



SLOVENSKI STANDARD
oSIST prEN IEC 60086-4:2024
01-maj-2024

Primarne baterije - 4. del: Varnostni standard za litijeve baterije

Primary batteries - Part 4: Safety of lithium batteries

Primärbatterien - Teil 4: Sicherheit von Lithium-Batterien

Piles électriques - Partie 4: Sécurité des piles au lithium

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<input checked="" type="checkbox"/> SUBMITTED FOR CENELEC PARALLEL VOTING Attention IEC-CENELEC parallel voting The attention of IEC National Committees, members of CENELEC, is drawn to the fact that this Committee Draft for Vote (CDV) is submitted for parallel voting. The CENELEC members are invited to vote through the CENELEC online voting system.	<input type="checkbox"/> NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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TITLE:

Primary batteries - Part 4: Safety of lithium batteries

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRIMARY BATTERIES –

Part 4: Safety of lithium batteries

FOREWORD

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International Standard IEC 60086-4 has been prepared by technical committee 35: Primary cells and batteries.

This sixth edition cancels and replaces the fifth edition published in 2019. This edition constitutes a technical revision.

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

- a) Added definitions for leakage and venting, in addition to the test criteria;
- b) Revised overdischarge test;
- c) Revised marking requirements;
- d) Revised criteria for the child resistant packaging test;

- 54 e) Changed the purpose of Annex F from “informative” to “normative”
- 55 f) Added a new annex with additional measures against misuse of batteries not intended
56 for consumer replacement;
- 57 g) Integrated the contents of Interpretation Sheet 1 (IEC 60086-4:2019/ISH1:2020);
- 58 h) In Clause 3, terms were reordered according their functions: basic terms,
59 electrochemical systems, battery shapes, battery sizes, electrical characteristics,
60 specifications, safety aspects, failure modes.
- 61 i) In 6.4.4, the exemption for the shock acceleration for lithium primary batteries was
62 reduced from 12 kg to 4,482 kg in order to reflect the fact that this is the threshold in
63 IEC 62281, Test T-4, where the peak acceleration decreases below 150 g_n .

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

FDIS	Report on voting
35/xxx/FDIS	35/xxx/RVD

65
66 Full information on the voting for the approval of this standard can be found in the report on
67 voting indicated in the above table.

68 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

69 NOTE The following print types are used:

- 70 – instructions/warnings for consumers: *in italic type*.

71 A list of all parts in the IEC 60086 series, under the general title *Primary batteries*, can be
72 found on the IEC website.

73 The committee has decided that the contents of this publication will remain unchanged until
74 the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data
75 related to the specific publication. At this date, the publication will be

- 76 • reconfirmed,
- 77 • withdrawn,
- 78 • replaced by a revised edition, or
- 79 • amended.

80 NOTE The attention of National Committees is drawn to the fact that equipment manufacturers and testing
81 organizations may need a transitional period following publication of a new, amended or revised IEC document in
82 which to make products in accordance with the new requirements and to equip themselves for conducting new or
83 revised tests. It is the recommendation of the committee that the content of this document be adopted for
84 implementation nationally not earlier than 2 years from the date of publication. The transitional period applies
85 specifically to Table 10. In the meantime, the previous edition can still be ordered by contacting your local IEC
86 member National Committee or the IEC Secretariat.

87

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 document using a colour printer.

88

89

90

INTRODUCTION

91 The concept of safety is closely related to safeguarding the integrity of people and property.
92 This document specifies tests and requirements for lithium batteries and has been prepared in
93 accordance with ISO/IEC guidelines, taking into account all relevant national and international
94 standards which apply.

95 Lithium batteries are different from conventional primary batteries using aqueous electrolyte
96 in that they contain flammable materials.

97 Consequently, it is important to carefully consider safety during design, production,
98 distribution, use, and disposal of lithium batteries. Based on such special characteristics,
99 lithium batteries for consumer applications were initially small in size and had low power
100 output. There were also lithium batteries with high power output which were used for special
101 industrial and military applications and were characterized as being “technician replaceable”.
102 The first edition of this document was drafted to accommodate this situation.

103 However, from around the end of the 1980s, lithium batteries with high power output started to
104 be widely used in the consumer replacement market, mainly as a power source in camera
105 applications. Since the demand for such lithium batteries with high power output significantly
106 increased, various manufacturers started to produce these types of lithium batteries. As a
107 consequence of this situation, the safety aspects for lithium batteries with high power output
108 were included in the second edition of this document.

