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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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High-temperature secondary batteries – Part 2: Safety requirements and tests

Batteries d'accumulateurs à haute température – Partie 2: Exigences de sécurité et essais

IEC 62984-2:2020-03(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CONTENTS

FOREWORD 4
1 Scope 6
2 Normative references 6
3 Terms, definitions, symbols and abbreviated terms 6
3.1 Battery safety 7
3.2 Symbols and abbreviated terms 9
4 Environmental (service) conditions 9
4.1 General 9
4.2 Normal service conditions for stationary installations 9
4.3 Special service conditions for stationary installations 9
4.4 Normal service conditions for mobile installations (except propulsion) 9
4.5 Special service conditions for mobile installations (except propulsion) 9
5 Safety requirements 10
5.1 Functional safety requirements 10
5.1.1 Safety of battery management system 10
5.1.2 Battery protective management 10
5.1.3 Thermal management 10
5.2 Mechanical requirements 10
5.2.1 General 10
5.2.2 Battery enclosure 10
5.3 Protection against electrical shock 10
5.3.1 General 10
5.3.2 Normal conditions 11
5.3.3 Single-fault conditions 11
5.3.4 Insulation voltage 12
5.3.5 Separation 15
5.3.6 Spacing 15
5.3.7 Earthing 16
5.4 Resistance to abnormal conditions 18
5.4.1 Resistance to overcharge 18
5.4.2 Resistance to short circuit 18
5.4.3 Resistance to external fire 19
5.4.4 Resistance to internal overheating 19
5.4.5 Flooding 19
5.4.6 Drop 19
6 Safety tests 20
6.1 General 20
6.1.1 Classification of tests 20
6.1.2 Test object selection 20
6.1.3 DUT initial conditions before tests 20
6.1.4 Measuring equipment 20
6.2 List of tests 21
6.3 Type tests 21
6.3.1 Overcharge test 21
6.3.2 Short circuit test 22
6.3.3 External fire exposure test 22

6.3.4 Cell failure propagation test 24
6.3.5 Overheating test 25
6.3.6 Drop test 27
6.4 Routine tests 28
6.4.1 Withstand voltage test 28
6.4.2 Insulation resistance measurement 29
6.5 Special tests 30
6.5.1 Immersion test 30
7 Markings 30
7.1 General 30
7.2 Data plate marking 32
8 Rules for transportation, installation and maintenance 32
8.1 Transportation 32
8.2 Installation 32
8.3 Maintenance 32
9 Documentation 32
9.1 Instruction manual 32
9.2 Test report 32
Annex A (informative) Standard template for report of test results and description of the DUT – Report of type test 33
Bibliography 36

Figure 1 – Examples of binding screw assemblies 18
Figure 2 – Fire exposure test: pre-heating 23
Figure 3 – Fire exposure test: direct exposure 24
Figure 4 – Fire exposure: end 24
Figure 5 – Plan view of specimen cross section for cell failure propagation test 25
Figure 6 – Temperature management subsystem 26
Figure 7 – Application of test voltage 29
Figure 8 – Insulation resistance measurement 29
Figure 9 – Examples of safety labels for sodium-nickel-chloride / sodium-sulfur batteries 31

Table 1 – List of symbols and abbreviated terms 9
Table 2 – Withstand voltages 13
Table 3 – Actual test voltage for impulse test with corresponding altitudes 14
Table 4 – Guide to overvoltage category assignment 15
Table 5 – Multiplication factors for clearances of equipment rated for operation at altitudes up to 5 000 m 16
Table 6 – Type tests 21
Table 7 – Routine tests 21
Table 8 – Special tests 21
Table 9 – Drop test severity classes 27

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HIGH-TEMPERATURE SECONDARY BATTERIES –

Part 2: Safety requirements and tests

FOREWORD

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International Standard IEC 62984-2 has been prepared by IEC technical committee 21: Secondary cells and batteries.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
21/1032/FDIS	21/1042/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.

This document is to be read in conjunction with IEC 62984-1:2020.

A list of all parts in the IEC 62984 series, published under the general title *High-temperature secondary batteries*, can be found on the IEC website.

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
- amended.

