



Edition 4.0 2019-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Safety of primary and secondary lithium cells and batteries during transport

Sécurité des piles et des accumulateurs au lithium pendant le transport

<u>IEC 62281:2019</u> https://standards.iteh.ai/catalog/standards/sist/958b9ff4-a02b-48e6-b0db-5f0ade747f47/iec-62281-2019





THIS PUBLICATION IS COPYRIGHT PROTECTED Copyright © 2019 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office 3, rue de Varembé CH-1211 Geneva 20 Switzerland Tel.: +41 22 919 02 11 info@iec.ch www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number text technical committee,...). It also gives information on projects, replaced and withdrawn publications.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once 28 a month by email. https://standards.iteh.ai/catalog/standard

IEC Customer Service Centre - webstore.iec.6fl/csc747f47/iec If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Glossary - std.iec.ch/glossary

67,000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.





Edition 4.0 2019-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Safety of primary and secondary lithium cells and batteries during transport Sécurité des piles et des accumulateurs au lithium pendant le transport

> IEC 62281:2019 https://standards.iteh.ai/catalog/standards/sist/958b9ff4-a02b-48e6-b0db-5f0ade747f47/iec-62281-2019

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 29.220.10

ISBN 978-2-8322-6661-8

Warning! Make sure that you obtained this publication from an authorized distributor. Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

 Registered trademark of the International Electrotechnical Commission Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FC	OREWO	RD	.4				
IN	INTRODUCTION						
1	Scop	Scope					
2	Normative references						
3	Terms and definitions7						
4 Requirements for safety							
4.1 General considerations							
	4.2	Quality plan	11				
	4.3	Packaging	11				
5	Туре	testing, sampling and re-testing	11				
	5.1	Type testing	11				
	5.2	Overcharge protection	12				
	5.3	Battery assemblies	12				
	5.3.1	General	12				
	5.3.2	Small battery assemblies	12				
	5.3.3	Large battery assemblies	12				
	5.4	Batteries forming an integral part of equipment	12				
	5.5	Sampling. II CII STANDARD PKEVIEW	12				
	5.6	Re-testing	13				
6	Test	methods and requirements	14				
	6.1	General	14				
	6.1.1	Cautionaryunotibeteh.ai/catalog/standards/sist/958b9ff4-a02b-48e6-b0db-	14				
	6.1.2	Ambient temperature ^{10ade/4/14//lec-62281-2019}	14				
	6.1.3	Parameter measurement tolerances	14				
	6.1.4	Pre-discharge and pre-cycling	14				
	6.2	Evaluation of test criteria	14				
	6.2.1	Shifting	14				
	6.2.2	Distortion	14				
	6.2.3	Short-circuit	15				
	6.2.4	Excessive temperature rise	15				
	6.2.5	Leakage	15				
	6.2.6	Venting	15				
	0.2.7	Fire	15				
	0.2.0		15				
	0.2.9	Tests and requirements Overview	10				
	0.3 6.4	Transport tests	10				
	641	Test T-1: Altitude	16				
	642	Test T-2 [·] Thermal cycling	16				
	643	Test T-3. Vibration	17				
	6.4.4	Test T-4: Shock	18				
	6.4.5	Test T-5: External short-circuit	18				
	6.4.6	Test T-6: Impact/crush	19				
	6.5	Misuse tests	21				
	6.5.1	Test T-7: Overcharge	21				
	6.5.2	Test T-8: Forced discharge	21				

