

Primary batteries —

Part 4: Safety standard for lithium batteries

The European Standard EN 60086-4:2000 has the status of a British Standard

ICS 29.220.10

National foreword

This British Standard is the official English language version of EN 60086-4:2000. It is identical with IEC 60086-4:2000. It supersedes BS EN 60086-4:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee CPL/35, Primary cells and batteries, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

From 1 January 1997, all IEC publications have the number 60000 added to the old number. For instance, IEC 27-1 has been renumbered as IEC 60027-1. For a period of time during the change over from one numbering system to the other, publications may contain identifiers from both systems.

Cross-references

Attention is drawn to the fact that CEN and CENELEC Standards normally include an annex which lists normative references to international publications with their corresponding European publications. The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 33 and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 November 2000

© BSI 11-2000

ISBN 0 580 36594 8

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD

EN 60086-4

NORME EUROPÉENNE

EUROPÄISCHE NORM

August 2000

ICS 29.220.10

Supersedes EN 60086-4:1996

English version

Primary batteries
Part 4: Safety standard for lithium batteries
(IEC 60086-4:2000)

Piles électriques
Partie 4: Norme de sécurité pour les piles
au lithium
(CEI 60086-4:2000)

Primärbatterien
Teil 4: Sicherheitsnorm für Lithium-
Batterien
(IEC 60086-4:2000)

This European Standard was approved by CENELEC on 2000-04-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

© 2000 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Foreword

The text of document 35/1114/FDIS, future edition 2 of IEC 60086-4, prepared by IEC TC 35, Primary cells and batteries, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 60086-4 on 2000-04-01.

This European Standard supersedes EN 60086-4:1996.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2001-01-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2003-04-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annex ZA is normative and annexes A, B and C are informative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 60086-4:2000 was approved by CENELEC as a European Standard without any modification.

In the official version, for the Bibliography, the following notes have to be added for the standards indicated:

- | | |
|-----------------------|--|
| IEC 60068-2-6:1995 | NOTE: Harmonized as EN 60068-2-6:1995 (not modified). |
| IEC 60068-2-27:1987 | NOTE: Harmonized as EN 60068-2-27:1993 (not modified). |
| IEC 60068-2-32:1975 | NOTE: Harmonized as EN 60068-2-32:1993 (not modified). |
| IEC 60617 (all parts) | NOTE: Harmonized in the series EN 60617. |
-

CONTENTS

	Page
INTRODUCTION	4
Clause	
1 Scope	5
2 Normative reference	5
3 Definitions	5
4 Requirements for safety	7
4.1 Design	7
4.2 Quality plan	7
5 Sampling	8
6 Testing and requirements	8
6.1 General	8
6.1.1 Safety notice	8
6.1.2 Ambient temperature	8
6.1.3 Explosion levels	8
6.1.4 Determination of weight loss	9
6.1.5 PredischARGE	9
6.1.6 Additional batteries	9
6.2 Intended use	9
6.2.1 Sampling, test sequence and requirements	9
6.2.2 Test procedures	11
6.3 Reasonably foreseeable misuse	14
6.3.1 Sampling, test sequence and requirements	14
6.3.2 Test procedures	17
7 Information for safety	23
7.1 Safety precautions during design of equipment	23
7.1.1 Charge protection	23
7.1.2 Parallel connection	23
7.2 Safety precautions during handling of batteries	23
7.3 Safety precautions during packaging, handling, transportation, display, storage and disposal	25
7.3.1 Packaging	25
7.3.2 Handling of battery cartons	25
7.3.3 Transportation	26
7.3.4 Display and storage	26
7.3.5 Disposal	26
8 Instructions for use	27
9 Marking	27
9.1 General	27
9.2 Small batteries	27
Annex A (informative) Guidelines for the achievement of safety of lithium batteries	28
Annex B (informative) Guidelines for designers of equipment using lithium batteries	29
Annex C (informative) Additional information on display and storage	31
Bibliography	32
Annex ZA (normative) Normative references to international publications with their corresponding European publications	33

INTRODUCTION

The concept of safety is closely related to safeguarding the integrity of people and property. This standard specifies requirements and tests for lithium batteries and has been prepared in accordance with ISO/IEC guidelines, taking into account all relevant national and international standards which apply.

