

INTERNATIONAL STANDARD



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

iTech Standards
(<https://standards.itih.ai>)
Document Preview

IEC 60086-5:2016

<https://standards.itih.ai/standards/iec/065a5268-1de4-441c-b903-cfdbbfd7e7d/iec-60086-5-2016>

Withhold



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2016 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

INTERNATIONAL STANDARD



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

<https://standards.iteh.ai/standards/iec/065a5268-1de4-441c-b903-cfd7bbfd7e7d/iec-60086-5-2016>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.220.10

ISBN 978-2-8322-3534-8

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references.....	8
3 Terms and definitions	8
4 Requirements for safety.....	11
4.1 Design	11
4.1.1 General	11
4.1.2 Venting	11
4.1.3 Insulation resistance	11
4.2 Quality plan.....	11
5 Sampling.....	11
5.1 General.....	11
5.2 Sampling for type approval.....	11
6 Testing and requirements	12
6.1 General.....	12
6.1.1 Applicable safety tests.....	12
6.1.2 Safety Cautionary notice.....	13
6.1.3 Ambient temperature.....	14
6.2 Intended use.....	14
6.2.1 Intended use tests and requirements.....	14
6.2.2 Intended use test procedures.....	14
6.3 Reasonably foreseeable misuse	17
6.3.1 Reasonably foreseeable misuse tests and requirements	17
6.3.2 Reasonably foreseeable misuse test procedures.....	17
7 Information for safety.....	19
7.1 Safety Precautions during handling of batteries.....	19
7.2 Packaging.....	21
7.3 Handling of battery cartons.....	21
7.4 Display and storage	22
7.5 Transportation.....	22
7.6 Disposal.....	22
8 Instructions for use	22
9 Marking	23
9.1 General (see Table 7)	23
9.2 Marking of small batteries (see Table 7)	23
9.3 Safety pictograms	24
Annex A (informative) Additional information to 7.4 on display and storage	25
Annex B (informative) Battery compartment design guidelines	26
B.1 Background.....	26
B.1.1 General	26
B.1.2 Battery failures resulting from poor battery compartment design.....	26
B.1.3 Potential hazards resulting from battery reversal.....	26
B.1.4 Potential hazards resulting from a short circuit.....	26
B.2 General guidance for appliance design	27

B.2.1	Key battery factors to be first considered	27
B.2.2	Other important factors to consider	27
B.3	Specific measures against reversed installation	28
B.3.1	General	28
B.3.2	Design of the positive contact	28
B.3.3	Design of the negative contact	28
B.3.4	Design with respect to battery orientation	29
B.3.5	Dimensional considerations	29
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	Overview General	36
C.2	Pictograms	36
C.3	Instructions Recommendations for use	38
Bibliography	39
Figure 1	– Sampling for type approval tests and number of batteries required	12
Figure 2	– Temperature cycling procedure	17
Figure 3	– Circuit diagram for incorrect installation (four batteries in series)	18
Figure 4	– Circuit diagram for external short circuit	18
Figure 5	– Circuit diagram for overdischarge	19
Figure 6	– XYZ axes for free fall	19
Figure 7	– Ingestion gauge (inner dimensions)	21
Figure B.1	– Example of series connection with one battery reversed	26
Figure B.2	– Positive contact recessed between ribs	28
Figure B.3	– Positive contact recessed within surrounding insulation	28
Figure B.4	– Negative contact U-shaped to ensure no positive (+) battery contact	29
Figure B.5	– Design with respect to battery orientation	29
Figure B.6	– Example of the design of a positive contact of an appliance	30
Figure B.7	– Example of a short circuit, 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	– One example of protected insertion	32
Figure B.12	– Example of negative contacts	33
Figure B.13	– Example of series connection of batteries with voltage tapping	35
Table 1	– Test matrix	13
Table 2	– Intended use tests and requirements	14
Table 3	– Shock pulse	15

Table 4 – Test sequence.....	15
Table 5 – Test sequence.....	16
Table 6 – Reasonably foreseeable misuse tests and requirements.....	17
Table 7 – Marking requirements.....	24
Table B.1 – Dimensions of battery terminals and recommended dimensions of the positive contact of an appliance in Figure B.6.....	30
Table B.2 – Minimum wire diameters.....	33
Table B.3 – Dimensions of the negative battery terminal.....	34
Table C.1 – Safety pictograms (1 of 3).....	36

Witholdawm

iTech Standards
(<https://standards.iteh.ai>)
Document Preview

IEC 60086-5:2016

<https://standards.iteh.ai/standards/iec/085a5268-1de4-441c-b903-cfdbbfd7e7d/iec-60086-5-2016>

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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

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

This fourth edition cancels and replaces the third edition published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) The definition of explosion was changed to suitable sentence in order to harmonize in IEC 60086 series;
- b) To prevent removal of hydrogen gas, we revised it to the suitable sentence,
- c) To prevent misuse, the battery compartments with parallel connections were revised to the suitable sentence.
- d) To clarify the method to determine the insulation resistance.

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

FDIS	Report on voting
35/1360/FDIS	35/1361/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 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 publication will remain unchanged until the stability date indicated on the IEC website 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.