6.6 Packaging test – Test P-1: Drop test	21			
6.7 Information to be given in the relevant specification	22			
6.8 Test report summary	22			
7 Information for safety				
7.1 Packaging	23			
7.2 Handling of battery cartons	23			
7.3 Transport	23			
7.3.1 General	23			
7.3.2 Air transport	23			
7.3.3 Sea transport	23			
7.3.4 Land transport	23			
7.3.5 Classification	23			
7.4 Storage				
8 Instructions for packaging and handling during transport – Quarantine	24			
9 Marking	24			
9.1 Marking of primary and secondary (rechargeable) cells and batteries	24			
9.2 Marking of the packaging and shipping documents	24			
Annex A (informative) Shock test – adjustment of acceleration for large batteries	25			
A.1 General	25			
A.2 Shock energy depends on mass, acceleration, and pulse duration	25			
A.3 The constant acceleration approach	26			
A.4 The constant energy approach.ards.iten.al.	27			
Annex B (informative) Deviations from Chapter 38.3 of the UN Manual	28			
B.1 General. <u>IEC 62281:2019</u>	28			
B.2 Summary table of required tests for primary cells and batteries	28			
B.3 Summary table of required tests for rechargeable cells and batteries	29			
B.4 Evaluation of a rupture	31			
B.5 Evaluation of an explosion				
Bibliography				
Figure 1 – Example of a test set-up for the impact test	20			
Figure A.1 – Half sine shock for batteries (constant peak acceleration)	26			
Figure A.2 – Half sine shock for batteries (constant energy)	27			
Table 1 – Number of primary test cells and batteries for type testing	13			
Table 2 – Number of secondary test cells and batteries for type testing	13			
Table 3 – Number of packages with primary or secondary test cells and batteries				
Table 4 Mass loss limits	10			
	15			
Table 5 – Transport and packaging tests and requirements	16			
Table 6 – Vibration profile (sinusoidal)	17			
Table 7 – Shock parameters	18			
Table B.1 – Summary table of required tests for primary cells and batteries	29			
Table B.2 – Summary table of required tests for rechargeable cells and batteries				

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF PRIMARY AND SECONDARY LITHIUM CELLS AND BATTERIES DURING TRANSPORT

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any enduser.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of contormity. Independent certification bodies provide conformity assessment services tand, in some lareas, access to IEC marks of conformity CIEC is not responsible for any services carried out by independent certification bodies.-62281-2019
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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

This fourth edition cancels and replaces the third edition published in 2016. This edition constitutes a technical revision.

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

- a) button cell definition revised, moved to coin (cell or battery);
- b) addition of provisions for batteries forming an integral part of equipment (5.4);
- c) all tests for secondary cells and batteries now also contain a requirement for 25 charge and recharge cycles prior to the test;
- d) addition of alternative tables for Table 1 and Table 2 in Annex B;

- e) addition of "forcible" to the rupture criteria;
- test report 6.8 merged with test certificate 6.9 and replaced with the items listed in [12]; f)
- g) addition of an informative Annex B with important deviations from the UN Manual of Tests and Criteria, Chapter 38.3.

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

FDIS	Report on voting		
35/1416/FDIS	35/1422/RVD		

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

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

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

- reconfirmed, •
- withdrawn, •
- replaced by a revised edition, or **II ch STANDARD PREVIEW** .
- amended. •

(standards.iteh.ai)

IEC 62281:2019 https://standards.iteh.ai/catalog/standards/sist/958b9ff4-a02b-48e6-b0db-5f0ade747f47/iec-62281-2019

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 document 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 document 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.

iTeh STANDARD PREVIEW

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 document the safety testing of packaging used for the transportation of these products.

This document 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 [12]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 assembles assembled in Watt-hours).

¹ Numbers in square brackets refer to the Bibliography.

SAFETY OF PRIMARY AND SECONDARY LITHIUM CELLS AND BATTERIES DURING TRANSPORT

Scope 1

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 document 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

There are no normative references in this document.

Terms and definitions 3

Teh STANDARD PREVIEW For the purposes of this document, the following terms and definitions apply. standards.iteh.ai)

ISO and IEC maintain terminological databases for use in standardization at the following addresses: IEC 62281:2019

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp •

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 [12]. This document was, however, carefully prepared so that the test set-up for each test is harmonized with the UN Manual.

Note 2 to entry: A cell used in equipment where the equipment is providing the functions of a case, terminals, markings and protective devices etc., as necessary for use in the equipment, is, for the purposes of this document, considered to be a battery.

[SOURCE: IEC 60050-482:2004 [1], 482-01-04, modified - Reference to "electrically connected" has been added.]

3.3 battery assembly

battery comprising two or more batteries

3.4 coin cell or battery lithium button cell or battery

small round cell or battery where the overall height is less than the diameter, containing non-aqueous electrolyte

Note 1 to entry: The nominal voltage of lithium batteries is typically greater than 2 V.

