



GUIDE FOR

USE OF LITHIUM BATTERIES IN THE MARINE AND OFFSHORE INDUSTRIES

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**American Bureau of Shipping
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Foreword

ABS recognizes the increasing use of batteries in the marine and offshore industries and their benefits. Lithium batteries, as the dominant rechargeable battery, exhibit favorable characteristics such as high energy density, lightweight, faster charging, low self-discharging rate, and low memory effect. The development of lithium batteries for large energy applications is still relatively new, especially in the marine and offshore industry. ABS has produced this Guide to provide requirements and reference standards to facilitate effective installation and operation of lithium battery systems.

The purpose of this Guide is to establish safety guidelines for owners, operators, shipyards, designers, and manufacturers. The lithium battery types covered by this Guide include lithium-ion, lithium-alloy, lithium metal, and lithium polymer types. For requirements applicable to conventional battery types (such as lead-acid, alkaline, etc.), please refer to the requirements in Part 4 of the *ABS Rules for Building and Classing Steel Vessels*. For requirements applicable to batteries used in underwater vehicles, please refer to the requirements in Subsection 10/11 of the *ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities*.

Battery technology is continuously evolving with respect to battery chemistries and designs. Alternative arrangements or battery technologies may be considered provided it can be shown, through either satisfactory service experience or a systematic analysis based on sound engineering principles, to meet the overall safety standards of this Guide and the ABS Rules.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.



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SECTION 1 General

1 Introduction

ABS recognizes the increasing use of batteries in the marine and offshore industries and the benefits they can bring to operations. This Guide has been developed to facilitate the effective installation and operation of lithium batteries. This Guide is to be used in conjunction with and as a supplement to Part 4 of the *ABS Rules for Building and Classing Steel Vessels (Steel Vessel Rules)* and the *ABS Rules for Building and Classing Mobile Offshore Drilling Units (MODU Rules)*, as applicable. The basic safety principles such as having sufficient power generation (storage) capacity, having adequate standby and emergency power sources, arrangements to have continuity of supply in the event of a fault, general electrical safety (such as proper cable sizing, appropriate insulation, appropriate equipment enclosure ratings, etc.) contained in the ABS Rules are to be followed in general. These specific requirements are not repeated in this Guide.

3 Application

This Guide is applicable to marine and offshore assets designed, constructed, or retrofitted with a lithium battery system used as an additional source of power with a capacity greater than 25 kWh. An optional notation (**BATTERY-Li**) may be granted to those assets once the battery installation has complied with the requirements of this Guide. When batteries are being used as the main source of power, the additional requirements set forth in Section 4 are to be met.

When Type Approval for a lithium battery system is requested, applicants should contact ABS for the approval process. For ABS Type Approval Program requirements, please refer to Appendix 4-1-A3 of the *Steel Vessel Rules*.

5 Scope

Lithium battery types covered by this Guide include lithium-ion, lithium-alloy, lithium metal, and lithium polymer types.

For requirements related to conventional battery types, please refer to 4-8-3/5.9 of the *Steel Vessel Rules* or 4-3-3/3.7 of the *MODU Rules*.

For requirements related to the use of batteries in underwater vehicles, please refer to Subsection 10/11 of the *ABS Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities*.

Battery technology is a field that is continuously evolving with respect to battery chemistries and designs. Alternative battery technologies and arrangements may be considered provided it can be shown, through either satisfactory service experience or a systematic analysis based on sound engineering principles, to meet the overall safety standards of this Guide and the ABS Rules.

7 Terminology

Primary Cell/Battery. A cell or battery that can only be discharged once. It is not designed to be rechargeable and is usually protected from a charging current.

Secondary Cell/Battery. A cell or battery that is intended to be subjected to numerous charge and discharge cycles in accordance with manufacturer's recommendations.

