TECHNICAL REPORT

IEC 61955

First edition
1998-08

Primary batteries –

Summary of research and actions limiting risks to reversed installation of primary batteries

Piles –

Résumé des recherches et des mesures de limitation des risques dus à l'installation de piles avec polarité inversée

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* See web site address on title page.

TECHNICAL REPORT – TYPE 3

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRIMARY BATTERIES –

Summary of research and actions limiting risks to reversed installation of primary batteries

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.
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- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
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- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 61955, which is a technical report of type 3, has been prepared by technical committee 35: Primary cells and batteries.

The text of this technical report is based on the following documents:

Committee draft	Report on voting
35/1030/CDV	35/1045/RVC

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

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

PRIMARY BATTERIES –

Summary of research and actions limiting risks to reversed installation of primary batteries

1 Scope

This technical report provides information relevant to the safe design of batteries and battery powered devices together with appropriate cautionary advice to consumers. This report is primarily intended to be used by

- battery manufacturers;
- equipment manufacturers;
- designers;
- standard writers;
- consumer organizations;
- charger manufacturers.

This report may also be of assistance to

- educational authorities;
- users;
- procurement personnel;
- regulatory authorities.

2 Reference documents

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

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

IEC Guide 104:1997, *The preparation of safety publications and the use of basic safety publications and group safety publications*

ISO/IEC Guide 51:1990, *Guidelines for the inclusion of safety aspects in standards*

3 Background

Primary batteries have become more sophisticated in both chemistry and construction with both capacity and rate capability being increased to meet the ever-growing advances in battery-powered equipment technology. Resulting from these continuing developments and recognizing the need for safety, technical committee 35 investigated the common modes of failure resulting from consumer inadvertent misuse. Specific attention was given to researching solutions limiting risks due to reverse installation of batteries which is the most common mode of consumer misuse.

Statistical research:

- information coming from publicly available data relating to accidents involving batteries;
  industry-based statistics provided through trade associations;
- availability of independent statistics through the IEC Advisory Committee on Safety (ACOS).

Battery design considerations

- investigated mandatory design convergence;
- alternative design solutions including patent research;
- clarified information in existing documentation relating to terminal design.

Battery compartment design considerations

- published battery compartment design guidelines to limit the problems associated with the reverse placement of a battery in multi-cell (three or more) applications;
- promoted the safe positioning of compartments and foolproofing access.

Consumer information

promoted the safe handling of batteries by publishing a consumer information leaflet including cautionary advice.

4 General

4.1 Battery compartment guidelines

The battery compartment guidelines published in annex B of this report are intended to direct the attention of the device designer to integrate a number of important features which, according to battery industry resources, significantly reduce the hazards associated with battery abuse.

4.2 Clarification note to IEC 60086-1

In order to provide clear design options for both the device and battery designer, a note was added to IEC 60086-1, clause 5, which specifically draws attention to the existence of both a protruding and a recessed negative contact.

4.3 Consumer information

The consumer information contained in IEC 60086-1, clause 13, and published in this report provides clear and unambiguous advice which promotes the safe and proper use of batteries and also highlights the risks associated with abuse and/or misuse.

4.4 Concentricity of the positive terminal

In order to ensure that the position of the positive terminal facilitates polarization, concentricity limits were added to the dimensional specifications in IEC 60086-1, figures 1A and 1B.

4.5 IEC 60086-5* – Product safety standard for primary batteries

The IEC has already published a safety standard for lithium batteries and in the further pursuance of the needs for safety, technical committee 35 is currently preparing an international standard which incorporates all elements of safety pertinent to non-lithium primary batteries

* In preparation

5 Conclusion

The attention of the user/reader of this technical report is drawn to the fact that the requirements of IEC/ISO Guide 51 and IEC Guide 104 were met with respect to design principles and duty to warn. Specific references in this regard are found in:

Guide 51

Requirements for safety
Testing and verification
Information for safety
Warning notices
Marking
Instructions for use
Packaging

Guide 104

Annex C – Principle elements of the safety objectives for electrical equipment

Annex A
(informative)

Consumer information leaflet

The following consumer information is taken from IEC 60086-1, clause 13.