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HIGH-TEMPERATURE SECONDARY BATTERIES –

Part 2: Safety requirements and tests

1 Scope

This part of IEC 62984 specifies safety requirements and test procedures for high-temperature batteries for mobile and/or stationary use and whose rated voltage does not exceed 1 500 V.

This document does not cover aircraft batteries, which are covered by IEC 60952 (all parts), and batteries for the propulsion of electric road vehicles, covered by IEC 61982 (all parts).

NOTE High-temperature batteries are electrochemical systems whose cells' internal minimum operating temperature is above 100 °C.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-18:2017, *Environmental testing – Part 2-18: Tests – Test R and guidance: Water*

IEC 60112, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*

IEC 60204-1, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 62984-1:2020, *High-temperature secondary batteries – Part 1: General requirements*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 62984-1 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/

- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Battery safety

3.1.1
rated insulation voltage
rated value of the RMS withstand voltage assigned by the manufacturer to the equipment or to a part of it, characterizing the specified (long-term) withstand capability of its insulation

Note 1 to entry: The rated insulation voltage is not necessarily equal to the rated voltage of equipment which is primarily related to functional performance.

[SOURCE: IEC 60050-312:2014, 312-06-02]

3.1.2
functional insulation
insulation between conductive parts, necessary for the proper functioning of the equipment

[SOURCE: IEC 60050-195:1998, 195-02-41]

3.1.3
supplementary insulation
independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation

[SOURCE: IEC 60050-195:1998, 195-06-07, modified – "for fault protection" has been replaced by "in order to provide protection against electric shock in the event of a failure of basic insulation".]

3.1.4
reinforced insulation
insulation of hazardous-live-parts which provides a degree of protection against electric shock equivalent to double insulation

[SOURCE: IEC 60050-195:1998, 195-06-09, modified – The note has been omitted.]

3.1.5
double insulation
insulation comprising both basic insulation and supplementary insulation

Note 1 to entry: Basic and supplementary insulation are separate, each designed for basic protection against electric shock.

[SOURCE: IEC 60050-195:1998, 195-06-08, modified – The note to entry has been added.]

3.1.6
extra-low voltage
ELV
voltage not exceeding the maximum value of the prospective touch voltage which is permitted to be maintained indefinitely under specified conditions of external influences

[SOURCE: IEC 61140:2016, 3.26]

3.1.7
SELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and

– under single fault conditions, including earth faults in other electric circuits

Note 1 to entry: SELV is the abbreviation for safety extra low voltage.

[SOURCE: IEC 60050-826:2004, 826-12-31]

3.1.8
PELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

– under normal conditions and

– under single fault conditions, except earth faults in other electric circuits

Note 1 to entry: PELV is the abbreviation for protective extra low voltage.

[SOURCE: IEC 60050-826:2004, 826-12-32]

3.1.9
protective-equipotential-bonding
PEB
equipotential bonding for the purposes of safety

EXAMPLE Protection against electric shock is an example of a safety purpose.

Note 1 to entry: Functional-equipotential-bonding is defined in IEV 195-01-16.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 60050-195:1998, 195-01-15, modified – Added abbreviated term, example and notes.]

3.1.10
class I equipment
equipment with basic insulation as provision for basic protection against electric shock and protective bonding as provision for fault protection, such that conductive parts on the outside of the equipment case cannot become live in the event of a failure of the basic insulation

Note 1 to entry: Content based on IEC 60050-851:2008, 851-15-10.

3.1.11
class II equipment
equipment with basic insulation as provision for basic protection against electric shock, and supplementary insulation as provision for fault protection, or in which basic protection and fault protection are provided by reinforced insulation

Note 1 to entry: There should be no provision for a protective conductor or reliance upon installation conditions for safety purposes. It is, however, possible to connect an earth conductor to Class II equipment for functional (for example, EMC) purposes.

Note 2 to entry: Content based on IEC 60050-851:2008, 851-15-11.

3.1.12
class III equipment
equipment, or parts of equipment, in which protection against electric shock relies upon supply from SELV or PELV systems and in which hazardous voltages (see hazardous-live-part) are not generated

3.1.13
overvoltage category
number defining a transient overvoltage condition

Note 1 to entry: Overvoltage categories I, II, III are used.

