INTERNATIONAL STANDARD

IEC 60086-5

First edition
2000-07

Primary batteries –

Part 5:
Safety of batteries with aqueous electrolyte

Piles électriques –

Partie 5:
Sécurité des piles à électrolyte aqueux

Reference number
IEC 60086-5:2000(E)

Numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series.

Consolidated publications

Consolidated versions of some IEC publications including amendments are available. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

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- **IEC web site***
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- **IEC Bulletin**
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Terminology, graphical and letter symbols

For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams*.

* See web site address on title page.

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Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE U

For price, see current catalogue

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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PRIMARY BATTERIES –

Part 5: Safety of batteries with aqueous electrolyte

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.
3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
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6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

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

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

FDIS	Report on voting
35/1127/FDIS	35/1130/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.

IEC 60086 consists of the following parts, under the general title: Primary batteries:

Part 1: General

Part 2: Specification sheets

Part 3: Watch batteries

Part 4: Safety of lithium batteries

Part 5: Safety of batteries with aqueous electrolyte

This publication has been drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A and B are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2002. 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 concept of safety is closely related to safeguarding the integrity of people and property. This part of IEC 60086 specifies requirements and tests 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.

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 normal use and reasonably foreseeable misuse.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60086. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60086 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

IEC 60086-2:1997, *Primary batteries – Part 2: Specification sheets*

IEC 60086-4:2000, *Primary batteries – Part 4: Safety of lithium batteries*

IEC 60050(481):1996, *International Electrotechnical Vocabulary (IEV) – Chapter 481: Primary cells and batteries*

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-27:1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 60068-2-32:1975, *Environmental testing – Part 2: Tests – Test Ed: Free fall (Procedure 1)*

3 Definitions

For the purpose of this part of IEC 60086, the definitions given in IEC 60050(481) (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 figures 2, 3 and 4 of IEC 60086-1

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

3.5
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

3.6
harm
physical injury and/or damage to health or property

3.7
hazard
a potential source of harm

3.8
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

3.9
leakage
unplanned escape of electrolyte, gas or other material from a battery

3.10
nominal voltage
a suitable approximate value of voltage used to identify the voltage of a primary battery

3.11
prismatic battery
primary battery with non-round geometry; batteries not complying with IEC 60086-1, 4.3

3.12
reasonably foreseeable misuse
the use of a product, process or service under conditions or for purposes not intended by the supplier, but which can happen

3.13
risk
the probable rate of occurrence of a hazard causing harm and the degree of severity of the harm

3.14
safety
freedom from unacceptable risk of harm

3.15
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

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 MΩ at (500 ± 20) V.

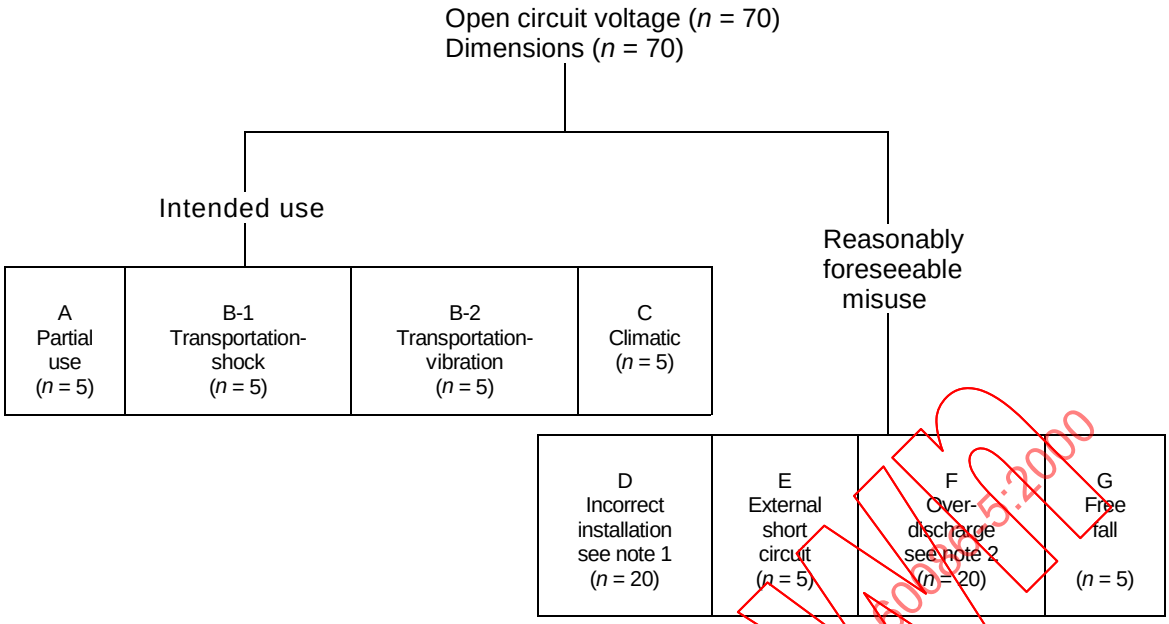
4.2 Quality plan

The manufacturer shall prepare a quality plan defining the procedures for the inspection of materials, components, cells and batteries to be applied to the total process of producing a specific type of battery.

