BS EN IEC 60086-5:2021
Incorporating corrigendum June 2022

BSI Standards Publication

Primary batteries

Part 5: Safety of batteries with aqueous electrolyte

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

National foreword

This British Standard is the UK implementation of EN IEC 60086-5:2021. It is identical to IEC 60086-5:2021, incorporating corrigendum June 2022. It supersedes BS EN 60086-5:2016, which is withdrawn.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by IEC corrigendum June 2022 is indicated in the text by ▌AC1⟩ ⟨AC1▐.

The UK participation in its preparation was entrusted to Technical Committee CPL/35, Primary cells.

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

BSI, as a member of CENELEC, is obliged to publish EN IEC 60086-5:2021 as a British Standard. However, attention is drawn to the fact that during the development of this European Standard, the UK committee voted against its approval.

It is the belief of the UK committee that abuse testing of batteries with aqueous electrolyte should be more thorough and that the method described within this document is oversimplified. The UK committee advises users to simulate test conditions whereby one battery in a set of four connected in series parallel is reversed.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2022
Published by BSI Standards Limited 2022

ISBN 978 0 539 23202 8

ICS 29.220.10

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 November 2021.

Amendments/corrigenda issued since publication

Date	Text affected
31 October 2022	Implementation of IEC corrigendum June 2022

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 60086-5

November 2021

ICS 29.220.10

Supersedes EN 60086-5:2016 and all of its amendments and corrigenda (if any)

English Version

Primary batteries - Part 5: Safety of batteries with aqueous electrolyte (IEC 60086-5:2021)

Piles électriques - Partie 5: Sécurité des piles à électrolyte aqueux (IEC 60086-5:2021)

Primärbatterien - Teil 5: Sicherheit von Batterien mit wässrigem Elektrolyt (IEC 60086-5:2021)

This European Standard was approved by CENELEC on 2021-11-04. 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 CEN-CENELEC Management Centre 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 CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

© 2021 CENELEC All rights of exploitation in any form and by any means reserved worldwide for CENELEC Members.

Ref. No. EN IEC 60086-5:2021 E

AVA Documents Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

European foreword

The text of document 35/1471/FDIS, future edition 5 of IEC 60086-5, prepared by IEC/TC 35 “Primary cells and batteries” was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60086-5:2021.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2022–08–04
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024–11–04

This document supersedes EN 60086-5:2016 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users’ national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 60086-5:2021 was approved by CENELEC as a European Standard without any modification.

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

IEC 60068-2-27 NOTE Harmonized as EN 60068-2-27

IEC 60068-2-6 NOTE Harmonized as EN 60068-2-6

IEC 60068-2-31 NOTE Harmonized as EN 60068-2-31

ISO 7010:2019 NOTE Harmonized as EN ISO 7010:2020 (not modified)

IEC 60086-3 NOTE Harmonized as EN IEC 60086-3

IEC 60086-4 NOTE Harmonized as EN IEC 60086-4

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60086-1	2015	Primary batteries - Part 1: General	EN 60086-1	2015
IEC 60086-2	2015	Primary batteries - Part 2: Physical and electrical specifications	EN 60086-2	2016

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

This page deliberately left blank

Documents
Document Sharing Hub

CONTENTS

FOREWORD 5
INTRODUCTION 7
1 Scope 8
2 Normative references 8
3 Terms and definitions 8
4 Requirements for safety 10
4.1 Design 10
4.1.1 General 10
4.1.2 Venting 10
4.2 Quality plan 10
5 Sampling 10
5.1 General 10
5.2 Sampling for type testing 11
5.3 Validity of testing 11
6 Testing and requirements 11
6.1 General 11
6.1.1 Applicable safety tests 11
6.1.2 Cautionary notice 12
6.1.3 Ambient temperature 12
6.2 Evaluation of test criteria 13
6.2.1 Explosion 13
6.2.2 Fire 13
6.2.3 Leakage 13
6.2.4 Venting 13
6.3 Intended use 13
6.3.1 Intended use tests and requirements 13
6.3.2 Intended use test procedures 13
6.4 Reasonably foreseeable misuse 16
6.4.1 Reasonably foreseeable misuse tests and requirements 16
6.4.2 Reasonably foreseeable misuse test procedures 16
7 Information for safety 18
7.1 Precautions during handling of batteries 18
7.2 Packaging 20
7.3 Handling of battery cartons 20
7.4 Display and storage 20
7.5 Transportation 21
7.6 Disposal 21
8 Instructions for use 21
9 Marking and packaging 22
9.1 General batteries 22
9.2 Swallowable button cells 22
9.3 Safety pictograms 22
Annex A (informative) Additional information on display and storage 24
Annex B (informative) Battery compartment design guidelines 25
B.1 Background 25