A.1 Guidelines for handling primary/non-rechargeable batteries and the design of battery compartments

A.1.1 User precautions for handling batteries

a) Follow equipment instructions carefully and use the recommended batteries.

b) Check the contacts of both equipment and batteries for cleanliness. If necessary, clean with a damp cloth and then dry. Insert batteries correctly with regard to polarity (+ and –).

c) Do not allow children to replace batteries without adult supervision. Keep small batteries out of the reach of children.

d) Never mix old and new, used and unused, or mix different battery types (for example different electrochemical systems, different grades or different brands).

e) Do not attempt to revive used batteries by heating, charging or other means.

f) Do not short-circuit batteries.

g) Do not heat batteries or throw batteries into fire.

h) Do not disassemble batteries.

i) Be sure to switch off the equipment after use.

j) Remove batteries from equipment if it is not to be used for an extended period of time.

k) Store batteries in a cool, dry place and out of direct sunlight.

l) Do not defreeze batteries (household freezer).

A.1.2 Design of equipment

A.1.2.1 Battery compartment

a) Consider the battery dimensions and tolerances found in IEC 60086-1 when designing the battery compartment.

NOTE – The design of the negative contact should make allowance for any recess of the battery terminal.

b) Clearly indicate the type of battery to be used, the correct polarity alignment and directions for insertion.

c) Use shape and/or dimension of positive (+) and negative (–) battery terminals in compartment designs to prevent the reverse connection of batteries. Positive (+) and negative (–) battery contacts should be visibly different in form to avoid confusion when inserting batteries.

d) Only the battery terminals should physically contact the electric circuit.

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

f) Battery and equipment terminals should be of compatible material and low electrical resistance.

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

h) Design compartments to prevent access by young children, i.e. those under three years of age.

i) Equipment designed to be powered by air depolarized batteries of either the A or P system shall provide for adequate air access. For the A system, the battery should preferably be in an upright position during normal operation. For P system batteries conforming to figure 4 of IEC 60086-1, positive electrical contact should be made on the side of the battery so that air access is not impeded.

j) Batteries should be series connected and not parallel connected. Align batteries as shown in figure A.1 below:

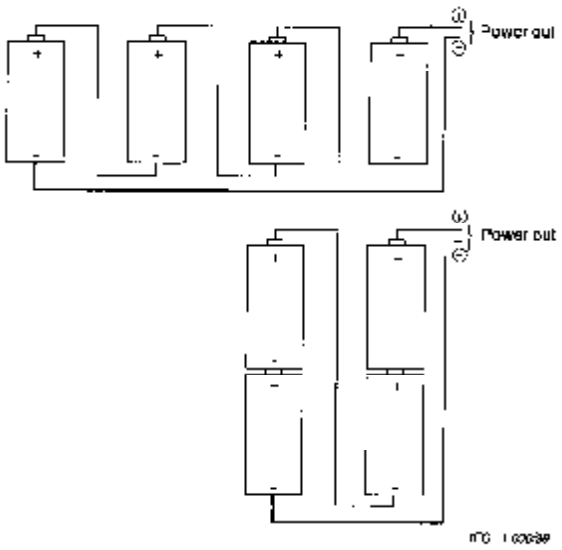

Figure A.1 – Preferred battery arrangement inside a device

k) Avoid encapsulation or potting of batteries.

l) Design compartments with high resistance to battery electrolyte leakage.

m) For waterproof and non-vented devices, it is important that hydrogen gas generated by the batteries during use is either adsorbed or allowed to escape from the battery compartment. Otherwise, a rise in temperature or a spark could ignite the entrapped hydrogen/air mixture. The advice of the battery manufacturer should be sought at the design stage of such applications.

