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Tenth edition
2006-12

Primary batteries –

**Part 1:
General**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of 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, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). 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. 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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International Standard IEC 60086-1 has been prepared by IEC technical committee 35: Primary cells and batteries.

This tenth edition cancels and replaces the ninth edition (2000) and constitutes a technical revision.

The major technical changes concern the addition of "Test condition tolerances" in 6.6 and the standardization of the "Z" electrochemical system (Nickel oxyhydroxide) included in Table 3.

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

FDIS	Report on voting
35/1244/FDIS	35/1247/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 the 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 maintenance result 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- withdrawn;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.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

The technical content of this part of IEC 60086 provides fundamental requirements and information on primary cells and batteries. In this sense, IEC 60086-1 is the main component of the IEC 60086 series and forms the basis for the subsequent parts. For example, this part includes elementary information on definitions, nomenclature, dimensions and marking. While specific requirements are included, the content of this part tends to explain methodology (how) and justification (why).

Over the years, this part has been changed to improve its content and remains under continual scrutiny to ensure that the publication is kept up to date with the advances in both battery and battery-powered device technologies.

NOTE Safety information is available in IEC 60086-4, IEC 60086-5 and IEC 62281.

PRIMARY BATTERIES –

Part 1: General

1 Scope

The purpose of this part of IEC 60086 is to standardize primary batteries with respect to their electrochemical system, dimensions, nomenclature, terminal configurations, markings, test methods, typical performance, safety and environmental aspects.

NOTE The requirements justifying the inclusion or the ongoing retention of batteries in the IEC 60086 series are given in Annex A.

The objective of IEC 60086-1 is to benefit primary battery users, device designers and battery manufacturers by ensuring that batteries from different manufacturers are interchangeable according to standard form, fit and function. Furthermore, to ensure compliance with the above, this part specifies standard test methods for testing primary cells and batteries.

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

IEC 60086-3, *Primary batteries – Part 3: Watch batteries*

IEC 60086-4: *Primary batteries – Part 4: Safety of lithium batteries*

IEC 60086-5, *Primary batteries – Part 5: Safety of batteries with aqueous electrolyte*

IEC 60410, *Sampling plans and procedures for inspection by attributes*

IEC 61429, *Marking of secondary cells and batteries with the international recycling symbol ISO 7000-1135*

ISO/IEC Directives, Part 1: *Procedures for the technical work*

ISO 3951 (all parts as applicable), *Sampling procedures for inspection by variables*

3 Terms and definitions

For the purposes of this document, the definitions given in IEC 60050(482) (some of which are repeated below for convenience), as well as the following definitions, apply.

3.1
application test
simulation of the actual use of a battery in a specific application

3.2
discharge (of a primary battery)
operation during which a battery delivers current to an external circuit

[IEV 482-03-23:2004, modified]

3.3
dry (primary) battery
primary battery in which the liquid electrolyte is immobilized

[IEV 482-04-14:2004, modified]

3.4
effective internal resistance – DC method
resistance of any electrical component determined by calculating the ratio between the voltage drop ΔU across this component and the range of current Δi passing through this component and causing the voltage drop $R = \Delta U / \Delta i$

NOTE As an analogy, the internal d.c. resistance of any electrochemical cell is defined by the following relation:

$$R_{\mathrm{i}}\,(\Omega) = \frac{\Delta U\,(\mathrm{V})}{\Delta i\,(\mathrm{A})} \tag{1}$$

The internal d.c. resistance is illustrated by the schematic voltage transient as given below:

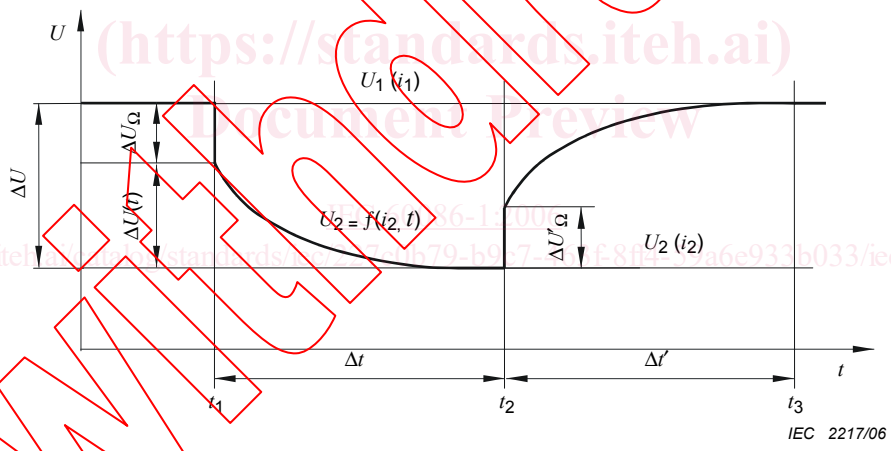

Figure 1 – Schematic voltage transient

As can be seen from this diagram, the voltage drop ΔU of the two components differs in nature, as shown in the following relation:

$$\Delta U = \Delta U_{\Omega} + \Delta U\,(t) \tag{2}$$

The first component ΔU_{Ω} for ($t = t_1$) is independent of time, and results from the increase in current Δi according to the relation:

$$\Delta U_{\Omega} = \Delta i \times R_{\Omega} \tag{3}$$

In this relation, R_{Ω} is a pure ohmic resistance. The second component $\Delta U(t)$ is time dependent and is of electrochemical origin.

