TÜRK LOYDU

Guidelines for the Certification, Installation and Testing of Lithium Batteries

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This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red colour.

Unless otherwise specified, these Rules apply to ships for which the date of contract for construction as defined in TL- PR 29 is on or after 1st of July 2019. New rules or amendments entering into force after the date of contract for construction are to be applied if required by those rules. See Rule Change Notices on TL website for details.

"General Terms and Conditions" of the respective latest edition will be applicable (see Rules for Classification and Surveys).

If there is a difference between the rules in English and in Turkish, the rule in English is to be considered as valid. This publication is available in print and electronic pdf version.

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Guidelines for the Certification, Installation and Testing of Lithium Batteries

SECTION 1

GENERAL

A. Application

1. These Rules apply to lithium battery installation on board ships, when batteries are used for propulsion and/or electric power supply purpose.

2. These Rules are to be used in conjunction with the requirements of **TL** Rules, Chapter 4, 4.1, 5 and 6.

3 Since the battery technology is a field that is continuously evolving with respect to lithium battery chemistry, additional requirements to those specified in these Rules may be required by **TL** on a case by case basis.

4. The additional class notation **Li-BATTERY** may be assigned to ships when Lithium batteries are used for propulsion and/or electric power supply purpose during ship operation.

B. Definitions

1. The following definitions and abbreviations are additional to those given in the applicable Rules:

- Battery Management System (BMS): an electronic system associated with a battery pack which controls, monitors and manages the state of the battery by protecting the battery from operating outside its safe operating-limits.

- Power Management System (PMS): a complete switchboard and generator control system providing monitoring and control of the energy capacities.

- Cell: basic electrochemical unit of a battery containing an assembly of electrodes, electrolyte, and terminals.

- Battery: assembly of cells ready for use as storage of electrical energy characterized by its voltage, size terminal arrangement, capacity and rate capability.

- Battery compartment: enclosed space in which lithium batteries located.

- Battery system: the whole battery installation including battery modules, electrical interconnections, BMS and other safety features.

- State of Charge (SOC): available capacity expressed as percentage of the rated capacity

- State of Health (SOH): reflects general condition of a battery, including its ability to deliver the specified performance compared with a new battery.

- Venting: release of excessive internal pressure from a cell/battery in a manner intended by design to preclude rupture or explosion.

- Explosion: failure that occurs when a cell container or battery case opens violently and major components are forcibly expelled.

C. Documents to be Submitted

1. The documentation listed in the following paragraph is to be submitted in triplicate or TL Electronic Approval System (TL - EPAS) for approval:

a) Block diagram of the battery system and system interfaces to the battery system, power management system, alarm system, emergency shutdown and other systems

b) Functional description of the controls and mechanisms to enhance battery safety, such as battery management system (BMS), power management system (PMS), shutdown mechanism, etc.

c) Battery system risk analysis document ~~A~~ which cover all potential hazards represented by the chemistry of batteries, the evaluation of the risk factors and measures to control and reduce the identified risks.

d) Test programs related to factory test, onboard tests, sea trials.

e) Electrical load balance including size of batteries, battery converter capacity and discharge/recharge capacity

2. One copy of the documentation listed in the following paragraph is to be submitted for information :

a) Description of cell/battery design including at least electrical characteristics (e.g. voltage, capacity, etc.), safety devices, cell/batteries configuration, battery chemistry, method of activation, dischargeand recharge rates for the batteries, etc.

b) Technical specification of the lithium batteries, including data and environmental conditions.

c) Software description and user manual including instructions during software maintenance.

d) An overall description of the propulsion and power installation and of operating philosophy for each operational mode (including charging) when battery installation is used as storage of power dedicated to the propulsion system or as part of the main source of electrical power.

e) Maintenance Manual

f) Operation Manual

3. Where a battery room is provided based on the Risk Assessment the following additional documentation is to be submitted for approval:

a) Fire detection arrangement,

b) Gas detection system,

c) Structural fire protection,

d) Fixed fire extinguishing system,

e) Ventilation/exhaust systems.

In addition a general arrangement plan of battery room is to be submitted for information.

