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INTERNATIONAL STANDARD

colour inside

Safety of primary and secondary lithium cells and batteries during transport

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF PRIMARY AND SECONDARY LITHIUM CELLS AND BATTERIES DURING TRANSPORT

FOREWORD

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International Standard IEC 62281 has been prepared jointly by IEC technical committee 35: Primary cells and batteries and by subcommittee 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes, of IEC technical committee 21: Secondary cells and batteries.

This second edition cancels and replaces the first edition, published in 2004, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) distinction between small and large cell or battery by gross mass rather than by lithium content or Watt-hour rating ("nominal" energy);
b) combination of the no mass loss (NM) and no leakage (NL) criteria into one criteria (NL);
c) extension of an acceptable mass loss of 0,2 % from 5 g to 75 g mass of a cell or battery;
d) reduction of large batteries to be tested under tests T-1 to T-5 and T-8 from 4 to 2 samples;

e) reduction of test samples required for small battery assemblies (5.2.2);

f) reduction of the vibration amplitude to 2 g for large batteries in T-3 vibration test method;

g) replacement of the impact test by the crush test for prismatic, pouch, button, and coin cells as well as cylindrical cells with no more than 20 mm in diameter.

The text of this standard is based on the following documents:

FDIS	Report on voting
35/1303/FDIS	35/1307/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Primary lithium cells and batteries were first introduced in military applications in the 1970s. At that time, little commercial interest and no industrial standards existed. Consequently, the United Nations (UN) Committee of Experts on the Transport of Dangerous Goods, although usually referring to industrial standards for testing and criteria, introduced a sub-section in the Manual of tests and criteria concerning safety tests relevant to transport of primary lithium cells and batteries. Meanwhile, commercial interest in primary and secondary (rechargeable) lithium cells and batteries has grown and several industrial standards exist. However, the existing IEC standards are manifold, not completely harmonized, and not necessarily relevant to transport. They are not suitable to be used as a source of reference in the UN Model Regulations. Therefore this group safety standard has been prepared to harmonize the tests and requirements relevant to transport.

This International Standard applies to primary and secondary (rechargeable) lithium cells and batteries containing lithium in any chemical form: lithium metal, lithium alloy or lithium-ion. Lithium-metal and lithium alloy primary electrochemical systems use metallic lithium and lithium alloy, respectively, as the negative electrode. Lithium-ion secondary electrochemical systems use intercalation compounds (intercalated lithium exists in an ionic or quasi-atomic form within the lattice of the electrode material) in the positive and in the negative electrodes.

This International Standard also applies to lithium polymer cells and batteries, which are considered either as primary lithium-metal cells and batteries or as secondary lithium-ion cells and batteries, depending on the nature of the material used in the negative electrode.

The history of transporting primary and secondary lithium cells and batteries is worth noting. Since the 1970s, over ten billion primary lithium cells and batteries have been transported, and since the early 1990s, over one billion secondary (rechargeable) lithium cells and batteries utilizing a lithium-ion system have been transported. As the number of primary and secondary lithium cells and batteries to be transported is increasing, it is appropriate to also include in this standard the safety testing of packaging used for the transportation of these products.

This International Standard specifically addresses the safety of primary and secondary lithium cells and batteries during transport and also the safety of the packaging used.

The UN Manual of Tests and Criteria [1][1] distinguishes between lithium metal and lithium alloy cells and batteries on the one hand, and lithium ion and lithium polymer cells and batteries on the other hand. While it defines that lithium metal and lithium alloy cells and batteries can be either primary (non-rechargeable) or rechargeable, it always considers lithium ion cells and batteries as rechargeable. However, test methods in the UN Manual of Tests and Criteria are the same for both secondary lithium metal and lithium alloy cells and batteries and lithium ion and lithium polymer cells and batteries. The concept is only needed to distinguish between small and large battery assemblies. Battery assemblies assembled from (primary or secondary) lithium metal and lithium alloy batteries are distinguished by the aggregate lithium content of all anodes (measured in grams), while battery assemblies assembled from lithium ion or lithium polymer batteries are distinguished by their “nominal” energy (measured in Watt-hours).

1 Numbers in square brackets refer to the Bibliography

SAFETY OF PRIMARY AND SECONDARY LITHIUM CELLS AND BATTERIES DURING TRANSPORT

1 Scope

This International Standard specifies test methods and requirements for primary and secondary (rechargeable) lithium cells and batteries to ensure their safety during transport other than for recycling or disposal. Requirements specified in this standard do not apply in those cases where special provisions given in the relevant regulations, listed in 7.3, provide exemptions.

NOTE Different standards may apply for lithium-ion traction battery systems used for electrically propelled road vehicles.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61960, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications*

IEC 62133, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications*

IEC 62660-1, *Secondary lithium-ion cells for the propulsion of electric road vehicles – Part 1: Performance testing*

3 Terms and definitions

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

3.1
aggregate lithium content
total lithium content of the cells comprising a battery

3.2
battery
one or more cells electrically connected and fitted in a case, with terminals, markings and protective devices etc., as necessary for use

Note 1 to entry: This definition is different from the definition used in the UN Manual of Tests and Criteria [1]. The standard was, however, carefully prepared so that the test set-up for each test is harmonized with the UN Manual.