Battery Management System. Electronic system associated with a battery module/pack that has functions to cut off in case of overcharge, overcurrent, over-discharge, and overheating. It monitors and/or manages its state, calculates secondary data, reports that data, and/or controls its environment to influence the battery's safety, performance, and/or service life. [IEC 62619]

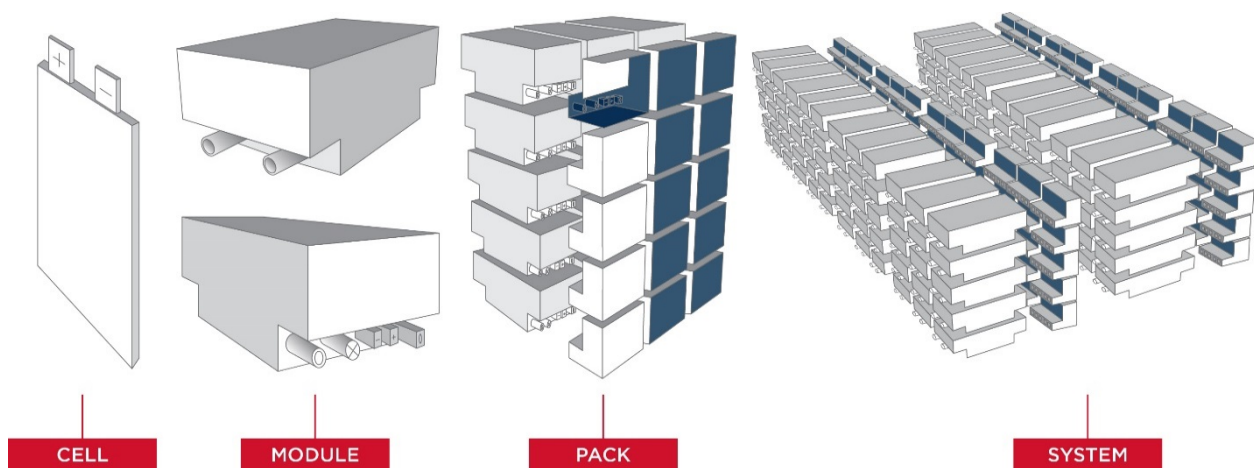
Battery Cell. The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, and terminals that is a source of electrical energy by insertion/extraction reactions of lithium ions or oxidation/reduction reaction of lithium between the negative electrode and the positive electrode. It is not ready for use in an application since it is not yet fitted with its final housing, terminal arrangement, and electronic control device(s). [UL 1642]

Battery Module. A group of cells connected together in a series and/or parallel configuration with or without protective devices and monitoring circuitry. [IEC 62620]

Battery Pack. Energy storage device that is comprised of one or more cells or modules electrically connected. It has a monitoring circuitry that provides information to a battery system. [IEC 62620]

Battery System (Array). System comprised of one or more cells, modules, or battery packs. It has a battery management system to cut off in case of overcharge, overcurrent, over-discharge, and overheating.

FIGURE 1
Battery Storage System



Battery Space (Compartment). The space in which the battery system is physically located. A typical battery space (compartment) is illustrated in the ABS *Advisory on Hybrid Electric Power Systems*.

Battery String. A number of battery cells or modules are connected in series to produce the same voltage level of the battery system.

Cell Balancing. The mechanism of forcing all battery cells within a battery module to have identical voltages. Cell balancing is achieved by means of a “balancing circuit” (usually implemented as part of the Battery Management System). In the absence of a balancing circuit, one or more cells (as a result of ageing differently over its lifetime) may become under-charged or overcharged, either of which can lead to a failure of the battery module. Cell balancing is not an instantaneous process and requires some time for its completion.

Power Management System (PMS). A complete switchboard and generator control system controls power generation and distribution including multiple switchboards and ring bus systems. The PMS on board a vessel is responsible for functions such as load sharing among different power sources, load shedding when generated power is insufficient, etc.

Rated Capacity. The capacity value of a cell or battery determined under specified conditions and declared by the manufacturer. [IEC 62620] Capacity is usually measured in Ampere-hours (Ah).

State of Charge (SOC). Available capacity in a battery expressed as a percentage of rated capacity. [IEC 62660-1]