INTERNATIONAL STANDARD

IEC 62133

First edition
2002-10

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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 62133, which supersedes IEC 61809, has been prepared by subcommittee 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes, of IEC technical committee 21: Secondary cells and batteries.

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

FDIS	Report on voting
21A/363/FDIS	21A/371/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 2008-01. At this date, the publication will be

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- withdrawn;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

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

1 General

1.1 Scope

This International Standard specifies requirements and tests for the safe operation of portable sealed secondary cells and batteries (other than button) containing alkaline or other non-acid electrolyte, under intended use and reasonably foreseeable misuse.

1.2 Normative references

The following referenced documents are indispensable for the application 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 60050-486, *International Electrotechnical Vocabulary – Chapter 486: Secondary cells and batteries*

IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60285, *Alkaline secondary cells and batteries – Sealed nickel-cadmium cylindrical rechargeable single cells*

IEC 60485, *Digital electronic d.c. voltmeters and d.c. electronic analogue-to-digital converters*

IEC 61436, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-metal hydride rechargeable single cells*

IEC 61438, *Possible safety and health hazards in the use of alkaline secondary cells and batteries – Guide to equipment manufacturers and users*

IEC 61440, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-cadmium small prismatic rechargeable single cells*

IEC 61951-1, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Portable sealed rechargeable single cells – Part 1: Nickel-cadmium*

IEC 61951-2, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Portable sealed rechargeable single cells – Part 2: Nickel-metal hydride*

IEC 61960, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for portable applications* [1]

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

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[1] To be published.

1.3 Definitions

For the purpose of this international standard, the definitions contained in IEC 60050-486 and ISO/IEC Guide 51 as well as the following definitions apply.

1.3.1
safety
freedom from unacceptable risk

1.3.2
risk
a combination of the probability of occurrence of harm and the severity of that harm

1.3.3
harm
physical injury or damage to the health of people or damage to property or to the environment

1.3.4
hazard
potential source of harm

1.3.5
intended use
use of a product, process or service in accordance with specifications, instructions and information provided by the supplier

1.3.6
reasonably foreseeable misuse
use of a product, process or service in a way which is not intended by the supplier, but which may result from readily predictable human behaviour

1.3.7
secondary cell
basic manufactured unit providing a source of electrical energy by direct conversion of chemical energy, that consists of electrodes, separators, electrolyte, container and terminals, and that is designed to be charged electrically

1.3.8
secondary battery
assembly of secondary cell(s) ready for use as a source of electrical energy characterized by its voltage, size, terminal arrangement, capacity and rate capability

1.3.9
leakage
visible escape of liquid electrolyte

1.3.10
venting
release of excessive internal pressure from a cell/battery in a manner intended by design to preclude rupture or explosion

1.3.11
rupture
mechanical failure of a cell container or battery case induced by an internal or external cause, resulting in exposure or spillage but not ejection of materials

1.3.12
explosion
failure that occurs when a cell container or battery case opens violently and major components are forcibly expelled

1.3.13
fire
the emission of flames from a cell or battery

1.3.14
portable battery
a battery for use in a device or appliance which is conveniently hand carried

1.3.15
portable cell
a cell intended for assembly in a portable battery

1.3.16
rated capacity
quantity of electricity C_5 Ah (ampere-hours) declared by the manufacturer which a single cell can deliver when discharged at the reference test current of 0,2 I_t A to a specified final voltage, after charging, storing and discharging under specified conditions

1.4 Parameter measurement tolerances

The overall accuracy of controlled or measured values, relative to the specified or actual parameters, shall be within these tolerances.

a) ±1 % for voltage;

b) ±1 % for current;

c) ±2 °C for temperature;

d) ±0,1 % for time;

e) ±1 % for dimension;

f) ±1 % for capacity.

These tolerances comprise the combined accuracy of the measuring instruments, the measurement techniques used, and all other sources of error in the test procedure.

For assistance in selecting instrumentation see IEC 60051 for analogue instruments and IEC 60485 for digital instruments. The details of the instrumentation used shall be provided in any report of results.

