



**International
Standard**

ISO 23625

Small craft — Lithium-ion batteries

Petits navires — Batteries lithium-ion

**First edition
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Contents

Page

Foreword	iv
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 System design requirements	4
5 Safe operating limits	5
6 General lithium-ion battery installations	5
7 Fire protection and cell venting	6
8 Battery management system and testing	7
9 Manufacturer's safety information and operator's manual	8
Annex A (informative) Battery thermal runaway	10
Annex B (informative) Protection devices	13
Annex C (informative) Protection device examples	14
Bibliography	17

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 188 *Small craft*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 464, *Small Craft*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition cancels and replaces ISO/TS 23625:2021, which has been technically revised.

The main changes are as follows:

- a terminological entry for “audible alarm” has been added;
- requirements to comply with IEC 62619 and IEC 62620 have been added;
- EMC requirements for BMS have been added;
- [Annex A](#) has been extended;
- [Annexes B](#) and [C](#) have been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Small craft — Lithium-ion batteries

WARNING — Lithium-ion batteries used in direct current (DC) electrical systems on boats that operate at potentials of 60 V or higher have additional safety requirements not addressed by this document. Refer to the battery manufacturer's recommendations.

1 Scope

This document specifies requirements and recommendations for the selection and installation of lithium-ion batteries for boats, as well as requirements for the safety information provided by the manufacturer.

This document is applicable to lithium-ion batteries and battery systems with a capacity greater than 500 Wh used on small craft for providing power for general electrical loads and/or to electric propulsion systems. It is primarily intended for manufacturers and battery installers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8846, *Small craft — Electrical devices — Protection against ignition of surrounding flammable gases*

ISO 13297, *Small craft — Electrical systems — Alternating and direct current installations*

ISO 25197, *Small craft — Electrical/electronic control systems for steering, shift and throttle*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 62619, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

IEC 62620, *Secondary cells and batteries containing alkaline or other non-acid electrolytes — Secondary lithium cells and batteries for use in industrial applications*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at <https://www.iso.org/obp>

— IEC Electropedia: available at <https://www.electropedia.org/>

3.1

ampere interrupt capacity

AIC

maximum current a circuit breaker or fuse is rated to safely interrupt at a specific voltage

3.2

battery

collection of *cells* (3.7) wired in series (or series/parallel) and constituting a single physical unit

3.3

battery bank

set of *batteries* (3.2) electrically connected (parallel/series) to increase capacity and/or voltage

3.4

battery capacity

C

amount of energy storage of the *battery* (3.2) from the manufacturer's specified fully charged to discharged voltage levels

Note 1 to entry: The battery capacity is expressed in ampere hours (Ah) at a nominal voltage or in watt hours (Wh).

Note 2 to entry: Ah and Wh capacity rating is at a given discharge rate or time.

3.5

battery management system

BMS

system designed to protect a lithium-ion *battery* (3.2) from potentially damaging events, such as *overcharging* (3.19) or *overdischarging* (3.20) and high and low temperatures

3.6

battery system

battery (3.2) or batteries and all ancillary components

3.7

cell

fundamental building block that is inside a lithium-ion *battery* (3.2) where electrical energy is derived from the insertion/extraction reactions of lithium ions or oxidation/reduction reaction of lithium between the negative electrode and the positive electrode

3.8

C rating

measure of *battery* (3.2) charge and discharge rating

Note 1 to entry: The C rating is expressed as a function of the rated ampere hours (Ah) *battery capacity* (3.4).

EXAMPLE A 100 Ah battery charged or discharged at 100 A is a 1C rate.

