# 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* 



Reference number IEC 61955:1998(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.

#### Validity of this publication

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology.

Information relating to the date of the reconfirmation of the publication is available in the IEC catalogue.

Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is to be found at the following IEC sources:

- IEC web site\*
- Catalogue of IEC publications Published yearly with regular updates (On-line catalogue)\*
- IEC Bulletin Available both at the IEC web site\* and as a printed periodical

#### 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.

# TECHNICAL REPORT – TYPE 3

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* 

© IEC 1998 — Copyright - all rights reserved

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 the publisher.

International Electrotechnical Commission Telefax: +41 22 919 0300 e

sion 3, e-mail: inmail@iec.ch

3, rue de Varembé Geneva, Switzerland ch IEC web site http://www.iec.ch



Commission Electrotechnique Internationale International Electrotechnical Commission Международная Электротехническая Комиссия

PRICE CODE

For price, see current catalogue

### CONTENTS

– 2 –

		Page						
FO	FOREWORD							
Clause								
1	Scope	4						
2	Reference documents							
3	Background							
4	General							
	4.1 Battery compartment guidelines	5						
	4.2 Clarification note to IEC 60086-1							
	4.3 Consumer information							
	4.4 Concentricity of the positive terminal							
	4.5 IEC 60086-5 – Product safety standard for primary batteries	5						
5	Conclusion	6						
Annex A (informative) Consumer information leaflet								
Annex B (informative) Battery compartment guidelines								

#### 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.
- 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 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.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 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.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but no immediate possibility of an agreement on an International Standard;
- 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<sup>\*</sup> – 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.

<sup>\*</sup> 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.
- I) 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.

- 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.
- I) 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.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.



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.

LICENSED TO MECON Limited. - RANCHI/BANGALORE FOR INTERNAL USE AT THIS LOCATION ONLY, SUPPLIED BY BOOK SUPPLY BUREAU.



We at the IEC want to know how our standards are used once they are published.

The answers to this survey will help us to improve IEC standards and standard related information to meet your future needs

Would you please take a minute to answer the survey on the other side and mail or fax to:

Customer Service Centre (CSC)

International Electrotechnical Commission 3, rue de Varembé Case postale 131

1211 Geneva 20 Switzerland

or

Fax to: CSC at +41 22 919 03 00

Thank you for your contribution to the standards making process.



Customer Service Centre (CSC) International Electrotechnical Commission 3, rue de Varembé Case postale 131 1211 GENEVA 20 Switzerland

1.		7.		13.	
No. of IEC standard:		Please rate the standard in the following areas as (1) bad, (2) below average, (3) average, (4) above average,		If you said yes to 12 then how many volumes:	
		(5) e	exceptional, (0) not applicable:		
2.			clearly written	14.	
Tell	us why you have the standard.		logically arranged	Whi	ch standards organizations
(che	eck as many as apply). I am:		information given by tables	pub	lished the standards in your
	the buyer		illustrations	libra	ary (e.g. ISO, DIN, ANSI, BSI,
	the user		technical information	etc.	).
	a librarian	8.			
	a researcher	Lwo	uld like to know how I can legally	15	
	an engineer	repr	oduce this standard for:	15. Mu	organization supports the
	a safety expert		internal use	star	idards-making process (check as
	involved in testing		sales information	mar	ny as apply):
	with a government agency		product demonstration		huving standards
	in industry		other		
	other	0			
		э. Ір. ш	hat madium of standard dass your		organization
3. This standard was purchased from?		orga stan	organization maintain most of its standards (check one):		serving on standards development committee
			paper		other
			microfilm/microfiche	16	
			mag tapes	Mv.	organization uses (check one)
4.			CD-ROM	iviy	
I his (che	standard will be used		floppy disk		French text only
	for reference		on line		English text only
	in a standards library				Both English/French text
		9A.		17.	
	to develop a new product	part	If your organization currently maintains part or all of its standards collection in electronic media, please indicate the		er comments:
	to write specifications	elec			
	to use in a tender	form	at(s):		
	for educational purposes		raster image		
	for a lawsuit		full text		
	for quality assessment	10.			
	for certification	In w	In what medium does your organization		
	for general information	inter	nd to maintain its standards collection		
	for design purposes		naner		
	for testing		microfilm/microfiche		
	other				
5.				18.	
This	standard will be used in conjunction		tioppy disk	Plea	ase give us information about you
			on line	anu	your company
		10A		nam	ie:
		For	electronic media which format will be		
	corporate	cnos		job	title:
	other (published by)		raster image	com	ipany:
	other (published by)		tull text	2011	
	other (published by)	11.		add	ress:
6.		My o	My organization is in the following sector		
This standard meets my needs		(e.g	(e.g. engineering, manufacturing)		
(check one)					
	not at all	12.			
	almost	Doe	s your organization have a standards		
_			·		

yes

no LICENSED TO MECON Limited. - RANCHI/BANGALORE FOR INTERNAL USE AT THIS LOCATION ONLY, SUPPLIED BY BOOK SUPPLY BUREAU.

No. employees at your location:.....

turnover/sales:.....

- $\Box$ almost
- fairly well
- exactly

LICENSED TO MECON Limited. - RANCHI/BANGALORE FOR INTERNAL USE AT THIS LOCATION ONLY, SUPPLIED BY BOOK SUPPLY BUREAU.



ICS 29.220.10