2 General safety considerations

The safety of secondary cells and batteries requires the consideration of two sets of applied conditions:

a) intended use;

b) reasonably foreseeable misuse.

Cells and batteries shall be so designed and constructed that they are safe under conditions of both intended use and reasonably foreseeable misuse. It is expected that cells or batteries subjected to misuse may fail to function following such experience. They shall not however present significant hazards. It may also be expected that cells and batteries subjected to intended use shall not only be safe but shall continue to be functional in all respects.

Potential hazards which are the subject of this standard are:

a) fire,
b) burst/explosion,
c) leakage of cell electrolyte,
d) venting,
e) burns from excessively high external temperatures,
f) rupture of battery case with exposure of internal components.

Conformity with 2.1 to 2.6 is checked by inspection, by the tests of clause 4, and in accordance with the appropriate standard (see 1.2).

2.1 Insulation and wiring

The insulation resistance between the positive terminal and externally exposed metal surfaces of the battery excluding electrical contact surfaces shall be not less than 5 MΩ at 500 V d.c.

Internal wiring and its insulation shall be sufficient to withstand the maximum anticipated current, voltage and temperature requirements. The orientation of wiring shall be such that adequate clearances and creepage distances are maintained between connectors. The mechanical integrity of internal connections shall be sufficient to accommodate conditions of reasonably foreseeable misuse.

2.2 Venting

Battery cases and cells shall incorporate a pressure relief mechanism or shall be so constructed that they will relieve excessive internal pressure at a value and rate that will preclude rupture, explosion and self-ignition. If encapsulation is used to support cells within an outer case, the type of encapsulant and the method of encapsulation shall neither cause the battery to overheat during normal operation nor inhibit pressure relief.

2.3 Temperature/current management

The design of batteries shall be such that abnormal temperature-rise conditions are prevented.

NOTE Where necessary, means can be provided to limit current to safe levels during charge and discharge.

2.4 Terminal contacts

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

2.5 Assembly of cells into batteries

Cells used in the assembly of batteries shall have closely matched capacities, be of the same design, be of the same chemistry and be from the same manufacturer. Batteries that are designed for the selective discharge of a portion of their series connected cells shall incorporate separate circuitry to prevent the cell reversal caused by uneven discharges.

2.6 Quality plan

The manufacturer shall prepare a quality plan that defines procedures for the inspection of materials, components, cells and batteries and which covers the whole process of producing each type of cell or battery.

3 Type test conditions

Tests are made with the number of cells or batteries specified in Table 1, using cells or batteries that are not more than three months old. Unless otherwise specified, tests are carried out in an ambient temperature of 20 °C ± 5 °C.

NOTE Test conditions are for type tests only and do not imply that intended use includes operation under these conditions. Similarly, the limit of three months is introduced for consistency and does not imply that battery safety is reduced after three months.

Table 1 – Sample size for type tests

Test	Cell	Battery
4.2.1	5	–
4.2.2	5	5
4.2.3	–	3
4.2.4	5	5
4.3.1	5 sets of 4	–
4.3.2	5 sets/Temperature	5 sets/Temperature
4.3.3	3	3
4.3.4	5	5
4.3.5	5	–
4.3.6	5	–
4.3.7	3	–
4.3.8	5	5
4.3.9	5	–
4.3.10	5	–
4.3.11	5	–

4 Specific requirements and tests

4.1 Charging procedure for test purposes

Unless otherwise stated in this standard, the charging procedure for test purposes is carried out in an ambient temperature of 20 °C ± 5 °C, using the method declared by the manufacturer.

Prior to charging, the battery shall have been discharged at 20 °C ± 5 °C at a constant current of 0,2 I_t A down to a specified final voltage.

Warning: THESE TESTS USE PROCEDURES WHICH MAY RESULT IN HARM IF ADEQUATE PRECAUTIONS ARE NOT TAKEN. TESTS SHOULD ONLY BE PERFORMED BY QUALIFIED AND EXPERIENCED TECHNICIANS USING ADEQUATE PROTECTION.

