IEC 60086-5

Edition 4.0 2016-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Primary batteries –
Part 5: Safety of batteries with aqueous electrolyte

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Piles électriques –
Partie 5: Sécurité des piles à électrolyte aqueux

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IEC 60086-5:2016-07(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRIMARY BATTERIES –

Part 5: Safety of batteries with aqueous electrolyte

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International Standard IEC 60086-5 has been prepared by IEC Technical Committee 35: Primary cells and batteries.

This fourth edition cancels and replaces the third edition published in 2011. This edition constitutes a technical revision.

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

a) The definition of explosion was changed to suitable sentence in order to harmonize in IEC 60086 series;
b) To prevent removal of hydrogen gas, we revised it to the suitable sentence,
c) To prevent misuse, the battery compartments with parallel connections were revised to the suitable sentence.
d) To clarify the method to determine the insulation resistance.

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

FDIS	Report on voting
35/1360/FDIS	35/1361/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.

A list of all parts in the IEC 60086 series, published under the general title *Primary batteries*, can be found on the IEC website.

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

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INTRODUCTION

The concept of safety is closely related to safeguarding the integrity of people and property. This part of IEC 60086 specifies tests and requirements for primary batteries with aqueous electrolyte and has been prepared in accordance with ISO/IEC guidelines, taking into account all relevant national and international standards which apply. Also included in this standard is guidance for appliance designers with respect to battery compartments and information regarding packaging, handling, warehousing and transportation.

Safety is a balance between freedom from risks of harm and other demands to be met by the product. There can be no absolute safety. Even at the highest level of safety, the product can only be relatively safe. In this respect, decision-making is based on risk evaluation and safety judgement.

As safety will pose different problems, it is impossible to provide a set of precise provisions and recommendations that will apply in every case. However, this standard, when followed on a judicious "use when applicable" basis, will provide reasonably consistent standards for safety.

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PRIMARY BATTERIES –

Part 5: Safety of batteries with aqueous electrolyte

1 Scope

This part of IEC 60086 specifies tests and requirements for primary batteries with aqueous electrolyte to ensure their safe operation under intended use and reasonably foreseeable misuse.

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 60086-1, *Primary batteries – Part 1: General*

IEC 60086-2, *Primary batteries – Part 2: Physical and electrical specifications*

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IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

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IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

3 Terms and definitions

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

NOTE Certain definitions taken from IEC 60050-482, IEC 60086-1, and IEC Guide 51 are repeated below for convenience.

3.1
battery
one or more cells electrically connected by permanent means, fitted in a case, with terminals, markings and protective devices etc., as necessary for use

[SOURCE: IEC 60050-482:2004, 482-01-04, modified definition]

3.2
button (cell or battery)
small round cell or battery where the overall height is less than the diameter

Note 1 to entry: In English, the term "button (cell or battery)" is only used for non-lithium batteries while the term "coin (cell or battery)" is used for lithium batteries only. In languages other than English, the terms "coin" and "button" are often used interchangeably, regardless of the electrochemical system.

3.3
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]

3.4
component cell
cell contained in a battery

3.5
cylindrical (cell or battery)
round cell or battery with a cylindrical shape in which the overall height is equal to or greater than the diameter

[SOURCE: IEC 60050-482:2004, 482-02-39, modified ("cell with a cylindrical shape" replaced by "round cell or battery")]

3.6
explosion (battery explosion)
the cell or battery opens and solid components are forcibly expelled

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3.7
fire
flames are emitted from the test cell or battery

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3.8
intended use
use in accordance with information provided with a product or system, or, in the absence of such information, by generally understood patterns of usage

[SOURCE: ISO/IEC Guide 51:2014, 3.6]

3.9
leakage
unplanned escape of electrolyte from a cell or battery

[SOURCE: IEC 60050-482:2004, 482-02-32]

3.10
nominal voltage (of a primary battery)
V_n
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, modified (addition of "(of a primary battery)" and symbol V_n)]

3.11
primary (cell or battery)
cell or battery that is not designed to be electrically recharged

3.12
prismatic (cell or battery)
cell or battery having the shape of a parallelepiped whose faces are rectangular

[SOURCE: IEC 60050-482:2004, 482-02-38, modified (deletion of "qualifies a")]

3.13
protective devices
devices such as fuses, diodes or other electric or electronic current limiter designed to interrupt the current flow in an electrical circuit

