INTERNATIONAL STANDARD

IEC 60086-1

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AMENDMENT 2
1999-03

Amendment 2

Primary batteries –

Part 1: General

Amendement 2

Piles électriques –

Partie 1: Généralités

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PRICE CODE F

For price, see current catalogue

FOREWORD

This amendment has been prepared by IEC technical committee 35: Primary cells and batteries.

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

FDIS	Report on voting
35/1090/FDIS	35/1097/RVD

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

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

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7.5 Off-load voltage limits

Add, after this subclause, the following new subclause 7.6:

7.6 Interchangeability: Battery voltage

Primary batteries as presently standardized in IEC 60086 can be categorized by their standard discharge voltage U_s[1]. For a new battery system, its interchangeability by voltage is assessed for compliance with the following formula:

$$n \times (U_r - 15\ \%) \leq m \times U_s \leq n \times (U_r + 15\ \%)$$

where

n is the number of cells connected in series, based on reference voltage U_r;

m is the number of cells connected in series, based on standard discharge voltage U_s.

Currently two voltage ranges that conform to the above formula have been identified. They are identified by reference voltage U_r, which is the midpoint of the relevant voltage range.

Voltage range 1, U_r = 1,4 (V): Batteries having a standard discharge voltage $m \times U_s$ equal to or within the range of $n \times 1{,}19$ (V) to $n \times 1{,}61$ (V)

Voltage range 2, U_r = 3,2 (V): Batteries having a standard discharge voltage $m \times U_s$ equal to or within the range of $n \times 2{,}72$ (V) to $n \times 3{,}68$ (V)

The term standard discharge voltage and related quantities, as well as the methods of their determination, are given in annex C.

NOTE – For single-cell batteries and for multi-cell batteries assembled with cells of the same voltage range, *m* and *n* will be identical; *m* and *n* will be different for multi-cell batteries if assembled with cells from a different voltage range than those of an already standardized battery.

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[1] The standard discharge voltage U_s was introduced to comply with the principle of experimental verifiability. Neither the nominal voltage nor the maximum off-load voltage complies with this requirement.

Voltage range 1 encompasses all presently standardized batteries with a nominal voltage of about 1,5 (V), i.e. "no-letter" system, systems A, F, G, L, P and S.

Voltage range 2 encompasses all presently standardized batteries with a nominal voltage of about 3 (V), i.e. systems B, C and E.

Because batteries from voltage range 1 and voltage range 2 show significantly different discharge voltages, they shall be designed physically non-interchangeable. Before standardizing a new electrochemical system, its standard discharge voltage shall be determined in accordance with the procedure given in annex C to resolve its interchangeability by voltage.

WARNING

Failure to comply with this requirement can present safety hazards to the user, such as fire, explosion, leakage and/or device damage.

This requirement is necessary for safety and operational reasons.

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Add, after annex B, the new annex C as follows:

Annex C
(informative)

Standard discharge voltage – definition and method of determination

C.1 Definition

The standard discharge voltage U_s is typical for a given electrochemical system. It is a unique voltage in that it is independent of both the size and the internal construction of the battery. It only depends on its charge-transfer reaction. The standard discharge voltage U_s is defined by the formula in (1):

$$U_s = \frac{C_s}{t_s} \times R_s \quad (1)$$

where

U_s is the standard discharge voltage;

C_s is the standard discharge capacity;

t_s is the standard discharge time;

R_s is the standard discharge resistor.

C.2 Determination

C.2.1 General considerations: The *C/R*-plot

The determination of the discharge voltage U_d is accomplished via a *C/R*-plot (where *C* is the discharge capacity of the battery; *R* is the discharge resistance). For illustration, see figure 1, which shows a schematic plot of discharge capacity *C* versus discharge resistor R_d [1] in normalized presentation, i.e. $C(R_d)/C_p$ is plotted as a function of R_d. For low R_d-values, low $C(R_d)$-values are obtained and vice versa. On the gradual increase of R_d, discharge capacity $C(R_d)$ also increases until finally a plateau is established and $C(R_d)$ becomes constant [2]:

$$C_p = \text{constant} \tag{2}$$

which means $C(R_d)/C_p = 1$ as indicated by the horizontal line in figure C.1. It further shows that capacity $C = f(R_d)$ is dependent on the cut-off-voltage U_c: the higher its value, the larger is fraction ΔC that cannot be realized during discharge.

