IEC 60086-5

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

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

IEC 60086-5:2011

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PRIMARY BATTERIES –

Part 5: Safety of batteries with aqueous electrolyte

FOREWORD

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

This third edition cancels and replaces the second edition (2005) and constitutes a technical revision.

The major technical changes with respect to the previous edition are the test requirements and the harmonization of the marking clause with the other standards of the IEC 60086 series. Moreover, the table of safety pictograms was added as Annex C.

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

CDV	Report on voting
35/1273/CDV	35/1276/RVC

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, 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 web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- Reconfirmed;
- Withdrawn;
- Replaced by a revised edition, or
- Amended.

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.

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 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 60086-1:2011, *Primary batteries – Part 1: General*

IEC 60086-2:2011, *Primary batteries – Part 2: Physical and electrical specifications*

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

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 purpose of this document, the terms and definitions given in IEC 60086-1 as well as the following terms and definitions apply.

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

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

3.2
button battery
small round battery, where the overall height is less than the diameter; batteries complying with Figures 3 and 4 of IEC 60086-2

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

[IEC 60050-482: 2004, 482-01-01]

3.4
cylindrical (cell or battery)
cell or battery with a cylindrical shape in which the overall height is equal to or greater than the diameter

[IEC 60050-482: 2004, 482-02-39, modified]

3.5
explosion (battery explosion)
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

3.6
harm
physical injury or damage to the health of people.

[ISO/IEC Guide 51:1999, 3.3]

3.7
hazard
potential source of harm

[ISO/IEC Guide 51:1999, 3.5]

3.8
intended use
use of a product, process or service in accordance with information provided by the supplier

[ISO/IEC Guide 51:1999, 3.13]

3.9
leakage
unplanned escape of electrolyte, gas or other material from a cell or battery

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

3.10
nominal voltage (of a primary battery)
V_n (symbol)
suitable approximate value of the voltage used to designate or identify a cell, a battery or an electrochemical system

[IEC 60050-482: 2004, 482-03-31, modified]

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

[IEC 60050-482: 2004, 482-02-38, modified]

3.13
protective device
device such as a fuse, a diode 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, process or service in a way not intended by the supplier, but which may result from readily predictable human behaviour

[ISO/IEC Guide 51:1999, 3.14]

3.15
risk
combination of the probability of occurrence of harm and the severity of that harm

[ISO/IEC Guide 51:1999, 3.2]

3.16
round (cell or battery)
cell or battery with circular cross section

3.17
safety
freedom from unacceptable risk

[ISO/IEC Guide 51:1999, 3.1]

3.18
undischarged
state of charge of a primary cell or battery corresponding to 0 % depth of discharge

3.19
venting
release of excessive internal pressure from a 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 $^{+100}_{0}$ V.

4.2 Quality plan

The manufacturer shall prepare 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.

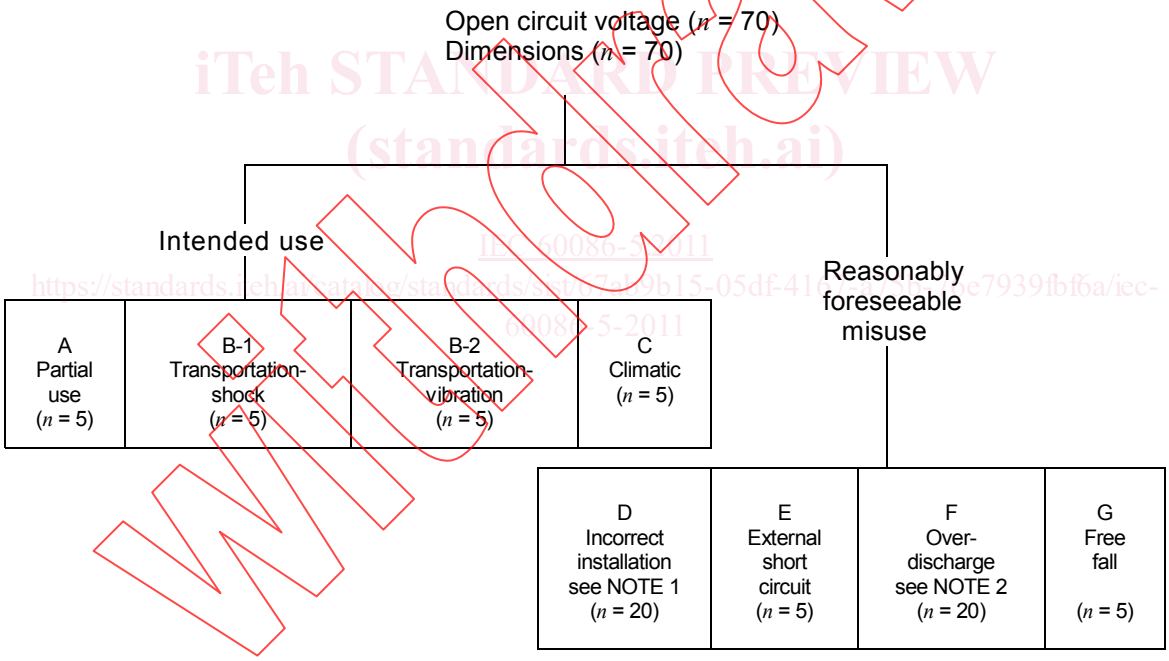
5 Sampling

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.



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 (3.4)

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.

6.1.2 Safety notice

WARNING

These tests call for the use of procedures which may 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 (20 ± 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)

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 ± 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.

The shock test shall be carried out under the conditions defined in Table 3 and the sequence in Table 4.

Shock pulse – The shock pulse applied to the battery shall be as follows:

Table 3 – Shock pulse

Acceleration		Waveform
Minimum average acceleration first three milliseconds	Peak acceleration	
75 g_n	125 g_n to 175 g_n	Half sine
NOTE g_n = 9,80665 m/s².		

Table 4 – Test sequence

Step	Storage time	Battery orientation	Number of shocks	Visual examination periods
1	–	–	–	Pre-test
2	–	[a]	1 each	–
3	–	[a]	1 each	–
4	–	[a]	1 each	–
5	1 h	–	–	–
6	–	–	–	Post-test
[a] The shock shall be applied in each of three mutually perpendicular directions.				

Step 1 Record open circuit voltage in accordance with 5.2.

Steps 2 to 4 Apply shock test specified in Table 3 and the sequence in Table 4.

Step 5 Rest battery for 1 h.

Step 6 Record examination results.

c) Requirements

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

6.2.2.3 Test B-2 – Transportation-vibration

a) Purpose

This test simulates vibration during transportation. This test condition is generally specified in IEC 60068-2-6.

b) Test procedure

An undischarged battery shall be tested as follows.

The vibration test shall be carried out under the following test conditions and the sequence in Table 5.

Vibration – A simple harmonic motion shall be applied to the battery having an amplitude of 0,8 mm, with a total maximum excursion of 1,6 mm. The frequency shall be 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) shall be traversed in (90 ± 5) min for each mounting position (direction of vibration).