5 Sampling

5.1 Samples are drawn from production lots in accordance with accepted statistical methods.

5.2 Sampling for type approval



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

Tests described in tables 1 and 5 are intended to simulate conditions which the battery is likely to encounter during intended use and reasonably foreseeable misuse.

Unless otherwise specified, these tests shall be carried out at (20 ± 5)°C.

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 Intended use

6.1.1 Intended use tests and requirements

Table 1 – Intended use tests and requirements

Test		Intended use simulation	Requirements
Electrical test	A	Storage after partial use	No leakage (NL) No explosion (NE)
Environmental tests	B-1	Transportation-shock	No leakage (NL) No explosion (NE)
	B-2	Transportation-vibration	No leakage (NL) No explosion (NE)
	C	Climatic-temperature cycling	No explosion (NE)

6.1.2 Intended use test procedures

6.1.2.1 Test A – storage after partial use

a) Purpose

This test simulates the situation when an appliance is switched off and the installed batteries are partly discharged. These batteries may be left in the appliance for a long time or they are removed from the appliance and stored for a long time.

b) Test procedure

An undischarged battery is discharged under an application/service output test condition as defined in IEC 60086-2 until the service life falls by 50 % of the minimum average duration (MAD) value, followed by storage at 45 °C for 30 days.

c) Requirement

See table 1.

6.1.2.2 Test B-1 – transportation-shock

a) Purpose

This test simulates the situation when an appliance is carelessly dropped with batteries installed in it. This test condition is generally specified in IEC 60068-2-27.

b) Test procedure

An undischarged battery shall be tested as follows.

The shock test shall be carried out under the conditions defined in table 2 and the sequence in table 3.

Shock pulse – The shock pulse applied to the battery shall be as follows:

Table 2 – Shock pulse

Acceleration		Waveform
Minimum average acceleration First three milliseconds	Peak acceleration	
75 g_n	125 g_n to 175 g_n	Half sine

Table 3 – Test sequence

Step	Storage time	Battery orientation	Number of shocks	Visual examination periods
1	–	–	–	Pre-test
2	–	See note	1 each	–
3	–	See note	1 each	–
4	–	See note	1 each	–
5	1 h	–	–	–
6				Post-test
NOTE The shock shall be applied in each of three mutually perpendicular directions.				

Step 1 Record electrical characteristics in accordance with 5.2.

Steps 2 to 4 Apply shock test specified in table 2 and the sequence in table 3.

Step 5 Rest battery for 1 h.

Step 6 Record examination results.

c) Requirement

See table 1.

6.1.2.3 Test B-2 – transportation-vibration

a) Purpose

This test simulates vibration during transportation. This test condition is generally specified in IEC 60068-2-6.

b) Test procedure

An undischarged battery shall be tested as follows.

The vibration test shall be carried out under the following test conditions and the sequence in table 4.

Vibration – A simple harmonic motion shall be applied to the battery having an amplitude of 0,8 mm, with a total maximum excursion of 1,6 mm. The frequency shall be varied at the rate of 1 Hz/min between the limits of 10 Hz and 55 Hz. The entire range of frequencies (10 Hz to 55 Hz) and return (55 Hz to 10 Hz), shall be traversed in (90 ± 5) minutes for each mounting position (direction of vibration).

Table 4 – Test sequence

Step	Storage time	Battery orientation	Vibration time	Visual examination periods
1	–	–	–	Pre-test
2	–	See note	90 ± 5 min each	–
3	–	See note	90 ± 5 min each	–
4	–	See note	90 ± 5 min each	–
5	1 h	–	–	–
6				Post-test
NOTE The vibration shall be applied in each of three mutually perpendicular directions.				

Step 1 Record electrical characteristics in accordance with 5.2.

Steps 2 to 4 Apply the vibration specified in 6.1.2.3 in the sequence in table 4.

Step 5 Rest battery for 1 h.

Step 6 Record examination results.

c) Requirement

See table 1.