3.5
end-point voltage
EV
specified voltage of a battery at which the battery discharge is terminated

[IEV 482-03-30:2004, modified]

3.6
leakage
unplanned escape of electrolyte, gas or other material from a battery

[IEV 482-02-32:2004, modified]

3.7
minimum average duration
MAD
minimum average time on discharge which shall be met by a sample of batteries

NOTE The discharge test is carried out according to the specified methods or standards and designed to show conformity with the standard applicable to the battery types.

3.8
nominal voltage of a primary battery
V_n
suitable approximate value of voltage used to identify the voltage of a primary battery

[IEV 482-03-31:2004, modified]

3.9
on-load voltage
closed-circuit voltage
CCV
voltage across the terminals of a battery when it is on discharge

[IEV 482-03-28:2004, modified]

3.10
open-circuit voltage
off-load voltage
OCV
voltage across the terminals of a battery when no current is flowing

[IEV 482-03-32:2004, modified]

3.11
primary battery
one or more primary cells, including case, terminals and marking

3.12
primary cell
source of electrical energy obtained by the direct conversion of chemical energy, that is not designed to be charged by any other electrical source

[IEV 482-01-02:2004, modified]

3.13
service output (of a primary battery)
service life, or capacity, or energy output of a battery under specified conditions of discharge

3.14
service output test
test designed to measure the service output of a battery

NOTE A service output test may be prescribed, for example, when

a) an application test is too complex to replicate;

b) the duration of an application test would make it impractical for routine testing purposes.

3.15
storage life
duration under specified conditions at the end of which a battery retains its ability to perform a specified service output

[IEV 482-03-47:2004, modified]

3.16
terminals (of a primary battery)
conductive parts provided for the connection of a battery to external conductors

4 Requirements

4.1 General

4.1.1 Design

Primary batteries are sold mainly in consumer markets. In recent years, they have become more sophisticated in both chemistry and construction, for example both capacity and rate capability have increased to meet the growing demands from new, battery-powered equipment technology.

When designing primary batteries, the aforementioned considerations shall be taken into account. Specifically, their dimensional conformity and stability, their physical and electrical performance and their safe operation under normal use and foreseeable mis-use conditions shall be assured.

Additionally, information on equipment design can be found in Annex B.

4.1.2 Battery dimensions

The dimensions for individual types of batteries are given in IEC 60086-2 and IEC 60086-3.

4.1.3 Terminals

Terminals shall be in accordance with Clause 7 of IEC 60086-2.

Their physical shape shall be designed in such a way that they ensure that the batteries make and maintain good electrical contact at all times.

They shall be made of materials that provide adequate electrical conductivity and corrosion protection.

4.1.3.1 Contact pressure resistance

Where stated in the battery specification tables, or the individual specification sheets in IEC 60086-2, the following applies:

– a force of 10 N applied through a steel ball of 1 mm diameter at the centre of each contact area for a period of 10 s shall not cause any apparent deformation which might prevent satisfactory operation of the battery.

NOTE See also IEC 60086-3 for exceptions.

4.1.3.2 Cap and base

This type of terminal is used for batteries which have their dimensions specified according to Figures 1 and 2 of IEC 60086-2, and which have the cylindrical side of the battery insulated from the terminals.

4.1.3.3 Cap and case

This type of terminal is used for batteries which have their dimensions specified according to Figures 3 and 4 of IEC 60086-2, but in which the cylindrical side of the battery forms part of the positive terminal.

4.1.3.4 Screw terminals

This contact consists of a threaded rod in combination with either a metal or insulated metal nut.

4.1.3.5 Flat contacts

These are essentially flat metal surfaces adapted to make electrical contact by suitable contact mechanisms bearing against them.

4.1.3.6 Flat or spiral springs

These contacts comprise flat metal strips or spirally wound wire which are in a form that provides pressure contact.

4.1.3.7 Plug-in-sockets

These are made up of a suitable assembly of metal contacts, mounted in an insulated housing or holding device and adapted to receive corresponding pins of a mating plug.

4.1.3.8 Snap fasteners

These contacts are composed of a combination comprising a stud (non-resilient) for the positive terminal and a socket (resilient) for the negative terminal.

They shall be of suitable metal so as to provide efficient electrical connection when joined to the corresponding parts of an external circuit.

4.1.3.8.1 Spacing of contacts

The spacing between the stud and socket is given in the following table and applies from centre to centre. The stud always forms the positive connection and the socket the negative connection on the battery.

Table 1 – Spacing of contacts

Nominal voltage V	Standard mm	Miniature mm
9	35 ± 0,4	12,7 ± 0,25