NOTE – Under plateau conditions capacity *C* is independent of R_d.

The discharge voltage U_d is determined by formula (3).

$$U_d = \frac{C_d}{t_d} \times R_d \tag{3}$$

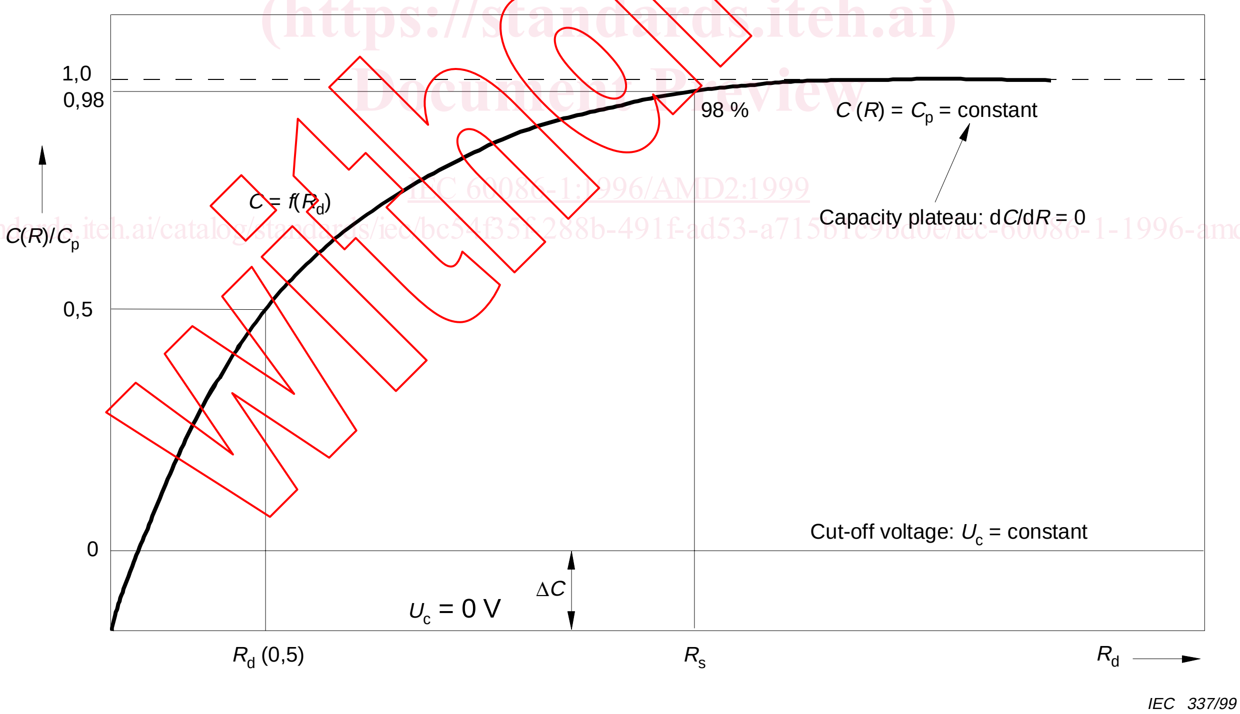

Figure C.1 – Normalized *C/R*-plot (schematic)

[1] Subscript d differentiates this resistance from R_s; see formula (1).

[2] For very long periods of discharge time C_p may decrease due to the battery's internal self-discharge. This may be noticeable for batteries having a high self-discharge, for example 10 % per month or above.