A.1.2.2 Equipment using alternative power sources

a) Design equipment so that primary batteries will not be charged.

b) Provide protective devices to ensure battery isolation from alternative power sources and safety from accidental battery charging.

A.1.3 Transportation, display and storage

a) Do not stack battery cartons beyond the recommended limit.

b) Store cartons containing batteries in a clean, cool, dry, and ventilated area.

c) Do not expose batteries to direct sunlight.

d) Do not expose batteries to wet conditions.

e) Rotate battery stock (first in, first out).

Annex B
(informative)

Battery compartment guidelines

The following design information is taken from IEC 60086-1, 9.2.2.

B.1 Battery compartment guidelines

B.1.1 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 and 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.

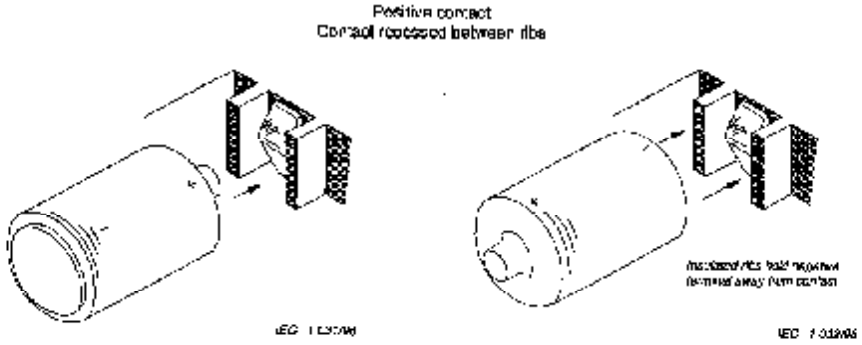

Figure B.1a – Correct placement of the battery

Figure B.1b – Incorrect placement of the battery

Figure B.1 – Positive contact is recessed between ribs

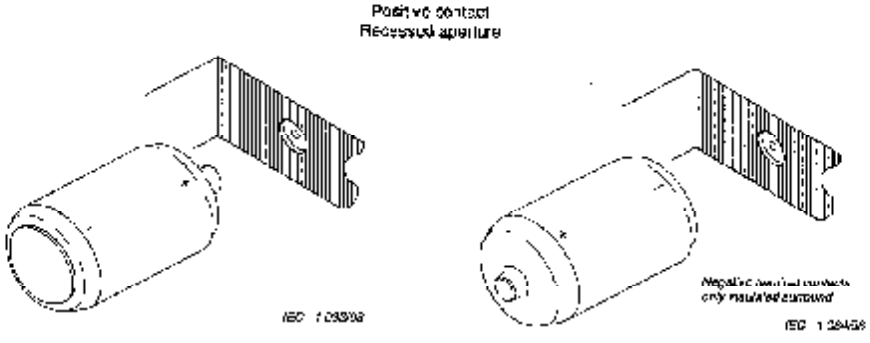

Figure B.2a – Correct placement of the battery

Figure B.2b – Incorrect placement of the battery

Figure B.2 – Positive contact is recessed

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

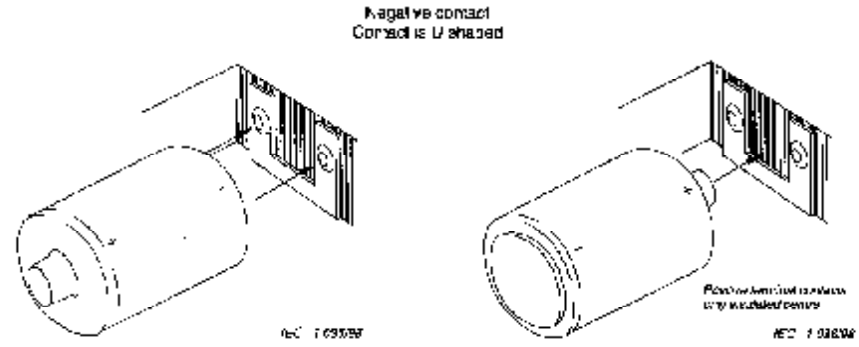

Figure B.3a – Correct placement of the battery

Figure B.3b – Incorrect placement of the battery

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

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

NOTE – This item can be recessed (dimension E of the relevant specification).