[SOURCE: IEC 60050-482:2004, 482-02-40, modified – The definition "small round cell or battery" replaces the original "cell with a cylindrical shape", "containing non-aqueous electrolyte" was added, the term "lithium button" was added]

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

iTeh STANDARD PREVIEW

<of a secondary (rechargeable) cell or batterys set of operations that is carried out on a
secondary (rechargeable) cell or battery and is repeated regularly in the same sequence</pre>

IEC 62281:2019

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", the term "cylindrical battery" has been added.]

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

Note 1 to entry: This note applies to the French language only.

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, adj

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

3.12

fully discharged, adj

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 domain "primary or secondary (rechargeable)" has been added.]

3.16

lithium content iTeh STANDARD PREVIEW mass of lithium in the negative electrode of a lithium metal or lithium alloy cell or battery in the undischarged or fully charged state and ards.iteh.ai)

3.17

IEC 62281:2019

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".]

- 10 -

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 61960-3 [5], IEC 62133-2 [6], IEC 62660-1 [7]. liteh.ai)

lanuarus

[SOURCE: IEC 60050-482:2004, 482-03-15, modified - Inclusion of "a cell or battery", addition of Note 1 to entry.] IEC 62281:2019

> https://standards.iteh.ai/catalog/standards/sist/958b9ff4-a02b-48e6-b0db-5f0ade747f47/iec-62281-2019

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, adj

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

IEC 62281:2019 © IEC 2019

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, stacked). 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.

The following design concepts for safety are common to all lithium cells and batteries:

- a) To prevent by design an abnormal temperature rise above the critical value defined by the manufacturer.
- b) To control by design temperature increases in the cell or battery e.g. by limiting the current flow or by adequate thermal management.
- c) To design lithium cells and batteries so as to relieve excessive internal pressure or to preclude a violent rupture under conditions of transport.
- d) To design lithium cells and batteries so as to prevent a short-circuit under normal conditions of transport and intended use.
- e) To equip primary lithium batteries containing cells or strings of cells connected in parallel with effective means, as may be necessary, to prevent dangerous reverse current flow (e.g. diodes, fuses, etc.).

4.2 Quality plan

(standards.iteh.ai) The manufacturer shall implement a documented quality plan (i.e. quality reports, inspection records, management structure) defining the procedures for the inspection of materials, components, cells and batteries during the course of manufacture, to be applied to the total process of producing a specific type of batterys. Manufacturers should understand their process capabilities and should institute the necessary process controls as they relate to product safety and reliability.

4.3 Packaging

Lithium cells and batteries shall be packaged so as to prevent an external short-circuit under normal transport conditions.

NOTE Additional requirements for packaging of dangerous goods are given in UN Model Regulations:2017 [13], section 6.1. See also regulations mentioned in 7.3.

5 Type testing, sampling and re-testing

5.1 Type testing

Lithium metal and lithium ion cells or batteries which differ from a tested type by

- a) for primary cells and batteries, a change of more than 0,1 g or 20 % by mass, whichever is greater, to the electrodes or to the electrolyte, or
- b) for rechargeable cells and batteries, a change in nominal energy (in Wh) of more than 20 % or an increase in nominal voltage of more than 20 %, or
- c) a change that would lead to failure of any of the tests,

shall be considered a different type and shall be subject to the required tests.

NOTE The type of change that might be considered to differ from a tested type, such that it might lead to failure of any of the test results, may include, but is not limited to

1) a change in the material of the anode, the cathode, the separator or the electrolyte,

- 2) a change of protective devices, including hardware and software,
- 3) a change of safety design in cells or batteries, such as a venting valve,
- 4) a change in the number of component cells, and
- 5) a change in connecting mode of component cells, and,
- 6) for batteries which are to be tested according to test T-4 with a peak acceleration less than 150 $g_{\rm p}$, a change in the mass which could adversely impact the result of the T-4 test and lead to a failure.

5.2 **Overcharge protection**

Secondary batteries not equipped with battery overcharge protection that are designed for use only in a battery assembly or in equipment, which affords such protection, are not subject to the requirements of test T-7.