Lithium batteries are different from conventional primary batteries using aqueous electrolyte in that they contain flammable materials.

Consequently, it is important to take safety precautions very carefully during design, production, distribution, use, and disposal of lithium batteries. Based on such special characteristics, lithium batteries for consumer applications were initially small in size and had low power output. There were also lithium batteries with high power output which were used for special industrial applications and were characterized as being “technician replaceable”.

The first edition of IEC 60086-4 (1996) was drafted to accommodate the above situation.

However, from around the end of the 1980s, lithium batteries with high power output have started to be widely used in the consumer replacement market, mainly as a power source in camera applications.

Since the demand for such lithium batteries with high power output has significantly increased in recent years, various manufacturers have started to produce these types of lithium batteries. As a consequence of this situation, the safety aspects for lithium batteries with high power output have been included in this second edition of IEC 60086-4.

Safety is a balance between freedom from hazard and other requirements 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 4: Safety of lithium batteries

1 Scope

This International Standard specifies tests and requirements for primary lithium batteries to ensure their safe operation under intended use and reasonably foreseeable misuse.

2 Normative reference

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60086-1:1996, *Primary batteries – Part 1: General*

3 Definitions

For the purpose of this part of IEC 60086, the definitions given in IEC 60086-1 (some of which are repeated below for convenience) and the following definitions apply.

3.1

battery (primary)

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

3.2

button battery

small round battery, where the overall height is less than the diameter; batteries complying with IEC 60086-1, figures 2, 3 and 4

3.3

cell (primary)

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

3.4

consumer batteries

batteries readily available in the commercial retail market and that are considered user replaceable, i.e. replaceable without the need of special tools

3.5

cylindrical battery

primary battery with cylindrical geometry where the overall height is equal to or greater than the diameter; batteries complying with IEC 60086-1, figures 1A and 1B

3.6

depth of discharge (DOD)

percentage of rated capacity discharged from a battery

3.7

distortion

any change in physical dimensions exceeding 10 %

3.8

explosion, battery (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

3.9

fire

combustion of cell/battery components with emission of flame

3.10

harm

physical injury and/or damage to health or property

3.11

hazard

a potential source of harm

3.12

high power battery

a battery that can deliver most of its energy within a short time at ambient temperature

3.13

industrial batteries

batteries not normally available to the consumer. Such batteries are often referred to as “technician replaceable” because of the skill required for their handling and installation

3.14

intended use

the use of a product, process or service under conditions or for purposes in accordance with specifications and instructions provided by the supplier, including information for publicity purposes

3.15

leakage

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

3.16

low power battery

a battery that cannot deliver most of its energy within a short time at ambient temperature

3.17

nominal voltage

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

3.18

open circuit voltage (OCV)

voltage across the terminals of a battery when no external current is flowing

3.19

overheating

a condition when battery temperature rises above the temperature range specified by the manufacturer

3.20

prismatic battery

primary battery with non-round geometry; batteries not complying with 4.3 of IEC 60086-1

3.21

rated capacity

capacity of a battery determined under conditions specified in the relevant standard (if applicable) and declared by the manufacturer or supplier. Also sometimes referred to as nominal capacity

3.22

reasonably foreseeable misuse

the use of a product, process or service under conditions or for purposes not intended by the supplier, but which may happen, as a result of common human behaviour

3.23

risk

the probable rate of occurrence of a hazard causing harm and the degree of severity of the harm

3.24

safety

freedom from unacceptable risk of harm

3.25

venting

the release of excessive internal pressure from a battery in a manner intended by design to preclude explosion

4 Requirements for safety

4.1 Design

Lithium batteries are categorized by their chemical composition (anode, cathode, electrolyte), internal construction (bobbin, spiral) and are available in cylindrical, button/coin, and prismatic configuration. It is necessary to consider all relevant safety aspects at the battery design stage, recognizing the fact that they may differ considerably, depending on the specific lithium system, power output and battery configuration.

The following design concepts for safety are common to all lithium batteries.