Documents
Document Sharing Hub

B.1.1 General ... 25
B.1.2 Battery failures resulting from poor battery compartment design ... 25
B.1.3 Potential hazards resulting from battery reversal ... 25
B.1.4 Potential hazards resulting from a short circuit ... 25
B.2 General guidance for appliance design ... 26
B.2.1 Key battery factors to be first considered ... 26
B.2.2 Other important factors to consider ... 26
B.3 Specific measures against reversed installation ... 27
B.3.1 General ... 27
B.3.2 Design of the positive contact ... 27
B.3.3 Design of the negative contact ... 27
B.3.4 Design with respect to battery orientation ... 28
B.3.5 Dimensional considerations ... 28
B.4 Specific measures to prevent short-circuiting of batteries ... 31
B.4.1 Measures to prevent short-circuiting due to battery jacket damage ... 31
B.4.2 Measures to prevent external short circuit of a battery caused when coiled spring contacts are employed for battery connection ... 31
B.5 Special considerations regarding recessed negative contacts ... 33
B.6 Waterproof and non-vented devices ... 34
B.7 Other design considerations ... 34
Annex C (informative) Safety pictograms ... 36
C.1 General ... 36
C.2 Pictograms ... 36
C.3 Recommendations for use ... 38
Annex D (informative) Use of the KEEP OUT OF REACH OF CHILDREN safety sign ... 39
D.1 General ... 39
D.2 Safety sign ... 39
D.3 Best practices for marking the packaging ... 39
Annex E (informative) Child resistant packaging ... 40
E.1 General ... 40
E.1.1 General ... 40
E.1.2 Applicability ... 40
E.1.3 Packaging design ... 40
E.2 Packaging tests ... 40
E.2.1 General ... 40
E.2.2 Test items ... 40
E.2.3 Test procedure ... 42
E.2.4 Criteria ... 42
Bibliography ... 44

Figure 1 – Sampling for tests and number of batteries required ... 11
Figure 2 – Temperature cycling procedure ... 16
Figure 3 – Circuit diagram for incorrect installation (four batteries in series) ... 17
Figure 4 – Circuit diagram for external short circuit ... 17
Figure 5 – Circuit diagram for overdischarge ... 18
Figure 6 – XYZ axes for free fall ... 18
Figure 7 – Ingestion gauge ... 19
Figure B.1 – Example of series connection with one battery reversed ... 25

Documents
Document Sharing Hub
Full document details: BS EN IEC 60086-5:2021

Figure B.2 – Positive contact recessed between ribs 27
Figure B.3 – Positive contact recessed within surrounding insulation 27
Figure B.4 – Negative contact U-shaped to ensure no positive (+) battery contact 27
Figure B.5 – Design with respect to battery orientation 28
Figure B.6 – Example of the design of a positive contact of an appliance 30
Figure B.7 – Example of a short circuit where a switch is piercing the battery insulating jacket 31
Figure B.8 – Typical example of insulation to prevent short circuit 31
Figure B.9 – Insertion against spring (to be avoided) 32
Figure B.10 – Examples showing distorted springs 32
Figure B.11 – Example of protected insertion 32
Figure B.12 – Example of negative contacts 34
Figure B.13 – Example of series connection of batteries with voltage tapping 35
Figure E.1 – Bending test 41
Figure E.2 – Torsion test 41
Figure E.3 – Tearing test 42
Figure E.4 – Pushing test 42
Figure E.5 – Maximum packaging opening 43

Table 1 – Test matrix 12
Table 2 – Intended use tests and requirements 13
Table 3 – Shock pulse 14
Table 4 – Test sequence of the shock test 14
Table 5 – Test sequence of the vibration test 15
Table 6 – Reasonably foreseeable misuse tests and requirements 16
Table 7 – Marking and packaging requirements 23
Table B.1 – Dimensions of battery terminals and recommended dimensions of the positive contact of an appliance in Figure B.6 29
Table B.2 – Minimum wire diameters 33
Table B.3 – Dimensions of the negative battery terminal 34
Table C.1 – Safety pictograms 36
Table E.1 – Test procedure 42

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRIMARY BATTERIES –

Part 5: Safety of batteries with aqueous electrolyte

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.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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.

Documents
Document Sharing Hub

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.

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.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

The contents of the corrigendum 1 (2022-06) have been included in this copy.

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

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.

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

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.]

Documents
Document Sharing Hub

Full document details: BS EN IEC 60086-5:2021

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

Documents
Document Sharing Hub
Full document details: BS EN IEC 60086-5:2021

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.

AVA Documents
Document Sharing Hub