3.9

contactor

relay/switch controlled by the *battery management system* (3.5)

3.10

disconnect device

switch controlled by the *battery management system* (3.5) which disconnects a *battery* (3.2) or *battery bank* (3.3) from charge and discharge sources, and other batteries or battery banks

3.11

high voltage cutout

HVC

battery management system's (3.5) response to a *high voltage event* (3.12) that protects the *battery* (3.2) from *overcharging* (3.19)

3.12

high voltage event

HVE

condition where a *cell* (3.7) has been charged to a voltage above the manufacturer's cell maximum voltage limit

3.13

low voltage cutout

LVC

battery management system's (3.5) response to a low voltage event (3.14) that protects the battery (3.2) from overdischarging (3.20)

3.14

low voltage event

LVE

condition where a *cell (3.7)* has been discharged beyond the cell manufacturer's cell low voltage limit

3.15

high temperature cut-off

HTC

battery management system's (3.5) response to a high temperature event (3.16)

3.16

high temperature event

HTE

condition where a *cell (3.7)*, parallel string or bank has a temperature above the manufacturer's maximum cell temperature limit

3.17

low temperature cut-off

LTC

battery management system's (3.5) response to a low temperature event (3.18)

3.18

low temperature event

LTE

condition where a *cell (3.7)*, parallel string or bank has a temperature below the manufacturer's minimum cell temperature limit

3.19

overcharging

charging a *cell (3.7)* above the cell manufacturer's upper cell voltage limit, which can result in damage to the cell

Note 1 to entry: Overcharging can result in *thermal runaway (3.24)* or damage to the *battery (3.2)* or cells.

3.20

overdischarging

discharging a *battery (3.2)* or *cell (3.7)* below the manufacturer's minimum cell voltage limit

Note 1 to entry: Overdischarging can result in damage to the battery or cells and can include cell polarity reversal.

Note 2 to entry: Subsequent charging after overdischarging can result in *thermal runaway (3.24)*.

3.21

readily accessible

capable of being reached quickly and safely for effective use under emergency conditions without the use of tools

3.22

safe operating limits

SOL

set of voltage, temperature and other parameters, within which the *battery (3.2)* is intended to be operated and which, if exceeded, initiates a *battery management system (3.5)* response to correct the problem or to shut the battery down

3.23

state of charge

SOC

indication of the amount of usable capacity available in the *battery* (3.2)

Note 1 to entry: SOC is expressed as a percentage.

EXAMPLE 0 % = empty; 100 % = full.

3.24

thermal runaway

potentially dangerous and self-propagating *battery* (3.2) heating condition that can occur within a *cell* (3.7) or cells

3.25

watertight

constructed so that water will not enter the enclosure

Note 1 to entry: Water integrity specifications can be found in IEC 60529.

3.26

weatherproof

constructed or protected so that exposure to the weather will not interfere with successful operation

Note 1 to entry: Water integrity specifications can be found in IEC 60529.

3.27

audible alarm

device with a sound pressure measured 1 m from the command station of at least 75 dB(A), but not greater than 85 dB(A)

4 System design requirements

4.1 Lithium-ion batteries and their systems shall be installed in accordance with the requirements of ISO 13297.

NOTE Lithium-ion batteries are not subject to routine electrolyte leakage or routine release of gas, therefore requirements regarding electrolyte containment and routine gas ventilation cannot apply to lithium-ion battery installations.

4.2 Lithium-ion battery systems shall be installed in accordance with the battery manufacturer's recommendations.

4.3 All battery system designs shall be done in a way that ensures that all installed lithium-ion batteries are kept within the battery manufacturer's specified SOL.

4.4 There shall be a BMS installed to control all installed lithium-ion batteries and maintain the battery manufacturer's specified SOL.

4.5 All battery systems shall have a BMS to provide for battery cut-off if hazardous conditions exist.

NOTE 1 A BMS can be external or internal to the battery.

NOTE 2 In the event of an individual BMS that disconnects, battery bank capacity can be reduced with no notification to the vessel operator.

4.6 Batteries shall meet the requirements of IEC 62619 and IEC 62620.

4.7 The battery system shall be sized in accordance with the application and the battery manufacturer's defined operating limits, and with the appropriate C rating listed in the battery specifications.

4.8 Output control from charging sources shall be within the battery manufacturer's specified ranges.

4.9 If a shut-down condition is approaching for propulsion systems or other critical system (equipment vital to safety), a BMS or system shall notify the operator with a visual and/or audible alarm, clearly perceptible from the main helm position, prior to disconnecting the battery from the DC system.

