

INTERNATIONAL STANDARD

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Primary batteries – **STANDARD PREVIEW**
Part 5: Safety of batteries with aqueous electrolyte
(standards.iteh.ai)

Piles électriques –
Partie 5: Sécurité des piles à électrolyte aqueux
IEC 60086-5:2021
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PRIMARY BATTERIES –**Part 5: Safety of batteries with aqueous electrolyte****FOREWORD**

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IEC 60086-5 has been prepared by IEC technical committee 35: Primary cells and batteries. It is an International Standard.

This fifth edition cancels and replaces the fourth 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) revised information for safety dealing with keeping batteries out of the reach of children;
- b) removal of the method to determine the insulation resistance;
- c) changes to the test matrix;
- d) revision of the over-discharge test;
- e) revised definition and note for "button cell" or "button battery" in 3.2;
- f) revised method for evaluation of an explosion, moved from 3.6 to 6.2.1.

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

FDIS	Report on voting
35/1471/FDIS	35/1472/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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 document will remain unchanged until the stability date indicated on the IEC website under 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- withdrawn,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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NOTE The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC document in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this document be adopted for implementation nationally not earlier than 2 years from the date of publication. The transitional period applies specifically to Table 7.

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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 document 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 document, 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 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 60086-1:2015, *Primary batteries – Part 1: General*

IEC 60086-2:2015, *Primary batteries – Part 2: Physical and electrical specifications*

3 Terms and definitions

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

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 [1], modified – The definition has been revised.]

3.2

button cell

button battery

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

Note 1 to entry: See coin (cell or battery), lithium button (cell or battery) in IEC 60086-1 and IEC 60086-2.

[SOURCE: IEC 60050-482:2004, 482-02-40, modified – The second term "coin cell" has been deleted, the definition has been revised and the note has been replaced with a new note.]

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, modified – The note has been deleted.]

3.4

component cell

cell contained in a battery

3.5

cylindrical battery

cylindrical cell

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 – In the definition, "cell" has been replaced by "round cell or battery".]

3.6

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 [2]]

3.7

nominal voltage

U_n

<of a primary battery> 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 – The domain and symbol have been added.]

3.8

primary cell

primary battery

cell or battery that is not designed to be electrically recharged

3.9

prismatic cell

prismatic battery

cell or battery having the shape of a parallelepiped whose faces are rectangular

[SOURCE: IEC 60050-482:2004, 482-02-38, modified – "cell" and "battery" have been added to the term and "qualifies a" has been deleted.]

3.10

protective device

device such as fuse, diode or other electric or electronic current limiter designed to interrupt the current flow in an electrical circuit

3.11

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 51:2014, 3.7, modified – The notes have been deleted.]

3.12

round cell

round battery

cell or battery with circular cross section

3.13

safety

freedom from risk which is not tolerable

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

3.14

undischarged

state of a primary cell or battery at 0 % depth of discharge

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.

4.2 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.