4. **TL** reserves the right to request the submission of additional documentation in case of non-conventional design or if it is deemed necessary for the evaluation of the system, equipment or components.

SECTION 2

DESIGN REQUIREMENTS

A. General

1. The design is to ensure that any single fault in the battery system shall not render any main functions unavailable for more than the maximum restoration time.

2. The batteries are to be properly insulated and located to prevent overheating of the system. The battery space shall not contain heat sources or high fire risk objects.

Battery room is to be air-conditioned and also mechanically ventilated (the temperature control shall follow recommendations given by the battery maker – max. and min.).

3. Battery cells of different physical characteristics, chemistries and electrical parameters are not to be used in the same electrical circuit.

4. Battery cells are to be designed to be within temperature, voltage and current limits specified by the cell Manufacturer. Battery system Designer is to ensure proper design and assembly.

5. Terminals are to have clear polarity marking on the external surface of the battery. The size and shape of the terminal contacts are to ensure that they can carry the maximum current. External terminal contact surfaces are to be formed from conductive materials with good mechanical strength and corrosion resistance. Terminal contacts are to be arranged so as to minimize the risk of short circuits.

6. The minimum degree of protection of the battery module enclosures is to be not lower than IP 44.

7. The cells shall be so constructed as to prevent spilling of electrolyte due to an inclination of 40° from normal position. The filling plugs shall be so constructed as to prevent spilling electrolyte due to ship's movements as e.g. Rolling and pitching.

8. The cells shall be grouped in crates or trays of rigid construction and suitable material equipped with handles. The mass of crates or trays should preferably not exceed 100 kg.

B. Design

1. When batteries are used as main power for the propulsion system or as part of the main source of electrical power, the capacity of the batteries is to be sufficient for the intended operation of the vessel.

2. The battery system is to have a Battery Management System (BMS). The battery charger is to be interfaced with and be controlled by the BMS.

The battery charging equipment shall operate within the limits given by the BMS.

3. Storage battery systems other than engine-starting batteries, shall be protected against overload and short circuit. Emergency batteries supplying essential equipments shall have short circuit protetion only.

4. Switching devices are to be provided to prevent accidental battery turn on.

5. Battery system is to be fitted with an emergency shutdown mechanism adjacent to, but outside of battery space.

6. For direct current components supplied by electrical batteries, voltage variations specified below are to be assumed:

- Components connected to the battery during charging: +30%, -20%
- Components not connected to the battery during charging: +20%, -25%

Note:

For this purpose an Power Management System (PMS) is to be provided.

7. Enough charging shall be possible during port stay to keep an acceptable state of charge.

SECTION 3

CONTROL, MONITORING, ALARM and SAFETY SYSTEMS

Page

A. General

1. The provisions of this Section are to be used in conjunction with the requirements of the applicable Rules.

2. Control, monitoring and safety systems are to have self-check facilities. In the event of failure to the systems or power supply, an alarm is to be activated.

3. The safety system is to be designed so as to limit the consequence of failures. It is to be constructed on the fail safe principle.

4. Sensors for safety functions are to be independent from sensors used for other purposes (e.g. for alarm system).

5. The sensors are to be designed to withstand the local environment. The enclosure of the sensor and the cable entry are to be appropriate to the space in which they are located. Any malfunctioning in the sensors is to be detectable.

6. Where required as result of the Risk Assessment, cables to be operable under fire conditions are to be of a fire-resistant type complying with IEC Publication 60331 series.

7. Battery room is to be monitored locally ;

- ambient temperature of battery space,
- indication of ventilation running.

B. Battery Management System (BMS)

1. The battery system is to have a Battery Management System (BMS).

2. The Battery Management System (BMS) is to be certified.

3. Battery Management System (BMS) is to be continuously powered and an alarm is to be given in the event of failure of the normal power supply.

4. The Battery Management System (BMS) is to monitor at least:

- Internal charging/discharging of the battery,
- Battery temperature and
- Cell to cell balancing during charging.

The following conditions are to result in an individual or group visual and audible alarm to be displayed in a continuously attended location:

- Cell voltage,
- Cell temperature,
- Battery current,
- Ambient temperature,
- Battery module/pack ground fault,
- Failure/shutdown of the battery system or failure of any of the individual modules.