4.2 Intended use

4.2.1 Continuous low-rate charging

a) Requirement

A continuous low-rate charge shall not cause fire or explosion.

b) Test

Fully charged cells are subjected for 28 days to a charge as specified by the manufacturer.

c) Acceptance criteria

- Nickel systems: no fire, no explosion.
- Lithium systems: no fire, no explosion, no leakage.

4.2.2 Vibration

a) Requirements

Vibration encountered during transportation shall not cause leakage, fire or explosion.

b) Test

Fully charged cells or batteries are vibration-tested under the following test conditions and the sequence in Table 2. A simple harmonic motion is applied to the cells or batteries with an amplitude of 0,76 mm, and a total maximum excursion of 1,52 mm. The frequency is varied at the rate of 1 Hz/min between the limits of 10 Hz and 55 Hz. The entire range of frequencies (10 Hz to 55 Hz) and return (55 Hz to 10 Hz), is traversed in 90 min ± 5 min for each mounting position (direction of vibration). The vibration is applied in each of three mutually perpendicular directions, in the sequence specified below.

Step 1: Verify that the measured voltage is typical of the charged product being tested.

Steps 2-4: Apply the vibration as specified in Table 2.

Step 5: Rest cell for 1 h, then make a visual inspection.

c) Acceptance criteria

No fire, no explosion, no leakage.

Table 2 – Conditions for vibration test

Step	Storage time h	Vibration time min	Visual examination
1	–	–	Pre-test
2	–	90 ± 5	–
3	–	90 ± 5	–
4	–	90 ± 5	–
5	1	–	Post-test

4.2.3 Moulded case stress at high ambient temperature

a) Requirement

Internal components of batteries shall not be exposed during use at high temperature.

b) Test

Fully charged batteries are exposed to a moderately high temperature to evaluate case integrity. The battery is placed in an air circulating oven at a temperature of 70 °C ± 2 °C. The batteries remain in the oven for 7 h, after which they are removed and allowed to return to room temperature.

c) Acceptance criteria

No physical distortion of the battery case resulting in exposure of internal components.

4.2.4 Temperature cycling

a) Requirements

Repeated exposure to high and low temperatures shall not cause fire or explosion.

b) Test according to the following procedure and the profile shown in figure 1.

Fully charged cells or batteries are subjected to temperature cycling (–20 °C, +75 °C), in forced draught chambers, according to the following procedure.

Step 1: Place the cells or batteries in an ambient temperature of 75 °C ± 2 °C for 4 h.

Step 2: Change the ambient temperature to 20 °C ± 5 °C within 30 min and maintain at this temperature for a minimum of 2 h.

Step 3: Change the ambient temperature to –20 °C ± 2 °C within 30 min and maintain at this temperature for 4 h.

Step 4: Change the ambient temperature to 20 °C ± 5 °C within 30 min and maintain at this temperature for a minimum of 2 h.

Step 5: Repeat steps 1 to 4 for a further four cycles.

Step 6: After the fifth cycle, store the cells or batteries for seven days prior to examination.

NOTE This test can be performed in a single chamber whose temperature is changed or in three separate chambers at three different test temperatures.

c) Acceptance criteria

No fire, no explosion, no leakage.