6.1.2.4 Test C – climatic-temperature cycling

a) Purpose

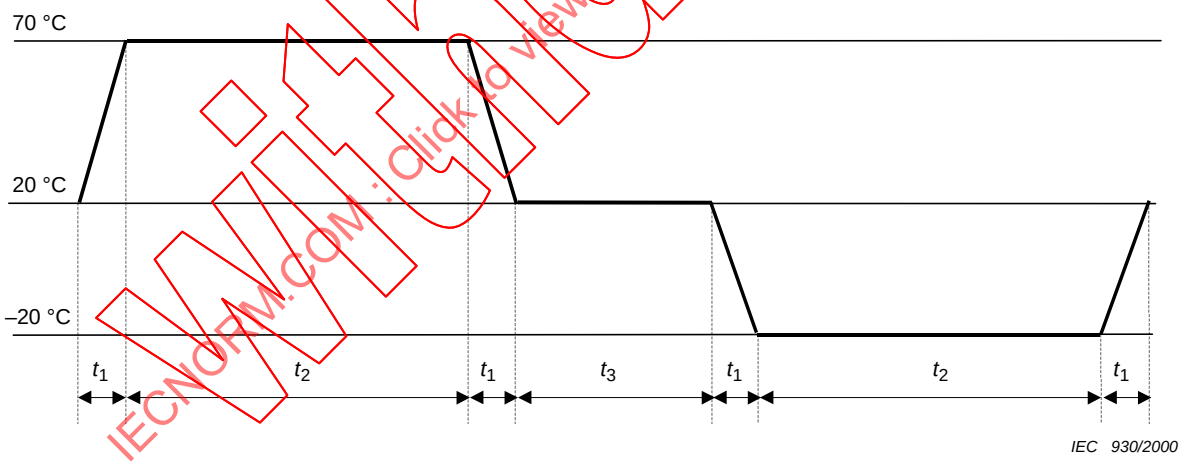
This test assesses the integrity of the battery seal which may be impaired after temperature cycling.

b) Test procedure

An undischarged battery shall be tested under the following procedure.

Temperature cycling procedure (see below and/or figure 2)

1) Place the batteries in a test chamber and raise the temperature of the chamber to 70 °C within 30 min (t_1).
2) Maintain the chamber at this temperature for 4 h (t_2).
3) Reduce the temperature of the chamber to 20 °C within t_1 = 30 min and maintain at this temperature for t_3 = 2 h.
4) Reduce the temperature of the chamber to –20 °C within not more than t_1 = 30 min and maintain at this temperature for t_2 = 4 h.
5) Raise the temperature of the chamber to 20 °C within t_1 = 30 min.
6) Repeat the sequence for a further nine cycles.
7) After the 10th cycle, store the batteries for seven days prior to examination.



t_1 : 30 min, t_2 : 4 h, t_3 : 2 h

Figure 2 – Temperature cycling procedure

c) Requirement

See table 1.

6.2 Reasonably foreseeable misuse

6.2.1 Reasonably foreseeable misuse tests and requirements

Table 5 – Reasonably foreseeable misuse tests and requirements

Test		Misuse simulation	Requirements
Electrical tests	D	Incorrect installation	No explosion (NE) *
	E	External short circuit	No explosion (NE)
	F	Overdischarge	No explosion (NE)
Environmental test	G	Free fall	No explosion (NE)
* See note 2 of 6.2.2.1			

6.2.2 Reasonably foreseeable misuse test procedure

6.2.2.1 Test D – incorrect installation (four batteries in series)

a) Purpose

This test simulates the condition when one battery in a set is reversed.

b) Test procedure

Four undischarged batteries of the same brand, type and origin shall be connected in series with one reversed (B1) as shown in figure 3. The circuit shall be completed for 24 h or until the battery case temperature has returned to ambient.

The resistance of the inter-connecting circuitry shall not exceed 0,1 Ω.

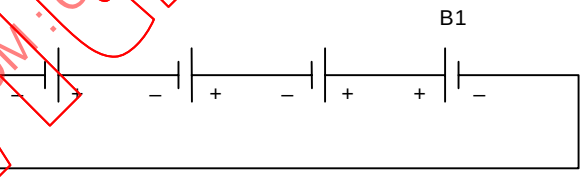


Figure 3 – Incorrect installation (four batteries in series)

NOTE 1 The circuit in figure 3 simulates a typical misuse condition.

NOTE 2 Primary batteries are not designed to be charged. However, reversed installation of a battery in a series of three or more exposes the reversed battery to a charging condition. Although cylindrical batteries are designed to relieve excessive internal pressure, in some instances an explosion may not be precluded. Therefore, the user shall be clearly advised to install batteries correctly with regard to polarity (+ and –) to avoid this hazard. (See 9.1g).

c) Requirement

See table 5.

6.2.2.2 Test E – external short circuit

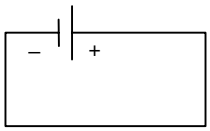
a) Purpose

This misuse may occur during daily handling of batteries.

b) Test procedure

An undischarged battery shall be connected as shown in figure 4. The circuit shall be completed for 24 h or until the battery case temperature has returned to ambient.