3.14
reasonably foreseeable misuse
use of a product or system in a way not intended by the supplier, but which can result from readily predictable human behaviour

[SOURCE: ISO/IEC Guide 51:1999, 3.14, modified ("process or service" replaced by "or system" and "may" replaced by "can" and deletion of the Note)]

3.15
round (cell or battery)
cell or battery with circular cross section

3.16
safety
freedom from risk which is not tolerable

[SOURCE: ISO/IEC Guide 51:2014, 3.14]

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3.17
undischarged
state of charge of a primary cell or battery corresponding to 0 % depth of discharge

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3.18
venting
release of excessive internal pressure from a cell or battery in a manner intended by design to preclude explosion

4 Requirements for safety

4.1 Design

4.1.1 General

Batteries shall be so designed that they do not present a safety hazard under conditions of normal (intended) use.

4.1.2 Venting

All batteries shall incorporate a pressure relief feature or shall be so constructed that they will relieve excessive internal pressure at a value and rate which will preclude explosion. If encapsulation is necessary to support cells within an outer case, the type of encapsulant and the method of encapsulation shall not cause the battery to overheat during normal operation nor inhibit the operation of the pressure relief feature.

The battery case material and/or its final assembly shall be so designed that, in the event of one or more cells venting, the battery case does not present a hazard in its own right.

4.1.3 Insulation resistance

The insulation resistance between externally exposed metal surfaces of the battery excluding electrical contact surfaces and either terminal shall be not less than 5 MΩ at 500 $V^{+100\,V}_{-0\,V}$ applied for a minimum of 60 seconds.

4.2 Quality plan

The manufacturer shall prepare and implement a quality plan 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 battery. Manufacturers should understand their process capabilities and should institute the necessary process controls as they relate to product safety.

5 Sampling

5.1 General

Samples should be drawn from production lots in accordance with accepted statistical methods.

5.2 Sampling for type approval

The number of samples drawn for type approval is given in Figure 1.

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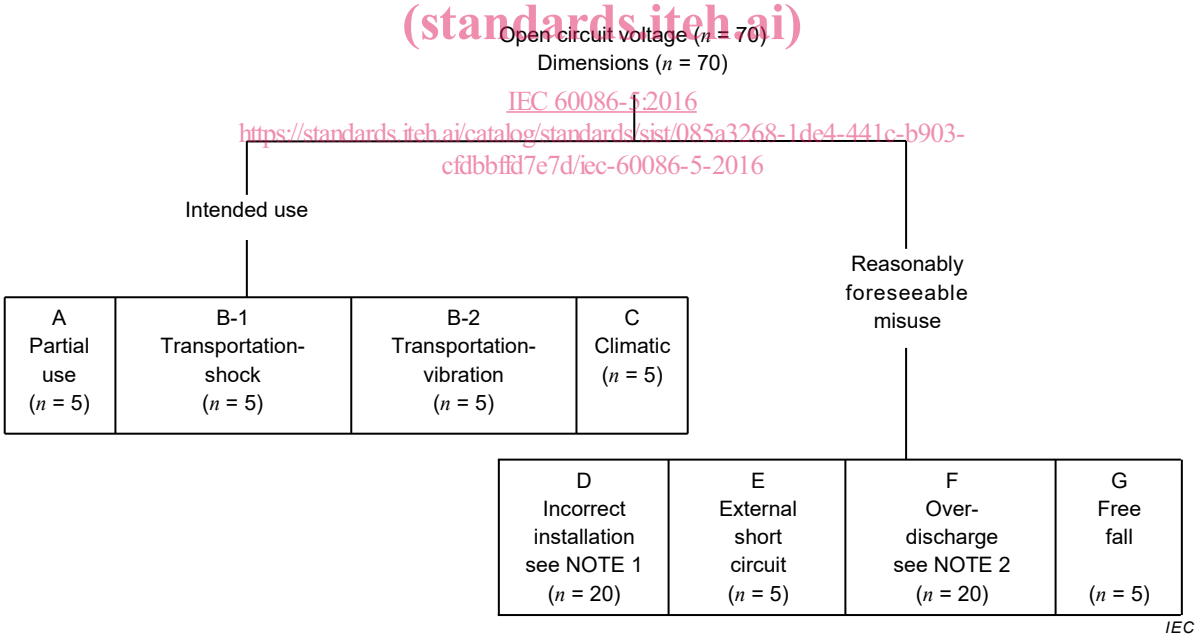

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NOTE 1 Four batteries connected in series with one of the four batteries reversed (5 sets).