Note 2 to entry: See 5.3.4 for overvoltage category details.

[SOURCE: IEC 60050-581:2008, 581-21-02, modified – Added notes to entry.]

3.1.14
hazardous-live-part
live part which, under certain conditions, can give a harmful electric shock

[SOURCE: IEC 60050-195:1998, 195-06-05]

3.2 Symbols and abbreviated terms

The list of symbols and abbreviated terms is given in Table 1.

Table 1 – List of symbols and abbreviated terms

Symbol / Abbreviated term	Full term	Reference
CTI	Comparative tracking index	
ELV	Extra low voltage	See 3.1.6
PEB	Protective-equipotential-bonding	See 3.1.9
PELV	Protective extra low voltage	See 3.1.8
SELV	Safety extra low voltage	See 3.1.7

4 Environmental (service) conditions

4.1 General

Refer to IEC 62984-1:2020, 4.1.

4.2 Normal service conditions for stationary installations

Refer to IEC 62984-1:2020, 4.2.

4.3 Special service conditions for stationary installations

Refer to IEC 62984-1:2020, 4.3.

4.4 Normal service conditions for mobile installations (except propulsion)

Refer to IEC 62984-1:2020, 4.4.

4.5 Special service conditions for mobile installations (except propulsion)

Refer to IEC 62984-1:2020, 4.5.

5 Safety requirements

5.1 Functional safety requirements

5.1.1 Safety of battery management system

Electronic devices and software relied upon for safety shall be compliant with IEC 61508 (all parts).

5.1.2 Battery protective management

If relied upon for maintaining the cells within their specified operating range, the battery management system (BMS) shall maintain cells within the specified voltage, temperature and current during standby, charging and discharging of the battery.

5.1.3 Thermal management

A battery system shall be provided with a thermal management control to ensure safe operation of the battery, including its internal heaters and to prevent the battery from being overheated or otherwise used outside of its specified operating temperature range. The battery management system shall prevent the battery from entering a hazardous state as a result of failure of the thermal management control.

Heaters used to maintain the cells at specified operating temperatures shall be dimensioned for the current and voltage involved and designed to prevent breakages and short circuits from occurring as a result of handling, installation and operation of the battery.

NOTE Good thermal management provides a good level of efficiency.

5.2 Mechanical requirements

5.2.1 General

Subclause 5.2.1 of IEC 62984-1:2020 is applicable with the following additional text:

The enclosure and mechanical support structure(s) for the battery arrangement shall have the strength and rigidity required to resist the possible physical abuses that it will be exposed to during its transport, installation and intended use, in order to reduce hazards.

The battery shall be capable of withstanding, with no harm to users, the vibrations and shocks likely to occur during its transportation, storage, installation and operation according to the intended application (stationary or mobile).

The requirements of 5.2.1 apply not only to modules, but also to the complete battery installation, including module interconnections and supporting structure.

NOTE These requirements do not cover specific applications outside the scope of this document.

5.2.2 Battery enclosure

Subclause 5.2.2 of IEC 62984-1:2020 is applicable with the following additional text:

Unless installed in a protective location that prevents access to hazardous parts of the system, the battery shall have a minimum IP rating of IP22 according to IEC 60529.

5.3 Protection against electrical shock

5.3.1 General

The battery shall not jeopardize the safety of people and property.

Users shall be protected against electric shock hazards by the employment of suitable construction and engineering practices.

The testing of components and equipment with regard to protection against electric shock shall be conducted as type tests and routine tests as defined in Clause 6.

Applicable fundamental rules for protection against electrical shock are given in IEC 61140:2016, Clause 4, with application either under normal conditions, or under single fault conditions.

The applicable principles covering these different conditions are given in IEC 61140:2016, 4.1, 4.2 and 4.3.

Provisions and measures for protection against electrical shock are described in IEC 61140:2016, Clause 5 and Clause 6, which are applicable as far as relevant.

5.3.2 Normal conditions

To meet the fundamental rules for protection against electric shock under normal conditions, basic protection is necessary. Basic protection shall consist of one or more provisions that under normal conditions prevent contact with hazardous-live-parts.