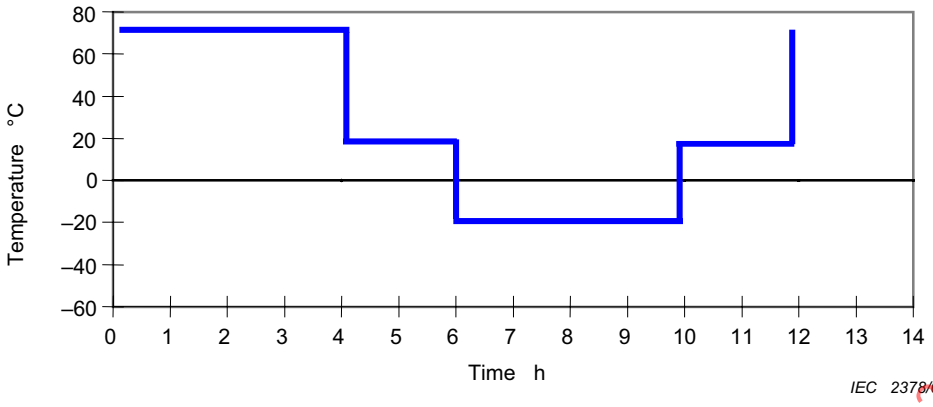

Figure 1 – Temperature profile for 4.2.4 – Temperature cycling test (one cycle)

4.3 Reasonably foreseeable misuse

4.3.1 Incorrect installation of a cell (nickel systems only)

a) Requirements

The incorrect installation of a single cell battery in a multi-cell application shall not cause fire or explosion.

b) Test

Fully charged cells are evaluated under conditions in which one of the cells is incorrectly installed. Four fully charged single cells of the same brand, type, size and age are connected in series with one of the four cells reversed. The resultant assembly is connected across a resistor of 1 Ω until the vent opens or until the temperature of the reversed cell returns to ambient temperature. Alternatively, a stabilized d.c. power supply can be used to simulate the conditions imposed on the reversed cell.

c) Acceptance criteria

No fire, no explosion.

4.3.2 External short circuit

a) Requirements

Short-circuiting of the positive and negative terminals shall not cause fire or explosion.

b) Test

Two sets of fully charged cells or batteries are stored in an ambient temperature of 20 °C ± 5 °C and 55 °C ± 5 °C respectively. Each cell or battery is then short-circuited by connecting the positive and negative terminals with a total external resistance of less than 100 mΩ. The cells or batteries remain on test for 24 h or until the case temperature declines by 20 % of the maximum temperature rise, whichever is the sooner.

c) Acceptance criteria

No fire, no explosion.

4.3.3 Free fall

a) Requirements

Dropping a cell or battery (for example, from a bench top) shall not cause fire or explosion.

b) Test

Each fully charged cell or battery is dropped three times from a height of 1,0 m onto a concrete floor. The cells or batteries are dropped so as to obtain impacts in random orientations.

c) Acceptance criteria

No fire, no explosion.

4.3.4 Mechanical shock (crash hazard)

a) Requirements

Shocks encountered during handling or transportation shall not cause fire, explosion or leakage.

b) Test

The fully charged cell or battery is secured to the testing machine by means of a rigid mount which will support all mounting surfaces of the cell or battery. The cell or battery is subjected to a total of three shocks of equal magnitude. The shocks are applied in each of three mutually perpendicular directions. At least one of them shall be perpendicular to a flat face.

For each shock the cell or battery is accelerated in such a manner that during the initial 3 milliseconds the minimum average acceleration is 75 g_n. The peak acceleration shall be between 125 g_n and 175 g_n. Cells or batteries are tested in an ambient temperature of 20 °C ± 5 °C.

c) Acceptance criteria

No fire, no explosion, no leakage.

4.3.5 Thermal abuse

a) Requirements

An extremely high temperature shall not cause fire or explosion.

b) Test

Each fully charged cell, stabilized at room temperature, is placed in a gravity or circulating air-convection oven. The oven temperature is raised at a rate of 5 °C/min ± 2 °C/min to a temperature of 130 °C ± 2 °C. The cell remains at this temperature for 10 min before the test is discontinued.

c) Acceptance criteria

No fire, no explosion.

4.3.6 Crushing of cells

a) Requirements

Severe crushing of a cell (for example, during disposal in a waste compactor) shall not cause fire or explosion.

b) Test

Each fully charged cell is crushed between two flat surfaces. The force for the crushing is applied by a hydraulic ram exerting a force of 13 kN ± 1 kN. The crushing is performed in a manner that will cause the most adverse result. Once the maximum force has been applied, or an abrupt voltage drop of one-third of the original voltage has been obtained, the force is released.

