FIRE EXTINGUISHING SYSTEM

7.5.4.1 For the fixed fire extinguishing system of the containerized power, except for prefabricated fire extinguishing system^①, components such as fire extinguishing agent vessels and agent release control valves are to be arranged in a special space outside the battery space.

7.5.4.2 In addition to local control, the fixed fire extinguishing system of the containerized power is to also have the function of remote operation in the navigation bridge or fire control station.

^①Prefabricated fire extinguishing system refers to a fire extinguishing system which is designed and assembled in complete sets according to certain application conditions, such as fire extinguishing agent storage device and spraying assembly.