[SOURCE: IEC 60050-482:2004 [2], 482-01-04, modified – reference to "electrically connected" has been added]

3.3
battery assembly
battery comprising two or more batteries

3.4
button (cell or battery)
coin (cell or battery)
small round cell or battery where the overall height is less than the diameter, e.g. in the shape of a button or a coin

[SOURCE: IEC 60050-482:2004, 482-02-40, modified – the term "small round cell or battery" replaces the original "cell with a cylindrical shape""]

3.5
cell
basic functional unit, consisting of an assembly of electrodes, electrolyte, container, terminals and, usually, separators that is a source of electric energy obtained by direct conversion of chemical energy

[SOURCE: IEC 60050-482:2004, 482-01-01]

3.6
component cell
cell contained in a battery

3.7
cycle (of a secondary (rechargeable) cell or battery)
set of operations that is carried out on a secondary (rechargeable) cell or battery and is repeated regularly in the same sequence

Note 1 to entry: These operations may consist of a sequence of a discharge followed by a charge or a charge followed by a discharge under specified conditions. This sequence may include rest periods.

[SOURCE: IEC 60050-482:2004, 482-05-28, modified – the words "secondary (rechargeable" have been added]

3.8
cylindrical (cell or battery)
round cell or battery in which the overall height is equal to or greater than the diameter

[SOURCE: IEC 60050-482:2004, 482-02-39, modified – the words "round cell or battery" replace the original "cell with a cylindrical shape"]

3.9
depth of discharge
DOD
percentage of rated capacity discharged from a battery

3.10
first cycle
initial cycle of a secondary (rechargeable) cell or battery following completion of all manufacturing, formation and quality control processes

3.11
fully charged
state of charge of a secondary (rechargeable) cell or battery corresponding to 0 % depth of discharge

3.12
fully discharged
state of charge of a cell or battery corresponding to 100 % depth of discharge

3.13
large battery
battery with a gross mass of more than 12 kg

3.14
large cell
cell with a gross mass of more than 500 g

3.15
lithium cell (primary or secondary (rechargeable))
cell containing a non-aqueous electrolyte and a negative electrode of lithium or containing lithium

Note 1 to entry: Depending on the design features chosen, a lithium cell may be primary or secondary (rechargeable).

[SOURCE: IEC 60050-482:2004, 482-01-06, modified – the notion of "primary or secondary (rechargeable" has been added]

3.16
lithium content
mass of lithium in the negative electrode of a lithium metal or lithium alloy cell or battery in the undischarged or fully charged state

3.17
lithium ion cell or battery
rechargeable non-aqueous cell or battery in which the positive and negative electrodes are both intercalation compounds constructed with no metallic lithium in either electrode

Note 1 to entry: Intercalated lithium exists in an ionic or quasi-atomic form with the lattice of the electrode material.

Note 2 to entry: A lithium polymer cell or battery that uses lithium ion chemistries, as described herein, is considered as a lithium ion cell or battery.

3.18
nominal energy
energy value of a cell or battery determined under specified conditions and declared by the manufacturer

Note 1 to entry: The nominal energy is calculated by multiplying the nominal voltage by rated capacity.

Note 2 to entry: The term “rated energy” could be more appropriate.

3.19
nominal voltage
suitable approximate value of the voltage used to designate or identify a cell, a battery or an electrochemical system

[SOURCE: IEC 60050-482:2004, 482-03-31]

3.20
open-circuit voltage
voltage across the terminals of a cell or battery when no external current is flowing

[SOURCE: IEC 60050-482:2004, 482-03-32, modified – "when no external current is flowing" replaces "when the discharge current is zero"]

3.21
primary (cell or battery)
cell or battery that is not designed to be electrically recharged

[SOURCE: IEC 60050-482:2004, 482-01-02, modified – addition of "or battery"]

3.22
prismatic (cell or battery)
cell or battery having rectangular sides and bases

[SOURCE: IEC 60050-482:2004, 482-02-38, modified – omission of "having the shape of a parallelepiped"]

3.23
protective devices
devices such as fuses, diodes or other electric or electronic current limiters designed to interrupt the current flow, block the current flow in one direction or limit the current flow in an electrical circuit

3.24
rated capacity
capacity value of a cell or battery determined under specified conditions and declared by the manufacturer

Note 1 to entry: The following IEC standards provide guidance and methodology for determining the rated capacity: IEC 61960, IEC 62133, IEC 62660-1.

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – inclusion of "a cell or battery", addition of Note to entry]

3.25
secondary (rechargeable) cell or battery
cell or battery which is designed to be electrically recharged

[SOURCE: IEC 60050-482:2004, 482-01-03, modified – addition of "rechargeable" and "or battery"]

3.26
small battery
battery with a gross mass of not more than 12 kg

3.27
small cell
cell with a gross mass of not more than 500 g

3.28
type (for cells or batteries)
particular electrochemical system and physical design of cells or batteries

3.29
undischarged
state of charge of a primary cell or battery corresponding to 0 % depth of discharge

4 Requirements for safety

4.1 General considerations

Lithium cells and batteries are categorized by their chemical composition (electrodes, electrolyte) and internal construction (bobbin, spiral). They are available in various shapes. It is necessary to consider all relevant safety aspects at the battery design stage, recognizing the fact that they may differ considerably, depending on the specific lithium system, power output and battery configuration.