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

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.

iTech Standards
(<https://standards.itih.ai>)
Document Preview

IEC 60086-5:2016

<https://standards.itih.ai/standards/iec/085a5268-1de4-441c-b903-cfd7e7d/iec-60086-5-2016>

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, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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:~~2014~~, *Primary batteries – Part 1: General*

IEC 60086-2:~~2014~~, *Primary batteries – Part 2: Physical and electrical specifications*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (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 purposes of this document, ~~the terms and definitions given in IEC 60086-1 as well as~~ the following terms and definitions apply.

NOTE Certain definitions taken from IEC 60050-482, IEC 60086-1, and IEC Guide 51 are repeated below for convenience.

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, modified definition]

3.2 button (cell or battery)

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

Note 1 to entry: In English, the term "button (cell or battery)" is only used for non-lithium batteries while the term "coin (cell or battery)" is used for lithium batteries only. In languages other than English, the terms "coin" and "button" are often used interchangeably, regardless of the electrochemical system.

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]

3.4**component cell**

cell contained in a battery

3.5**cylindrical (cell or battery)**

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 ("cell with a cylindrical shape" replaced by "round cell or battery")]

3.6**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~~
the cell or battery opens and solid components are forcibly expelled

~~**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]

3.7**fire**

flames are emitted from the test cell or battery

3.8**intended use**

~~use of a product, process or service in accordance with information provided by the supplier~~
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 51:1999 2014, 3.6]

3.9**leakage**

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

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

**3.10
nominal voltage (of a primary battery)**

V_n

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 (addition of "(of a primary battery)" and symbol V_n)]

**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

[SOURCE: IEC 60050-482:2004, 482-02-38, modified (deletion of "qualifies a")]

**3.13
protective devices**

devices such as fuses, diodes 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~~ system in a way not intended by the supplier, but which ~~may~~ can result from readily predictable human behaviour

[SOURCE: ISO/IEC Guide 51:1999, 3.14, modified ("process or service" replaced by "or system" and "may" replaced by "can" and deletion of the Note)]

**3.15
risk**

~~combination of the probability of occurrence of harm and the severity of that harm~~

[ISO/IEC Guide 51:1999, 3.2]

**3.15
round (cell or battery)**

cell or battery with circular cross section

**3.16
safety**

freedom from ~~unacceptable~~ risk which is not tolerable

[SOURCE: ISO/IEC Guide 51: ~~1999~~ 2014, 3.14]

**3.17
undischarged**

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

**3.18
venting**

release of excessive internal pressure from a cell or 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 $5 \text{ M}\Omega$ at $500 \text{ V}_{-0\text{V}}^{+100\text{V}}$ applied for a minimum of 60 seconds.

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.

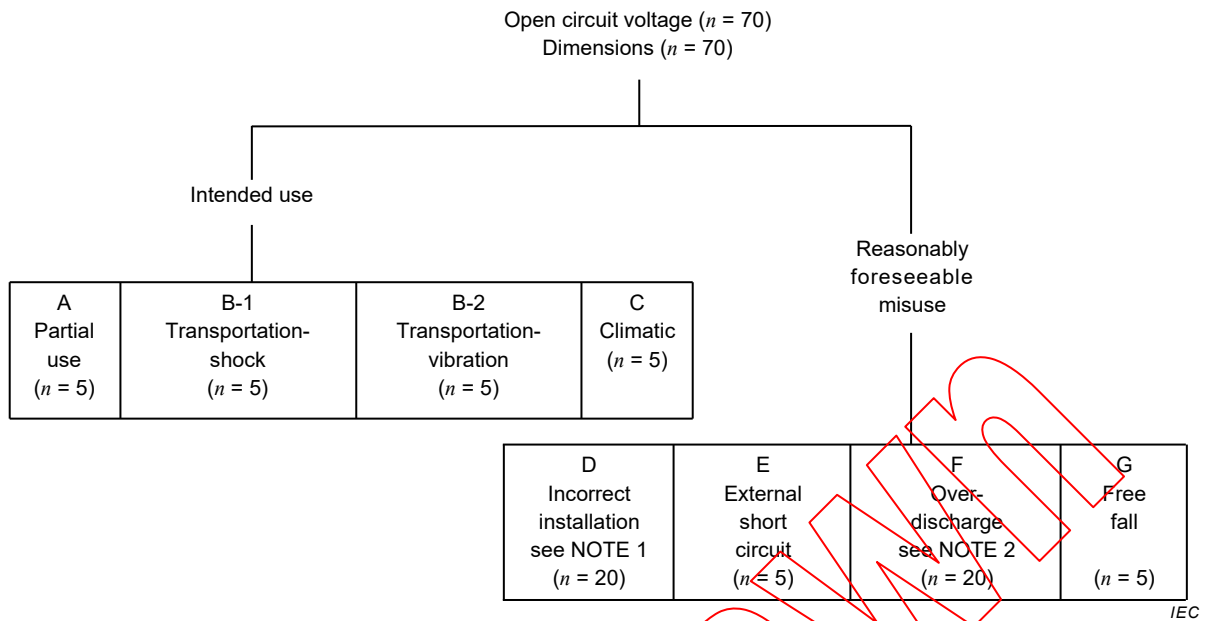
5 Sampling

5.1 General

Samples should be drawn from production lots in accordance with accepted statistical methods.

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.