The resistance of the inter-connecting circuitry shall not exceed 0,1 Ω.



IEC 932/2000

Figure 4 – External short circuit

c) Requirement

See table 5.

6.2.2.3 Test F – overdischarge

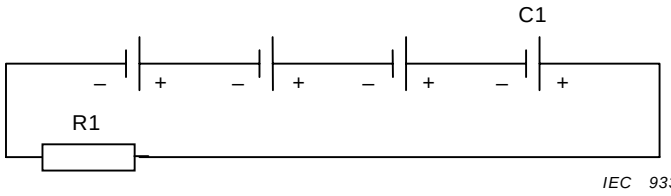
a) Purpose

This is a reasonably foreseeable misuse test which simulates the condition when one (1) discharged battery is series-connected with three (3) other undischarged batteries.

b) Test procedure

One undischarged battery (C1) is discharged under an application/service output test condition as defined in IEC 60086-2 until the onload voltage falls to 0,6 V. Then, three undischarged batteries and one discharged battery (C1) of the same brand, type and origin shall be connected in series as shown in figure 5. The circuit shall be completed until the total on-load voltage falls to 2,4 V.

The value of the resistance (R1) shall be approximately four times the value of that selected for the discharge of battery C1. The final value of the resistor (R1) shall be the nearest value to that prescribed in 8.3.3 of IEC 60086-1.



IEC 933/2000

Figure 5 – Overdischarge

c) Requirement

See table 5.

6.2.2.4 Test G – free fall test

a) Purpose

This test simulates the situation when a battery is accidentally dropped. The test condition is based upon IEC 60068-2-32.

b) Test procedure

Undischarged test batteries shall be dropped from a height of 1 m onto a concrete surface. Each test battery shall be dropped six times, a prismatic battery once on each of its six faces, a round battery twice in each of the three axes shown in figure 6. The test batteries shall be stored for 1 h afterwards.

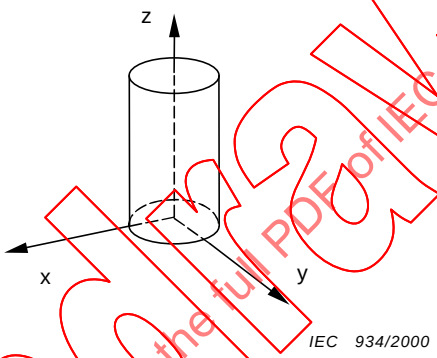


Figure 6 – XYZ axes of round battery

c) Requirement

See table 5.

Table 6 – Testing and requirements

System letter	Negative electrode	Electrolyte	Positive electrode	Nominal voltage per cell V		Applicable tests						
						A	B-1 B-2	C	D	E	F	G
–	Zinc	Ammonium chloride Zinc chloride	Manganese dioxide	1,5	R	×	×	×	×	×	×	×
					B				NR			
					P	×	×	×	NR	×	×	×
A	Zinc	Ammonium chloride Zinc chloride	Oxygen air	1,4	R	×	×	×	NR	×	×	×
					B				NR			
					P	×	×	×	NR	×	×	×
L	Zinc	Alkali metal hydroxide	Manganese dioxide	1,5	R	×	×	×	×	×	×	×
					B	×	×	×	NR	×	NR	×
					P	×	×	×	NR	×	NR	×
P	Zinc	Alkali metal hydroxide	Oxygen air	1,4	R				NR			
					B	NR	×	×	NR	×	NR	×
					P				NR			
S	Zinc	Alkali metal hydroxide	Silver oxide (Ag_2O)	1,55	R	×	×	×	NR	×	NR	×
					B	×	×	×	NR	×	NR	×
					P				NR			

Key
R: round (as per 3.4)
B: button (as per 3.2)
P: multicell
×: required
NR: not required

Systems L and S button cells or batteries under 250 mAh and system P button cells or batteries under 700 mAh are exempt from any testing.

7 Information for safety

7.1 Safety precautions during handling of batteries

When used correctly, primary batteries with aqueous electrolyte provide a safe and dependable source of power. However, if they are misused or abused, leakage or in extreme cases, explosion and/or possibly fire may result.

a) *Always take care to insert batteries correctly with regard to polarity (+ and –), marked on the battery and the equipment*

Batteries which are incorrectly placed into equipment may be short-circuited, or charged. This can result in a rapid temperature rise causing venting, leakage and explosion.

b) *Do not short-circuit batteries*

When the positive (+) and negative (–) terminals of a battery are in direct contact with each other, the battery becomes short-circuited. For example, batteries lying on top of each other or mixed together, can be short-circuited. This can result in venting and leakage.

c) *Do not charge batteries*

Attempting to charge a primary battery may cause internal gas and/or heat generation resulting in venting, leakage, explosion and/or possibly fire.