- a) Abnormal temperature rise above the critical value defined by the manufacturer shall be prevented by design.
- b) Temperature increases in the battery shall be controlled by a design which limits current flow.
- c) Batteries shall be designed to relieve excessive internal pressure (not applicable to low power industrial batteries).

See annex A for guidelines for the achievement of safety of lithium batteries.

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

Samples shall be taken randomly from production lots in accordance with accepted quality control procedures.

NOTE 1 Many tests in this standard require preliminary conditioning of the samples such as preliminary discharge or storage at elevated temperature.

NOTE 2 Details of sample size for type approval and conditioning are found in clause 6.

6 Testing and requirements

6.1 General

6.1.1 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.

6.1.2 Ambient temperature

Unless otherwise specified, the tests shall be carried out at $(20 \pm 5) ^\circ\text{C}$.

6.1.3 Explosion levels

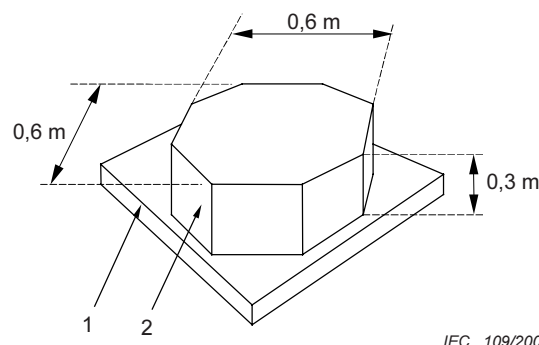
In order to quantify the explosion as defined in 3.8, the following procedure is provided. The test battery is placed on the steel plate shown in figure 1. The mesh chamber is centred over the test battery. The test battery is then subjected to the relevant test procedure. The result shall be determined using the following two levels.

NE: battery does not explode.

NE2: battery explodes but ejected solid material does not pass through the mesh chamber specified in figure 1.

CAUTION

Avoid short-circuiting. For protection, the mesh chamber shall be in a place that is separated from the observer.



NOTE The figure shows an aluminium wire mesh chamber (2) of octagonal shape resting on a steel plate (1). The aluminium wire has a diameter of 0,25 mm. The mesh has 16 to 18 wires per 25,4 mm.

Figure 1 – Mesh chamber

6.1.4 Determination of weight loss

In order to quantify the weight loss referred to in table 2, the following procedure is provided.

$$\Delta W = \frac{W_1 - W_2}{W_1} \times 100 \%$$

where

W_1 is the weight before the test;

W_2 is the weight after the test;

ΔW is the weight loss.

When weight loss does not exceed the values in table 1, it shall be considered as “no weight loss”.

Table 1 – Weight loss limits

Weight W of battery	Weight loss limit
$W \leq 1$ g	0,5 %
1 g $< W \leq 5$ g	0,2 %
$W > 5$ g	0,1 %

6.1.5 PredischARGE

Where a test requires predischARGE (25 %, 50 %, 75 % or 100 %), the test batteries shall be discharged to the respective depth of discharge with a resistive load with which the rated capacity is obtained or with a current specified by the manufacturer.

6.1.6 Additional batteries

Where additional batteries are required to perform a test, they shall be of the same type as the test battery.

Where additional batteries are required to perform a test, the total number n_i of batteries in series, including the test battery, shall be determined by calculating:

$$n = 12 V/U_n$$

and determining n_i by rounding up n to the nearest decimal integer while $n_i \geq n_{\min} = i$

where

U_n is the nominal voltage of one battery;

n_i is the total number of batteries;

$n_{\min}$ is the minimum number (2 or 3) of batteries given in the respective test description.

EXAMPLE 1 Let the minimum number of batteries be given as $n_{\min} = 2$ and let the test battery have a nominal voltage $U_n = 3,6$ V. Calculate $n = 3,9$ and determine $n_2 = 4$.

EXAMPLE 2 Let the minimum number of batteries be given as $n_{\min} = 3$ and let the test battery have a nominal voltage $U_n = 10$ V. Calculate $n = 1,2$ and determine $n_3 = 3$.

6.2 Intended use

6.2.1 Sampling, test sequence and requirements

Figure 2 gives an overview of the test sequence and samples to be taken for intended use tests while table 2 contains the requirements.