Consideration should be given to the position of the batteries within the compartment. For example, even if the battery contacts at the end of the typical series assembly in figure B.4 are designed as shown in figures B.1 to B.3, the reversed placement of either centrally located battery will result in that battery being charged (with the switch closed) at a current limited by the external load.

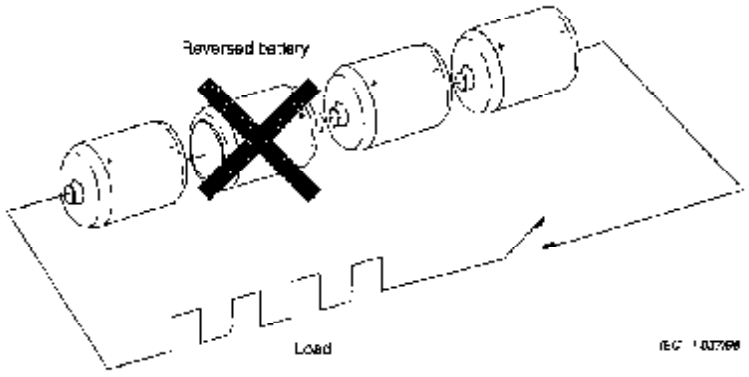

Figure B.4 – Example of series connection with one battery reversed

B.1.2 Recommended battery orientation (series assemblies)

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.5 (a) and (b) that may be extended as indicated by arrows.

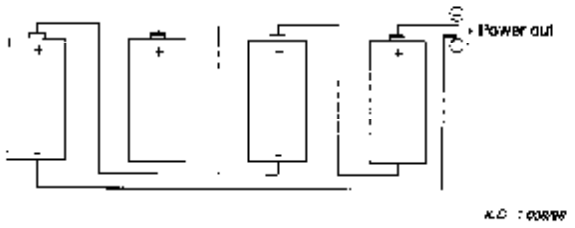

Figure B.5a – Protection of positive contact only required as shown in figures B.1 or B.2

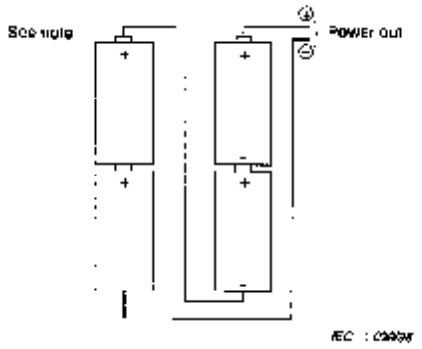

Figure B.5b – Protection of positive and negative contact required as shown in figures B.1 or B.2 and B.3

Note – This arrangement is considered acceptable only for R14 and R20 size batteries due to the small negative terminal area (dimension C of the relevant specification) of the other sizes.

Figure B.5 – Preferred battery arrangements inside a device

B.1.3 Caution

1) Waterproof and non-vented devices

It is important that hydrogen gas generated by the batteries during use is either adsorbed or allowed to escape from the battery compartment, otherwise a rise in temperature or a spark could ignite the entrapped hydrogen/air mixture. The advice of the battery manufacturer should be sought at the design stage of such applications.

2) Metal jacketed and plastic labelled batteries

In order to avoid the possibility of short circuits it is essential that no part of the equipment circuitry (including conductive rivets or screws used to secure the battery contacts, etc.) is allowed to contact the battery case/jacket.

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17

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