d) *Do not force discharge batteries*

When batteries are force discharged with an external power source, the voltage of the battery will be forced below its design capability and gases will be generated inside the battery. This may result in venting, leakage and explosion.

e) *Do not mix batteries (when replacing batteries, replace all of them at the same time with new batteries of the same brand and type)*

When batteries of different kinds are used together, or new and old batteries are used together, some batteries may be overdischarged due to a difference of voltage or capacity. This can result in venting, leakage and explosion.

f) *Exhausted batteries should be immediately removed from the equipment and disposed of*

When discharged batteries are kept in the equipment for a long time, electrolyte leakage may occur causing damage to the appliance.

g) *Do not heat batteries*

When a battery is heated, venting, leakage and explosion may occur.

h) *Do not directly solder batteries*

When a battery is directly soldered, it may be damaged by heat. This may cause internal short-circuiting and may result in venting, leakage and explosion.

i) *Do not dismantle batteries*

When a battery is dismantled, contact with the components may result in personal injury.

j) *Do not deform batteries*

Batteries should not be crushed, punctured, or otherwise mutilated. Such abuse may result in leakage or explosion.

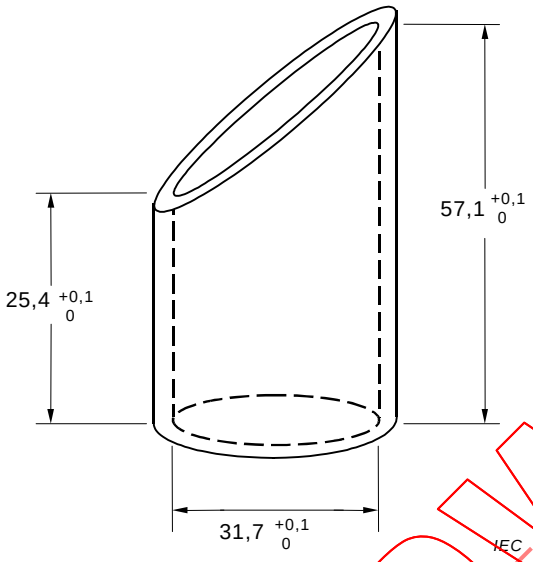
k) *Do not dispose of batteries in fire*

When batteries are disposed of in fire, the heat build-up may cause explosion. Do not incinerate batteries except in a controlled furnace.

l) *Do not allow children to replace batteries without adult supervision*

m) *Keep batteries out of the reach of children*

Keep batteries which are considered swallowable out of the reach of children, especially those batteries fitting within the limits of the ingestion gauge as defined in figure 7.



Dimensions in millimetres

Figure 7 – Ingestion gauge

In case of ingestion of a cell or battery, the person involved should seek medical assistance promptly.

n) *Do not encapsulate and/or modify batteries*

Encapsulation, or any other modification to a battery, may result in blockage of the safety vent mechanism(s) and subsequent explosion. Advice from the battery manufacturer should be sought if it is considered necessary to make any modification.

o) *Store unused batteries in their original packaging and keep them away from metal objects which may short-circuit them*

One of the best ways to avoid short-circuiting (see 7.1b) is to store unused batteries in their original packaging.

p) *Remove discharged batteries from equipment*

It is advantageous to remove batteries immediately from equipment which has ceased to function satisfactorily, or when a long period of disuse is anticipated (e.g. video-cameras, photoflash, etc.). Although most batteries on the market today are provided with protective jackets or other means to contain leakage, a battery that has been partially or completely exhausted may be more prone to leak than one that is unused.

7.2 Safety precautions during packaging, handling, transportation, display, storage, and disposal

7.2.1 Packaging

The packaging shall be adequate to avoid mechanical damage during transport, handling and stacking. The materials and packaging design shall be chosen so as to prevent the development of unintentional electrical contact, corrosion of the terminals and some protection from the environment.

7.2.2 Handling of battery cartons

Rough handling of battery cartons may result in battery damage and impaired electrical performance and may result in leakage, explosion, or possibly fire.

7.2.3 Display and storage

a) *Batteries shall be stored in well-ventilated, dry and cool conditions*

High temperature or high humidity may cause deterioration of the battery performance or surface corrosion.

b) *Battery cartons should not be piled up in several layers (or should not exceed a specified height)*

If too many battery cartons are piled up, batteries in the lowest cartons may be deformed and electrolyte leakage may occur.

c) *When batteries are stored in warehouses or displayed in retail stores, they should not be exposed to direct sun rays for a long time or placed in areas where they get wet by rain*

When batteries get wet, their insulation resistance decreases, self-discharge may occur and rust may be generated.

d) *Do not mix unpacked batteries so as to avoid mechanical damage and/or short-circuit among each other*

When mixed together, batteries may be subjected to physical damage or overheating resulting from external short circuit. Leakage and/or explosion may then occur. To avoid these possible hazards, batteries should be kept in their packaging until required for use.

e) *See annex A for additional details*

7.2.4 Disposal

a) Primary batteries may be disposed of via the communal refuse arrangements provided that no local rules to the contrary exist.

b) Do not dismantle batteries.

c) Do not dispose of batteries in fire except under conditions of controlled incineration.

