

CLASS PROGRAMME

Type approval

DNVGL-CP-0418

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Lithium batteries



FOREWORD

DNV GL class programmes contain procedural and technical requirements including acceptance criteria for obtaining and retaining certificates for objects and organisations related to classification.

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Any comments may be sent by e-mail to rules@dnvgl.com

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CHANGES – CURRENT

This is a new document.

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SECTION 1 GENERAL

1 Introduction

1.1 Objective

The objective of this class programme (CP) is to describe the type approval (TA) scheme for lithium batteries. For a description of the Society's type approval scheme in general and further information on general conditions and procedures for obtaining the Society's TA certificate, see the Society's document DNVGL CP 0338 - *Type approval scheme*.

1.2 Scope

This CP gives a description of the procedures and requirements related to documentation, design and type testing applicable for type approval (TA) of lithium batteries.

This CP does not set the design requirements to the equipment. TA is based on compliance with design requirements given in the Society's rules and/or other regulations and standards. The CP describes the applicable design requirements and how to document compliance with the requirements in order to obtain a TA certificate for the equipment.

1.3 Application

The procedures and requirements described in this CP are applicable for obtaining the Society's type approval certificate based on requirements given in:

- DNV GL rules for classification – Ships [RU SHIP Pt.4 Ch.8](#) – *Electrical Installations*
- DNV GL rules for classification - Ships [RU SHIP Pt.4 Ch.9](#) – *Control and monitoring systems*
- DNV GL rules for classification - Ships [RU SHIP Pt.6 Ch.2 Sec.1](#) – *Battery power*
- the DNV GL offshore standard [OS D201](#) *Electrical installations*
- the DNV GL offshore standard [OS D202](#) *Automation, Safety and Telecommunication Systems*
- Class guideline DNVGL [CG 0339](#) - *Environmental test specification for electrical, electronic and programmable equipment and systems*

A TA certificate will confirm compliance with the requirements in the Society's rules as specified above. The TA certificate will not confirm compliance with requirements in other parts of the rules. In case additional requirements in other parts of the rules shall be covered by the TA certificate, this shall be specified in the application for TA and will be stated in the TA certificate.

TA of equipment in accordance with this CP is not mandatory, but may be used as a part of the case by case design approvals for equipment to be installed on vessels classed with the Society.

1.4 Definitions

<i>Term</i>	<i>Definition</i>
<i>battery cell</i>	the smallest building block in a battery, a chemical unit
<i>battery module</i>	assembly of cells including electronic control
<i>battery pack</i>	one or more modules including complete BMS and can be used as a standalone unit
<i>battery space</i>	the space enclosed by structural separation in which the batteries are located
<i>battery string</i>	a battery string comprises a number of cells or modules connected in series with the same voltage level as the battery system

<i>Term</i>	<i>Definition</i>
<i>battery sub-pack</i>	same as battery module
<i>battery system</i>	the whole battery installation including battery modules, electrical interconnections, BMS and other safety features
<i>BMS</i>	battery management system, a collective terminology comprising control, monitoring and protective functions of the battery system
<i>C-rate</i>	C-rate is a measure of the rate at which a battery is charged/discharged relative to its maximum capacity
<i>EMS</i>	energy management system, a system providing monitoring and control of the energy capacities
<i>HVIL</i>	high voltage interlock loop
<i>LEL</i>	lower explosion limit
<i>RT</i>	routine test shall be performed on each battery system
<i>SOC</i>	state of charge in percentage of the rated capacity of new battery, available for the discharge of the battery ("fuel gauge")
<i>SOH</i>	the state of health reflects the general condition of a battery and its ability to deliver the specified performance compared with a new battery (0-100%)
<i>TT</i>	type tests, shall be performed on the first in a batch of identical battery system

2 Documentation

Documentation shall be submitted as required by [Table 1](#).

Table 1 Documentation requirements

<i>Object</i>	<i>Documentation type</i>	<i>Additional description</i>
Battery system	Safety description	
	Specification	Including ratings and environmental data
	Test procedure at manufacturer	
	Functional description	Battery management system (BMS)
	Block diagram	Battery management system (BMS)
	Power Supply arrangement	Battery management system (BMS)
	List of controlled and monitored points	Battery management system (BMS)
	Software Quality Plan	Battery management system (BMS)
	Circuit diagram	Battery management system (BMS)
	Calculation report	Documentation of the SOH and SOC calculation
AP = For approval; FI = For information ACO = As carried out; L = Local handling; R = On request; TA = Covered by type approval; VS = Vessel specific		

SECTION 2 PRODUCT REQUIREMENTS

1 General

The lithium batteries shall comply with the relevant requirements of the following publications in its latest edition including amendments.