5. State of Charge (SOC) and State of Health (SOH) of the batteries are to be monitored at a normally attended location for remaining capacity of batteries and state of health when lithium batteries are used as storage of power dedicated to the propulsion system or as part of the main source of electrical power.

6. Battery Management System (BMS) is to be capable of monitoring cells and ensure balanced operation against overcharge or overdischarged due to voltage unbalance between the cells.

C. Alarm System

1. The alarm system is to be continuously powered and an alarm is to be given in the event of failure of the normal power supply.

2. Any abnormal condition in the battery system is to initiate an alarm in the vessel's main alarm system with individual or group indication.

3. For vessels without a centralized main alarm system, battery alarms are to be presented at the bridge.

4. Abnormal conditions which can develop into safety hazards are to be alarmed before reaching the hazardous level. Sensors and other components used for such alarms is to be seperated from emergency shutdown or other protective safety functions.

5. Emergency shutdown of the battery is to activate an audible and visual alarm.

6. The following alarms are to be audible and visual and given in a normally attended location:

- Operation of the battery protective device,
- High cell or module temperature,
- High ambient temperature,
- Over and under voltage,
- High cell pressure or opening of cell safety venting device.
- failure of ventilation.

Note:

Other possible abnormal conditions are to be considered based on the Risk Assessment (e.g. gas detection, smoke detection, heat detection, overcurrent, ventilation failure, undervoltage, voltage unbalance between battery cells, charging failure, etc.).

7. When a battery system is regarded as storage of power dedicated to the propulsion system or as part of the main source of electrical power, an alarm is to be given on the bridge when State of Charge (SOC) reaches minimum required capacity as required for intended operation of the vessel.

D. Safety System

1. The safety system is to be activated automatically in the event of identified conditions which could lead to damage of lithium battery system. Activation of any automatic safety actions is to activate an alarm in a normally attended location.

2. Each cell or battery case is to incorporate a pressure relief mechanism or is to be constructed in such a way to relieve excessive internal pressure at a value and rate that will be precluded rupture, explosion and self-ignition.

3. A thermal protection device, capable to disconnect the battery in case of high temperature, is to be provided in the battery.

4. Voltage of any one of the single cells is not to exceed the upper limit of the charging voltage as specified by the cell Manufacturer. The battery charger is to be stopped when the upper limit of the charging voltage is exceeded for any one of the single cells.

5. The emergency shutdown required in Section 2,B.4 is to be provided locally, from outside the battery space, and from a normally attended location. It is to be arranged as a separated hardwired circuit and it is to be independent from the control system.

Note:

When battery installation is used as storage of power dedicated to the propulsion system or as part of the main source of electrical power, the emergency shutdown is to be located on the bridge.

6. Other conditions which could lead to damage or additional hazards to lithium battery system are to be considered based on the Risk Assessment.

7. Manual override of safety functions is not to be possible.

SECTION 4

ARRANGEMENT

Page

A. General

1. Battery spaces are not to be located forward of the collision bulkhead.

2. Battery spaces are to be arranged in such a way that danger to persons and damage to vessel is avoided due to failure of the batteries (e.g. caused by gassing, explosion, and fire).

3. Batteries are to be located where they are not exposed to excessive heat, extreme cold, spray, steam, shocks or vibration or other conditions which would impair performance.

4. The battery space is not to contain heat sources or high fire risk objects .

Note:

High fire risk objects are objects to those listed in SOLAS Reg. II-2/3.31.

Heat sources are sources with temperature higher than 220 °C as used in SOLAS Reg. II-2/4.2.2.6.1.

5. Batteries are to be located in a battery space placed in the machinery space or adjacent to it if batteries are used as storage of power dedicated to the propulsion system or as part of the main source of electrical power.

The exposed battery casing, covering cells and modules, is to be constructed of durable, flame-retardant, moisture resistant materials suitable for the marine environment likely to be exposed.

6. Batteries are not to be located in a battery box at open deck exposed to sun and frost.

7. Storage batteries shall be so installed as to ensure accessibility for changing of cells, inspection, testing, topping-up and cleaning. Storage batteries shall not be installed in the accommodation area or in cargo holds. An exception may be granted for gastight cells.