8 Instructions for use

a) *Always select the correct size and grade of battery most suitable for the intended use. Information provided with the equipment to assist correct battery selection should be retained for reference.*

b) *Replace all batteries of a set at the same time.*

c) *Clean the battery contacts and also those of the equipment prior to battery installation.*

d) *Ensure that the batteries are installed correctly with regard to polarity (+ and –).*

e) *Remove batteries from equipment which is not to be used for an extended period of time.*

f) *Remove exhausted batteries promptly.*

9 Marking

9.1 General

With the exception of batteries designed as small, each battery shall be marked with the following information:

a) electrochemical system;

b) designation;

c) year and month or week of manufacture, which may be in code, or the expiration of a guarantee period in clear;

d) polarity of terminals (when applicable);

e) nominal voltage;

f) name or trade mark of the manufacturer or supplier;

g) cautionary advice;

h) caution for ingestion of small batteries (refer to 7.1 m)).

9.2 Small batteries

Batteries whose external surface area is too small to accommodate the markings shown in 9.1 shall show, on the battery, the designation 9.1 b) and polarity 9.1 d). All other markings shown in 9.1 should be on the immediate packing.

Annex A
(informative)

Additional information to subclause 7.2.3

The purpose of this annex is to describe these good practices in general terms and, more specifically, to warn against procedures known from experience to be harmful. It takes the form of advice to battery manufacturers, distributors and users, and to equipment designers.

Storage and stock rotation

For normal storage, the temperature should be between +10 °C and +25 °C and never exceed +30 °C. Extremes of humidity (over 95 % RH and below 40 % RH) for sustained periods should be avoided since they are detrimental to both batteries and packing. Batteries should therefore not be stored next to radiators or boilers nor in direct sunlight.

Although the storage life of batteries at room temperature is good, storage is improved at lower temperatures provided special precautions are taken. The batteries should be enclosed in special protective packing (such as sealed plastic bags or variants) which should be retained to protect them from condensation during the time they are warming to ambient temperature. Accelerated warming is harmful.

Batteries which have been cold-stored should be put into use as soon as possible after return to ambient temperature.

Batteries may be stored fitted in equipment or packages if determined suitable by the battery manufacturer.

The height to which batteries may be stacked is clearly dependent on the strength of the pack. As a general guide, this height should not exceed 1,5 m for cardboard packs or 3 m for wooden cases.

The above recommendations are equally valid for storage conditions during prolonged transit. Thus, batteries should be stored away from ship engines and not left for long periods in unventilated metal box cars (containers) during summer.

Batteries should be despatched promptly after manufacture and in rotation to distribution centres and on to the users. In order that stock rotation (first-in, first-out) can be practised, storage areas and displays should be properly designed and packs should be adequately marked.

Annex B
(informative)

Battery compartment guidelines

B.1 Guidance for appliance designers

It is recommended that companies producing battery-powered equipment should maintain close liaison with the battery industry. The capabilities of existing batteries should be taken into account at design inception. Whenever possible, the battery type selected should be one included in publication IEC 60086-2.

Design compartments so that batteries are easily inserted and do not fall out.

Design compartments to prevent easy access to the batteries by young children.

Consider the battery dimensions and tolerance when designing the battery compartment.

Clearly indicate the type of battery to use, the correct polarity alignment and directions for insertion.

Although batteries are very much improved regarding their resistance to leakage, it can still occur occasionally. When the battery compartment cannot be completely isolated from the equipment, it should be positioned so as to minimize possible damage.

B.2 Design of battery compartments

To overcome the problems associated with the reversed placement of a battery, consideration should be given at the design stage to ensure that batteries cannot be installed incorrectly or, if so installed, will not make electrical contact.

Some suggestions for the R03, R1, R6, R14 and R20 size battery compartments are illustrated in figures B.1 through B.3 below. Provision should also be made to prevent unnecessary movement of batteries within the battery compartment.

NOTE Battery contacts should be shielded to prevent short-circuiting.