2 Design requirements

The Society's type approved lithium batteries shall comply with the relevant requirements of the following publications:

- DNV GL rules for classification – Ships RU SHIP Pt.6 Ch.2, RU SHIP Pt.4 Ch.8
- DNV GL offshore standard OS D201 as governed by applicable rules for offshore units
- Class guideline DNVGL CG 0339 *Environmental test specification for electrical, electronic and programmable equipment and systems*
- IEC 62619 *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for large format secondary lithium cells and batteries for use in industrial applications* (will be published 2016-07)
- IEC 62620 *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Large format secondary lithium cells and batteries for use in industrial applications.*

Guidance note:

For test of battery cells the following alternative standards are acceptable:

- IEC 62281 Safety of primary and secondary lithium cells and batteries during transport.
- UN38.3 Recommendations on the transportation of dangerous goods - Manual of Tests and Criteria - Lithium metal and lithium ion batteries.
- Until IEC 62619 has been released, safety requirements will be approved on a case by case basis.
- IEC 62133-2 + Propagation test as per IEC 62619

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3 Test requirements

The testing is divided into:

- visual inspection
- cell tests
- battery system tests
- battery system environmental tests.

3.1 Visual inspection

By visual inspection, it shall be verified that the test sample is in conformity with the approved plans.

3.2 Cell tests and battery system tests

The tests shall be according to the relevant parts of [Sec.3 table 1](#) and [Sec.3 table 2](#).

3.3 Battery system environmental tests

The tests shall be according to the relevant parts of [Sec.3 table3](#).

SECTION 3 TEST REQUIREMENTS

1 Lithium cell tests

Table 1 Type tests of battery cells.

Item	Test	Comments
1	External Short Circuit	IEC 62619 8.2.1 (alternatively IEC 62281 T-5 or UN38.3 T-5)
2	Impact	IEC 62619 8.2.2 (alternatively IEC 62281 T-6 or UN38.3 T-6)
3	Thermal abuse	IEC 62619 8.2.4 (alternatively IEC 62281 T-2 or UN38.3 T-2)
4	Overcharge	IEC 62619 8.2.5 (alternatively IEC 62281 T-7 or UN38.3 T-7)
5	Forced Discharge	IEC 62619 8.2.6 (alternatively IEC 62281 T-8 or UN38.3 T-8)

Guidance note:

If similar tests have been performed according to other standards, these tests may be acceptable.

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2 Lithium battery system tests

Table 2 Tests of battery systems.

Item	Test	Comments
1	Propagation/internal thermal event	IEC 62619 8.3.3
2	Overcharge with voltage	IEC 62619 9.2.2 ; alternatively IEC 62133-2
3	Overcharge with current	IEC 62619 9.2.3 ; alternatively IEC 62133-2
4	Overheating control	IEC 62619 9.2.4 ; alternatively IEC 62133-2
5	Sensor failures	Detection of all failure modes of the sensors
6	Cell balancing	According to specification
7	SOC validation	According to specification
8	Safety function test	<ul style="list-style-type: none"> – emergency stop function – alarms and shutdowns – high voltage interlock loop (HVIL) – temperature protection BMS – overvoltage protection BMS – undervoltage protection BMS – communication Failure – additional tests based on the implemented safety functions, ref FMEA for the BMS.
9	Capacity validation	According to specification, IEC 62620 may be used
10	Di-electrical strength (high voltage test)	DNV GL- CG 0339 Sec.3 [13]

Item	Test	Comments
11	Insulation resistance	DNV GL rules for classification – Ships RU SHIP Pt.4 Ch.8 Sec.10 Table 5
12	Pressure test of cooling system	In case of liquid cooled system

Guidance note:

If similar tests have been performed according to other standards, these tests may be acceptable.

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3 Lithium battery system environmental tests

The battery system shall be type tested according to Table 3. The tests shall be witnessed by a surveyor or be performed at a recognized laboratory.

Table 3 Environmental tests of batteries*.

Item	Test	Comments
1	Vibration	DNV GL – CG 0339 Sec.3 [6]
2	Dry Heat	DNV GL – CG 0339 Sec.3 [7]
3	Damp Heat	DNV GL – CG 0339 Sec.3 [8]
4	Cold**	DNV GL – CG 0339 Sec.3 [9]
5	Corrosion**	DNV GL – CG 0339 Sec.3 [10]
6	Flame retardant	IEC 60092-101 (if use of flammable materials)
7	EMC	DNV GL – CG 0339 Sec.3 [14]
* Minimum class A, according to DNV GL – CG 0339		
** Only applicable when the batteries is going to be located outside.		

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