8. Battery systems for emergency supply shall not be installed in the same cabinet or battery room as storage batteries for other consumers.

B. Battery Space

1. A Risk Assessment, to be initiated in the design phase, covering:

- All potential hazards represented by the type (chemistry) of battery,
- Evaluation of the risk factors,
- Measures to control and reduce the identified risk, including potential gas development (e.g. toxic, corrosive), fire and explosion risk and
- Action to be implemented,

is to be carried out to establish if battery system need to be installed in a room assigned to lithium batteries only.

In case of fire in battery room, ventilation should stop automatically.

Note:

External hazards, such as fire and water ingress are to be taken into account in the Risk Assessment, in order to access the risk associated with an external event (e.g. a fire spreading from adjacent rooms to the battery space, water flooding from below) and possible countermeasures (e.g. suitable segregation of the battery space).

2. On the Risk Assessment, detection of gases, that may be emitted from the battery system in the event of a serious fault, installation of a fire detection system and of a fire extinguishing system in the battery room is to be evaluated.

3. The battery space is to be installed with appropriate means to vent gases which may be generated during an abnormal situation, from the battery space to open.

4. The battery space is to be considered an auxiliary machinery space or a machinery space other than category A as defined in SOLAS Reg. II-2 and is subject to the structural fire protection requirements listed therein.

5. Electrical equipment in battery rooms shall be certified of safe type with explosion protection of IIC T1 at least.

6. Ventilation inlet and outlet openings shall be so arranged to ensure that fresh air flows over the surface of the storage battery. The air inlet openings shall be arranged below and air outlet openings shall be arranged above.

7. Battery space shall be accessible for replacement of parts of the system.

8. Battery spaces shall provide protection against external hazards (e.g. fire, mechanical impact).

SECTION 5

CERTIFICATION, TESTING and INSPECTION

Page

A. Certification

1. The provisions in this section are requiremnts for obtaining of classification of **Li-BATTERY** notation.

2. The battery system is to be provided with test certificates issued by the Manufacturer or by an independent testing organisation the tests are to be carried out at the presence of and to the satisfaction of the attending **TL** surveyor. Relevant Test Reports are to be submitted for acceptance.

3. Batteries are to be subjected to functional and safety tests according to IEC Publication 62620 or in accordance with other equivalent national or international standards recognized by **TL.**

4. Performance tests are to be carried out on the battery system according to a test program which is to be submitted for approval (see Section 1, C.1) and which is to include functional tests (alarm system, safety system, control system, etc.) and further tests, if any, resulting from the Risk Assessment.

5. Battery system used as storage of power dedicated to the propulsion system, as part of the main source of electrical power, as alternative power supply or as transitional power supply to emergency services is to be type approved.

6. For type approved products, tests to verify the conformity of the product with the approved prototype are to be carried out before installation on board; the tests are to be carried out according to a test program which is to include functional tests (alarm system, safety system, control system, etc.) and further tests, if any, resulting from the Risk Assessment.

B. Plans to be Kept on Board

At a minimum, the following documents are to be kept on board for easy reference by the crew during maintenance or repair:

1. Operation Manual for battery system.

2. Operation and Maintenance Manual for BMS.

3. Battery system Maintenance Manual.

C. Testing After Installation on Board

1. After installation, and after any important repair or alteration which may affect the safety of the arrangement, at least the following items are to be checked to the satisfaction of the Surveyor in charge:

- Visual inspection,
- Operational tests,
- Tests of proper worrking of all the alarms and related functions,
- Charging and discharging capacities,
- Emergency shutdown operation,
- Checking of operation of sensors, including simulation of changes in parameters and simulation of sensor failure,
- Simulation of communication failure,
- Insulation resistance test,

- Correct operation of ventilation, cooling, gas detection system, fire detection system and fire extinguishing system, etc., where provided.

2. All periodical surveys associated with the **Li-BATTERY** notation are to be carried out at the same time and interval as the periodical survey of the vessel.

At the discretion of **TL**, the checks may be carried out directly by the Manufacturer of the installation or by the person responsible for maintenance authorised by the above-mentioned Manufacturer and certified by the appointed **TL** Surveyor.