4.10 Batteries of different chemistries shall not be connected in series. A means shall be provided to prevent overcurrent conditions when connecting in parallel.

4.11 Multiple contactors are permitted (HVC, LVC, plus main), each providing specific protection from high voltage, low voltage and load isolation. A single contactor is permitted, if the control system provides for protection from all conditions.

4.12 On installations greater than 1 500 Wh when used for propulsion, the battery system shall be capable of providing a state of health of the battery system compared to its original capacity.

NOTE This indication can be available as a service function.

5 Safe operating limits

5.1 The SOL of a lithium-ion battery are defined by the manufacturer and comprise high and low voltage limits, charging/discharging current limits, charging/discharging temperature limits, and installation specifications. The SOL shall be adhered to during the design, storage, installation and operation of a lithium-ion battery.

NOTE All lithium-ion batteries lose capacity through cycling and over time. Capacity is also adversely affected by operating at higher temperatures and maintaining a lithium-ion battery in a high SOC and/or extended periods at a low SOC. This needs to be taken into account in terms of the SOL.

5.2 Lithium-ion batteries have very strict temperature operating limits established by the battery/cell manufacturers. To prevent damage and potentially hazardous conditions, the system shall be operated within specified operating temperatures under all operating conditions.

For craft in long-term storage, the battery installation shall follow the manufacturer's recommended battery storage procedures, based on ambient temperature, connected charging sources and parasitic loads.

6 General lithium-ion battery installations

6.1 Lithium-ion batteries shall not be installed in locations where temperatures outside (high or low) acceptable parameters can occur. Battery manufacturer installation specifications shall be met. This shall extend to areas that can be heated from the sun or other heat sources.

6.2 System connections and BMS electronics shall be protected from corrosion.

6.3 Lithium-ion batteries shall be installed and restrained in locations that prevent damage from shock and vibration, unless batteries are designed specifically for that application by the battery manufacturer.

6.4 Lithium-ion battery systems shall be designed, constructed and installed so that they do not have their safe operation jeopardized, during normal craft operation, by the damaging effects of exposure to water.

6.4.1 Lithium-ion batteries and their system components installed in locations subject to flooding or momentary submersion shall be watertight under the test conditions specified in IEC 60529, IP67.

6.4.2 Lithium-ion batteries and their system components installed in locations not subject to flooding or momentary submersion shall be weatherproof under the test conditions specified in IEC 60529, IP55.

6.5 Lithium-ion batteries, their system components and their electrical connections shall be protected from corrosion.

6.6 Devices located in compartments that require ignition protection shall be protected against ignition in accordance with ISO 8846.

6.7 Lithium-ion battery connections: No electrical connections shall be made directly to a lithium-ion battery that would bypass the BMS or the protection devices, unless specified by the battery system manufacturer's instructions.

6.8 Overcurrent protection: All lithium-ion battery installations shall have overcurrent protection that does not exceed the current interrupting capacity of the BMS. Examples of overcurrent protection and overcurrent protective devices can be found in [Annexes B](#) and [C](#).

6.9 Ampere interrupt capacity (AIC): If necessary, the lithium-ion battery bank shall be subdivided into units such that the AIC rating of fusing is not exceeded.

6.10 Series and paralleling installations shall comply with the lithium-ion battery manufacturer's specifications.

Appropriate measures shall be taken to allow for balancing and overcurrent protection between batteries, including the following:

- If used, automatic paralleling devices should have an appropriate current-limiting capability. Manual switches (e.g. a 1, 2, both switch or on/off switch) and automatic paralleling devices are not necessarily appropriate.
- Special attention to balancing is very important in larger battery banks.

6.11 If a battery manufacturer specifies a voltage deviation limit between individual battery voltages, it shall be met before the batteries are paralleled or connected in series to prevent excessive battery to battery current.

6.12 Charging sources shall be operated/controlled to meet the charging profile recommendations provided by the lithium-ion battery or cell manufacturer.

7 Fire protection and cell venting

7.1 Fire protection from thermal runaway: Lithium-ion batteries technologies have unique fire characteristics. See [Annex A](#) for more information.