5.3 **Battery assemblies**

5.3.1 General

Generally, battery assemblies, including battery packs, battery modules, and other units that may be assembled from batteries, are tested like batteries.

5.3.2 Small battery assemblies

When testing a battery assembly in which the aggregate lithium content of all anodes, when fully charged, is not more than 500 g, or in the case of a lithium ion battery, with a nominal energy of not more than 6 200 Wh, assembled from batteries that have passed all applicable tests, one battery assembly in a fully charged state shall be tested under tests T-3, T-4 and T-5, and, in addition, test T-7 in the case of a secondary battery assembly. stanuarus.iten.ar

NOTE The term "fully charged" is used in [12] although it applies only to secondary battery assemblies. For primary battery assemblies, the term "undischarged" would be more appropriate.

Large battery assemblies 5f0ade747f47/iec-62281-2019

5.3.3

A battery assembly with an aggregate lithium content of more than 500 g, or in the case of a lithium ion battery, with a nominal energy of more than 6 200 Wh, does not need to be tested if it is of a type that has been verified as preventing:

- overcharge, and
- short circuits; and .
- over discharge between the batteries.

5.4 Batteries forming an integral part of equipment

Cells or batteries that are an integral part of the equipment they are intended to power, and which are transported only when installed in the equipment, may be tested in accordance with the applicable tests when installed in the equipment.

5.5 Sampling

Each different type shall be tested by taking random samples. The number of samples for testing primary cells and batteries is given in Table 1. The number of samples for testing secondary cells and batteries is given in Table 2. The number of samples for testing packages of primary and secondary cells and batteries is given in Table 3.

Tests	Discharge state	Cells or single-cell batteries ^a	Multi-cell batteries			
Tests	Undischarged	10	4			
T-1 to T-5	Fully discharged	10	4			
TestTC	Undischarged	5	5 component cells			
Test 1-6	Fully discharged	5	5 component cells			
Test T-8	Fully discharged	10	10 component cells			
Total for all tests		40	8 batteries and 20 component cells			
^a Single-cell batteries containing one tested component cell do not require re-testing unless the change could result in a failure of any of the tests.						

Table 1 – Number of primary test cells and batteries for type testing

See also Clause B.2 in Annex B.

Table 2 – Number of secondary test cells and batteries for type testing

Tests	Cycles and	Cells Single-cell batter		batteries ^a	Multi-cell	batteries
	state		Small	Large	Small	Large
Tests	At first cycle, fully charged	5	5	5	4	2
T-1 to T-5	After 25 cycles, fully charged	5	5	⁵ ADD D		2
Tost T 6	At first cycle, at 50 % DOD	5	5 tanda	⁵ rds ite	5 component cells	5 component cells
Test 1-0	After 25 cycles, at 50 % DOD	5	5	5	5 component cells	5 component cells
Toot T 7	At first cycle, fully charged	dN/As. ^h tel	n. 4 i/&atalog/sta	n2ards/sist/95	8 8 9ff4-a02b-48e6-b0db-	2 °
Test 1-7	After 25 cycles, fully charged	N/A ^b	4 °	2 °	4 ^c	2 °
Toot T 9	At first cycle, fully discharged	10	10	10	10 component cells ^d	10 component cells ^d
1621-0	After 25 cycles, fully discharged	10	10	10	10 component cells ^d	10 component cells ^d
Total for all tests		40	48	44	16 batteries and 30 component cells	8 batteries and 30 component cells

^a Single-cell batteries containing one tested component cell do not require re-testing unless the change could result in a failure of any of the tests, except for test T-7 where only batteries are tested.

^b N/A = not applicable.

^c See 5.2.

^d Multi-cell batteries are considered to be protected against overdischarge of their component cells. Otherwise they would have to be tested as well.

See also Clause B.3 in Annex B.

Table 3 – Number of packages with primary or secondary test cells and batteries

Number of samples for test P-1

1 package as supplied for transport

5.6 Re-testing

In the event that a primary or secondary lithium cell or battery type does not meet the test requirements, steps shall be taken to correct the deficiency or deficiencies that caused the failure before such a cell or battery type is re-tested.