NOTE Paints, varnishes, lacquers and similar products alone are generally not considered to provide adequate insulation for protection against electric shock in normal service.

Basic protection provisions that may be used for basic protection are:

– basic insulation,
– barriers or enclosures,
– obstacles,
– placing out of arm's reach,
– limitation of voltage,
– limitation of steady state touch current and charge,
– other provisions (complying with the fundamental rules for protection against electric shock).

These provisions are described in IEC 61140:2016, 5.2.

Protection against electric shock for class I, II or III equipment is applicable to those parts accessible under normal conditions. ELV, PEB, PELV and SELV systems provide protection from electric shock by hazardous-live-parts, and are not necessarily related to a class I, II or III equipment class.

Any conductive part that is not separated from the hazardous-live-parts by at least basic insulation shall be considered to be a live part.

An accessible metallic part is considered to be conductive if its surface is bare or is covered by an insulating layer which does not comply with the requirements of basic insulation.

5.3.3 Single-fault conditions

5.3.3.1 General

To meet the fundamental rules for protection against electric shock under single-fault conditions, what is referred to in this document as fault protection is necessary. This protection can be achieved by

– a further protective provision, independent of that for basic protection, or

– an enhanced protective provision, which provides both basic and fault protection taking account of all relevant influences. Unearthed accessible conductive parts which may become hazardous-live-parts under a single-fault condition shall be separated from hazardous-live-parts by double or reinforced insulation or be connected to the protective conductor.

As a consequence, unearthed accessible conductive parts which may become hazardous-live-parts under single-fault conditions, shall be separated from hazardous-live-parts by double or reinforced insulation or be connected to the protective conductor.

5.3.3.2 Fault protection

Fault protection shall consist of one or more provision(s) independent of and in addition to those for basic protection.

The scope of this independent and additional provision is that a single-fault condition applied to the equipment shall not cause an electric shock hazard.

Provisions that may be used for fault protection are:

– supplementary insulation,
– protective-equipotential-bonding,
– protective screening,
– automatic disconnection of the supply,
– separation (between circuits),
– a non-conducting environment,
– other provisions (complying with the fundamental rules for protection against electric shock).

These provisions are described in IEC 61140:2016, 5.3.

5.3.3.3 Enhanced protective provisions

An enhanced protective provision shall provide both basic and fault protection.

Arrangements shall be made so that the protection provided by an enhanced protective provision is unlikely to become degraded and so that a single fault is unlikely to occur.

Provisions that may be used for enhanced protection are:

– reinforced insulation,
– protective separation between circuits,
– limited current source,
– protective impedance devices,
– other provisions.

These provisions are described in IEC 61140:2016, 5.4.

5.3.4 Insulation voltage

High-temperature batteries are not simple components, but are typically an assembly of subsystems, due to the need for a BMS controller and thermal management subsystem. Therefore, the choice of the insulation voltage needs to take into account the connections of each subsystem of the battery with the external environment and its insulation coordination needs.

Each independent circuit of the battery shall be tested according to its rated insulation voltage and relevant overvoltage category.

NOTE For example, in the case of sodium-based batteries, independent circuits that are typically present are the following:

– main battery terminals,
– heater/cooler supply,
– BMS supply,
– digital communication ports,
– digital and/or analog I/O.

Not all of these circuits are necessarily present and externally accessible on each battery design.

The required withstand voltages are given in Table 2.

Table 2 – Withstand voltages

Voltage in volts

Rated insulation voltage up to	Withstand voltage			
	AC RMS 1 min	Impulse 1,2/50 µs		
		Overvoltage category I	Overvoltage category II	Overvoltage category III
60	1 000	---	---	---
100	1 200	---	---	---
150	1 350	---	---	2 500
300	1 500	1 500	2 500	4 000
600	1 800	2 500	4 000	6 000
800	2 000	3 300	5 000	7 000
1 000	2 200	4 000	6 000	8 000
1 500	2 700	6 000	8 000	10 000
The voltage AC RMS value is to be applied for 1 min.				

The actual test voltage for the impulse test is calculated from the rated impulse withstand voltage, taking into account the altitude correction factor, according to Table 3.