NOTE 2 Four batteries connected in series, one of which is discharged (5 sets).

Figure 1 – Sampling for type approval tests and number of batteries required

6 Testing and requirements

6.1 General

6.1.1 Applicable safety tests

Applicable safety tests are shown in Table 1.

The tests described in Tables 2 and 6 are intended to simulate conditions which the battery is likely to encounter during intended use and reasonably foreseeable misuse.

Table 1 – Test matrix

System letter	Negative electrode	Electrolyte	Positive electrode	Nominal voltage per cell V	Form	Applicable tests						
						A	B-1 B-2	C	D	E	F	G
No letter	Zinc (Zn)	Ammonium chloride, Zinc chloride	Manganese dioxide (MnO_2)	1,5	R	x	x	x	x	x	x	x
					B	NR						
					Pr	x	x	x	x	x	x	x
					M	x	x	x	NR	x	x	x
A	Zinc (Zn)	Ammonium chloride, Zinc chloride	Oxygen (O_2)	1,4	R	x	x	x	NR	x	x	x
					B	NR						
					Pr	x	x	x	x	x	x	x
					M	x	x	x	NR	x	x	x
L	Zinc (Zn)	Alkali metal hydroxide	Manganese dioxide (MnO_2)	1,5	R	x	x	x	x	x	x	x
					B	x	x	x	NR	x	NR	x
					Pr	x	x	x	x	x	x	x
					M	x	x	x	NR	x	NR	x
P	Zinc (Zn)	Alkali metal hydroxide	Oxygen air (O_2)	1,4	R	NR						
					B	NR	x	x	NR	x	NR	x
					Pr	x	x	x	x	x	x	x
					M	NR						
S	Zinc (Zn)	Alkali metal hydroxide	Silver oxide (Ag_2O)	1,55	R	x	x	x	NR	x	NR	x
					B	x	x	x	NR	x	NR	x
					Pr	x	x	x	x	x	x	x
					M	NR						

Test description:

A: storage after partial use
B-1: transportation-shock
B-2: transportation-vibration
C: climatic-temperature cycling
D: incorrect installation
E: external short circuit
F: overdischarge
G: free fall

Key

R: cylindrical (3.5)
B: button (3.2)
Pr: prismatic single cell (3.12)
M: multicell

x: required
NR: Not required

Systems L and S button cells or batteries under 250 mAh capacity and system P button cells or batteries under 700 mAh capacity are exempt from any testing.

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6.1.2 Cautionary notice

WARNING

These tests call for the use of procedures which can result in injury if adequate precautions are not taken.

It has been assumed in the drafting of these tests that their execution is undertaken by appropriately qualified and experienced technicians using adequate protection.

6.1.3 Ambient temperature

Unless otherwise specified, these tests shall be carried out at an ambient temperature of 20 °C ± 5 °C.

6.2 Intended use

6.2.1 Intended use tests and requirements

Table 2 – Intended use tests and requirements

Test		Intended use simulation	Requirements
Electrical test	A	Storage after partial use	No leakage (NL) No fire (NF) No explosion (NE)
Environmental tests	B-1	Transportation-shock	No leakage (NL) No fire (NF) No explosion (NE)
	B-2	Transportation-vibration	No leakage (NL) No fire (NF) No explosion (NE)
Climatic-temperature	C	Climatic-temperature cycling	No fire (NF) No explosion (NE)

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6.2.2 Intended use test procedures

6.2.2.1 Test A – Storage after partial use

a) Purpose

This test simulates the situation when an appliance is switched off and the installed batteries are partly discharged. These batteries may be left in the appliance for a long time or they are removed from the appliance and stored for a long time.

b) Test procedure

An undischarged battery is discharged under an application/service output test condition, with the lowest resistive load test as defined in IEC 60086-2 until the service life falls by 50 % of the minimum average duration (MAD) value, followed by storage at 45 °C ± 5 °C for 30 days.

c) Requirements

There shall be no leakage, no fire and no explosion during this test.

6.2.2.2 Test B-1 – Transportation-shock

a) Purpose

This test simulates the situation when an appliance is carelessly dropped with batteries installed in it. This test condition is generally specified in IEC 60068-2-27.

b) Test procedure

An undischarged battery shall be tested as follows.