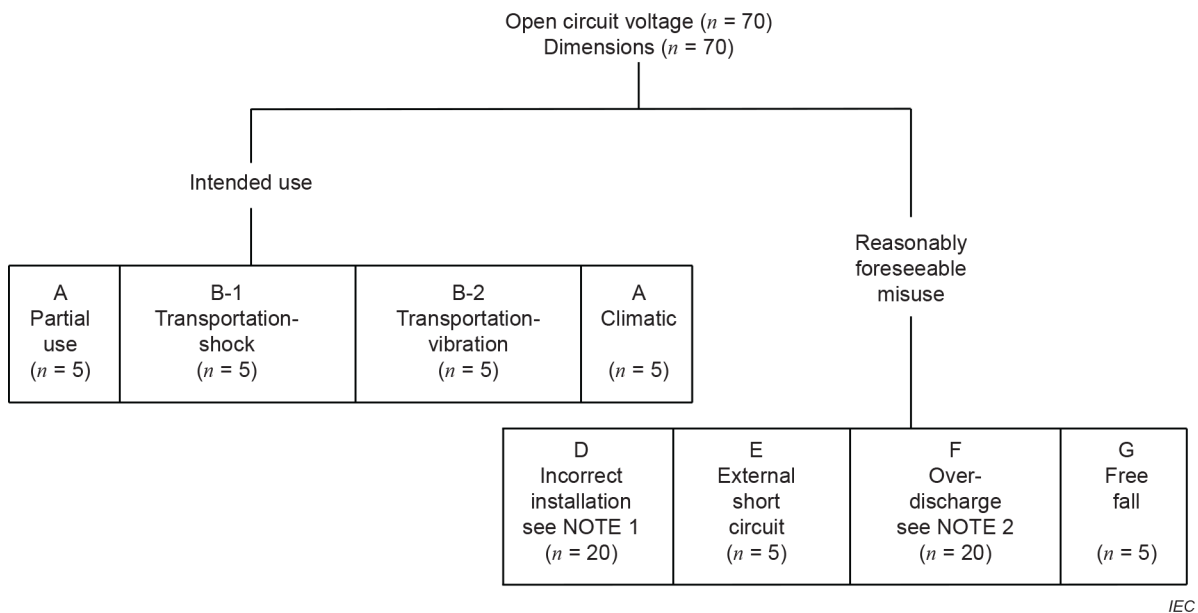
5 Sampling

5.1 General

Samples should be drawn from production lots in accordance with accepted statistical methods and shall meet the requirements specified for dimensions and open circuit voltage set forth in IEC 60086-2. Samples failing to meet these requirements shall be discarded and new samples selected.

5.2 Sampling for type testing

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



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 tests and number of batteries required

5.3 Validity of testing

Cells or batteries with aqueous electrolyte shall be subjected to the tests, as required in this document. Testing remains valid until a design change or requirement revision has been made. Retesting is required when:

- a) a battery specification changes by more than 0,1 g or 20 % mass, whichever is greater, for the cathode, anode or electrolyte;
- b) a battery specification change would lead to a failure of any of the tests;
- c) there is an addition of new tests or requirements; or
- d) there is a requirement change that would lead to a failure of any of the tests.

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 Table 2 and Table 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	NR	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 or 1,45	R	NR						
					B	NR	NR	NR	NR	NR	NR	NR
					Pr	x	x	x	x	x	x	x
					M	NR						
S	Zinc (Zn)	Alkali metal hydroxide	Silver oxide (Ag ₂ O)	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 (3.11)
 M: multicell
 x: Required
 NR: Not required

If necessary, follow the discharge conditions of the IEC 60086-2 service output test. Systems L and S button cells or batteries under 3,5 g are exempt from any testing.

6.1.2 Cautionary notice

WARNING – The tests in this document 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 Evaluation of test criteria

6.2.1 Explosion

An explosion is considered to have occurred when there is an instantaneous release wherein solid matter from any part of the battery is propelled to a distance greater than 25 cm away from the battery.

6.2.2 Fire

A fire is considered to have occurred if flames are emitted from a test cell or battery.

6.2.3 Leakage

Leakage is considered to have occurred if there is an unplanned escape of electrolyte from a cell or battery.

6.2.4 Venting

Venting is considered to have occurred if there is a release of excessive internal pressure from a cell or battery in a manner intended by design to preclude explosion.

6.3 Intended use

6.3.1 Intended use tests and requirements

Table 2 – Intended use tests and requirements
(standards.iteh.ai)

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)

6.3.2 Intended use test procedures

6.3.2.1 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 or service output test condition, with the load defined in IEC 60086-2 resulting in the longest test duration until the service life falls by 50 % of the highest minimum average duration (MAD) value, followed by storage at $45 \text{ °C} \pm 2 \text{ °C}$ for 30 days.

The temperature tolerance of $\pm 2 \text{ °C}$ is for the temperature maintain period and a brief overshoot in temperature is allowed during the transition period.

c) Requirements

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