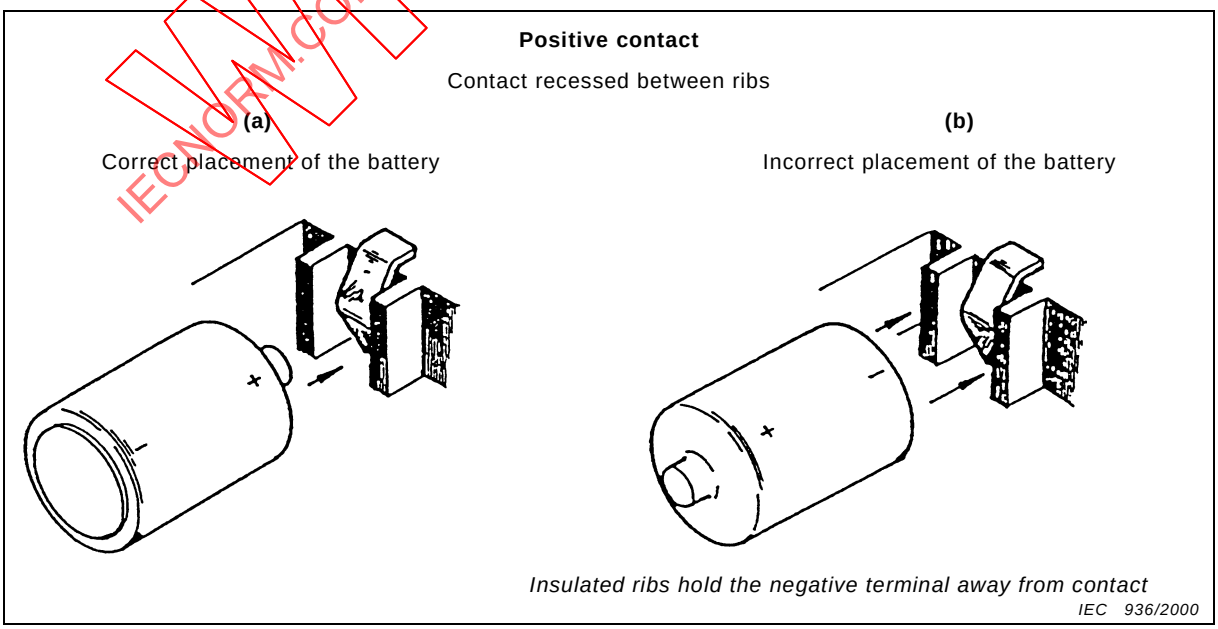


Figure B.1 – Positive contact recessed between ribs

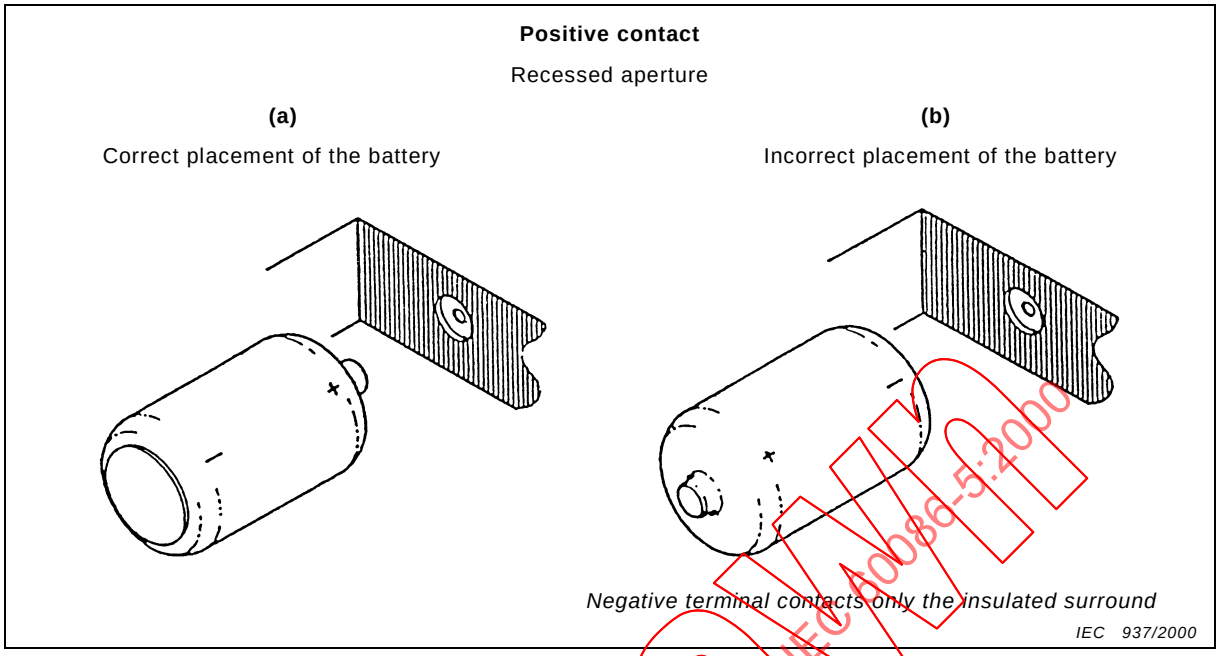


Figure B.2 – Positive contact is recessed

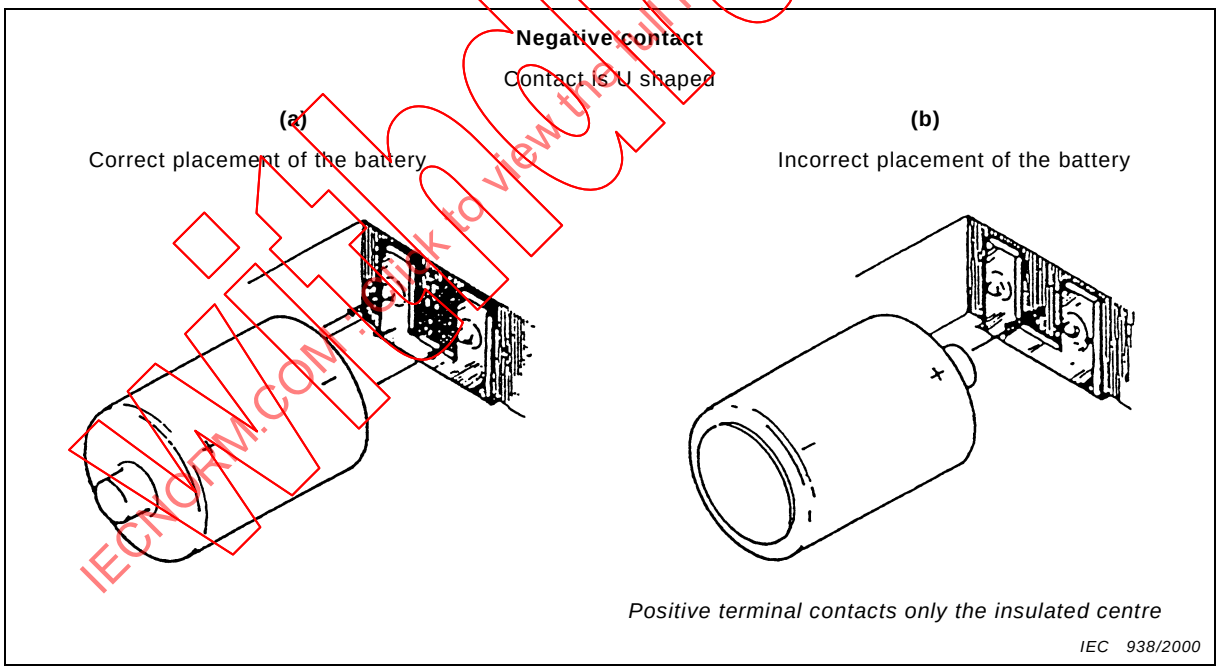


Figure B.3 – Negative contact which is shaped to avoid the positive terminal

It should be stressed that battery compartment dimensions should not be tied to dimensions and tolerances of a particular manufacturer as this can create problems if replacements of different origin are installed.

For dimensional details, particularly those related to the positive and negative terminals, reference should be made to figures 1A and 1B IEC 60086-1 and the relevant battery specification sheet contained in IEC 60086-2.

Only the battery terminals should physically contact the electric circuit.

Battery compartments should be electrically insulated from the electric circuit and positioned so as to minimize possible damage and/or risk of injury.

A lot of equipment is designed to operate with alternative power supplies (e.g. mains, additional batteries, etc.) and this is particularly relevant to primary battery memory back-up applications.

In these situations, the circuitry of the equipment should be so designed to either:

a) prevent charging of the primary battery, or

b) include primary battery protective devices, for example a diode, so that the charging (leakage) current from the protective device(s) to which the primary battery would be subjected, does not exceed that recommended by the battery manufacturer.

Any intended protective device circuit should be selected so as to be appropriate to the type and electrochemical system of the primary battery concerned and preferably not subject to single component failure. It is recommended that equipment designers obtain advice from the battery manufacturer concerning the primary battery memory back-up protection device circuit.

Failure to observe these precautions may lead to short service life, leakage or explosion.

Positive (+) and negative (–) battery contacts should be visibly different in form to avoid confusion when inserting batteries.

Select terminal contact materials with the lowest electrical resistance and compatible with battery contacts.

Battery compartments should be designed to allow the gas generated from batteries to escape.

The material of a battery compartment should be selected to avoid shock and environmental pollution.

Equipment designed to be powered by air-depolarized batteries of either the A or P system should provide for adequate air access.

For the A system, the battery should preferably be in an upright position during normal operation.

Parallel connections are not recommended since an incorrectly placed battery causes continuous discharge of the batteries.

To overcome the problem of reversed placement described above and with the end user in mind, consideration should be given to the arrangement in figure B.4 (a) and (b) that may be extended as indicated by arrows.