A cylindrical or prismatic cell is crushed with its longitudinal axis parallel to the flat surfaces of the crushing apparatus. To test both wide and narrow sides of prismatic cells, a second set of cells is tested, rotated 90° around their longitudinal axes compared to the first set.

c) Acceptance criteria

No fire, no explosion.

4.3.7 Low pressure

a) Requirements

Low pressure (for example, during transportation in an aircraft cargo hold) shall not cause fire or explosion.

b) Test

Each fully charged cell is placed in a vacuum chamber, in an ambient temperature of 20 °C ± 5 °C. Once the chamber has been sealed, its internal pressure is gradually reduced to a pressure equal to or less than 11,6 kPa (this simulates an altitude of 15 240 m) held at that value for 6 h.

c) Acceptance criteria

No fire, no explosion, no leakage.

4.3.8 Overcharge for nickel systems

a) Requirements

Charging for longer periods and at a higher rate than specified by the manufacturer shall not cause fire or explosion.

b) Test

A discharged cell or battery is subjected to a high-rate charge of 2,5 times the recommended charging current for a time that produces a 250 % charge input (250 % of rated capacity).

c) Acceptance criteria

No fire, no explosion.

4.3.9 Overcharge for lithium systems

a) Requirements

Charging for longer periods than specified by the manufacturer shall not cause fire or explosion.

b) Test

The cell is discharged as described in IEC 61960, then charged from a power supply of ≥10 V, at the charging current I_{rec}, recommended by the manufacturer, for 2,5 C_5/I_{rec} h.

c) Acceptance criteria

No fire, no explosion.

4.3.10 Forced discharge

a) Requirements

A cell in a multicell application shall withstand polarity reversal without causing fire or explosion.

b) Test

A discharged cell is subjected to a reverse charge at 1 I_t A for 90 min.

c) Acceptance criteria

No fire, no explosion.

4.3.11 Cell protection against a high charging rate (lithium systems only)

a) Requirements

A cell shall not cause fire or explosion if a charger malfunctions or if excess current flows in a parallel battery pack.

b) Test

The cell is discharged as described in IEC 61960, then charged at three times the charging current recommended by the manufacturer, until the cell is fully charged or an internal safety device cuts off the charge current before the cell is fully charged.

c) Acceptance criteria

No fire, no explosion.

5 Information for safety

The use, and particularly abuse, of portable sealed secondary cells and batteries containing alkaline or other non-acid electrolyte may result in the creation of hazards and may cause harm. Manufacturers of secondary cells and batteries shall ensure that equipment manufacturers and, in the case of direct sales, end-users are provided with information to minimize and mitigate these hazards. It is the equipment manufacturer's responsibility to inform end-users of the potential hazards arising from the use of equipment containing secondary cells and batteries.

Guidance on the possible hazards is provided in IEC 61438, and non-exhaustive lists of good advice are provided for information in Annexes A and B.

Conformity is checked by examination of manufacturer's documentation.

6 Marking

6.1 Cell marking

Cells shall be marked as specified in the following applicable cell standards: IEC 60285, IEC 61436, IEC 61440, IEC 61951-1, IEC 61951-2 or IEC 61960.

NOTE By agreement between the manufacturer and user, cells used in the manufacture of a battery need not be marked.

Conformity is checked by inspection.

6.2 Battery marking

Batteries shall be marked as for the cells from which they are assembled, as specified in 6.1. They shall bear in addition an appropriate caution statement.

Conformity is checked by inspection.

6.3 Other information

The following information shall be marked on or supplied with the battery:

- disposal instructions;
- recommended charging instructions.

Conformity is checked by examination of markings and manufacturer's documentation.

7 Packaging

The packaging shall be adequate to avoid mechanical damage during transport, handling and stacking. The materials and pack design shall be chosen so as to prevent the development of unintentional electrical conduction, corrosion of the terminals and ingress of moisture.