109 Primary lithium batteries both for consumer and industrial applications are well-established
110 safe and reliable products in the market, which is at least partly due to the existence of safety
111 standards such as this document and, for transport, IEC 62281. The fourth edition of this
112 document reflected minor changes which became necessary in order to keep it harmonized
113 with IEC 62281 and to continuously improve the user information about safety related matters.

114 Guidelines addressing safety issues during the design of lithium batteries are provided in
115 Annex A. Annex B provides guidelines addressing safety issues during the design of
116 equipment where lithium batteries are installed. Both Annex A and B reflect experience with
117 lithium batteries used in camera applications and are based on [22]¹.

118 The ingestion hazard of coin cell batteries has become an issue and was addressed in the
119 fifth and sixth editions of this document by several independent measures such as the
120 development of a new safety sign “KEEP OUT OF REACH OF CHILDREN” as well as the
121 introduction of child resistant packaging.

122 A new Annex H addresses measures against misuse of cells and batteries not intended for
123 consumer replacement.

124 Safety is freedom from unacceptable risk. There can be no absolute safety: some risk will
125 remain. Therefore a product, process or service can only be relatively safe. Safety is achieved
126 by reducing risk to a tolerable level determined by the search for an optimal balance between
127 the ideal of absolute safety and the demands to be met by a product, process or service, and
128 factors such as benefit to the user, suitability for purpose, cost effectiveness, and conventions
129 of the society concerned.

130 As safety will pose different problems, it is impossible to provide a set of precise provisions
131 and recommendations that will apply in every case. However, this document, when followed
132 on a judicious “use when applicable” basis, will provide reasonably consistent standards for
133 safety.

134

¹ Numbers in square brackets refer to the bibliography.

PRIMARY BATTERIES –

Part 4: Safety of lithium batteries

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141 **1 Scope**

142 This part of IEC 60086 specifies tests and requirements for primary lithium batteries to ensure
143 their safe operation under intended use and reasonably foreseeable misuse.

144 NOTE Primary lithium batteries that are standardized in IEC 60086-2 are expected to meet all applicable
145 requirements herein. It is understood that consideration of this part of IEC 60086 might also be given to measuring
146 and/or ensuring the safety of non-standardized primary lithium batteries. In either case, no claim or warranty is
147 made that compliance or non-compliance with this part of IEC 60086 will fulfil or not fulfil any of the user's
148 particular purposes or needs.

149 **2 Normative references**

150 The following documents are referred to in the text in such a way that some or all of their
151 content constitutes requirements of this document. For dated references, only the edition
152 cited applies. For undated references, the latest edition of the referenced document (including
153 any amendments) applies.

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

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

156 IEC 62281, *Safety of primary and secondary lithium cells and batteries during transport*

157 **3 Terms and definitions**

oSIST prEN IEC 60086-4:2024

158 For the purposes of this document, the following terms and definitions apply. <https://standards.itec.ai/> <https://standards.itec.ai/standards/osist-pr-en-iec-60086-4-2024>

159 ISO and IEC maintain terminological databases for use in standardization at the following
160 addresses:

- 161 • IEC Electropedia: available at <http://www.electropedia.org/>
- 162 • ISO Online browsing platform: available at <http://www.iso.org/obp>

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

165 **3.1** 166 **cell**

167 basic functional unit, consisting of an assembly of electrodes, electrolyte, container, terminals
168 and usually separators, that is a source of electric energy obtained by direct conversion of
169 chemical energy

170 [SOURCE: IEC 60050-482:2004, 482-01-01]

171 **3.2** 172 **battery**

173 one or more cells electrically connected and fitted in a case, with terminals, markings and
174 protective devices etc., as necessary for use

175 [SOURCE: IEC 60050-482:2004, 482-01-04, modified ("fitted with devices necessary for use,
176 for example case" replaced by "electrically connected and fitted in a case", addition of "etc.,
177 as necessary for use")]

178 **3.3**
179 **component cell**
180 cell contained in a battery

181 **3.4**
182 **lithium cell**
183 cell containing a non-aqueous electrolyte and a negative electrode of lithium or containing
184 lithium

185 [SOURCE: IEC 60050-482:2004 482-01-06, modified (removal of NOTE)]

186 **3.5**
187 **coin cell**
188 **coin battery**
189 **lithium button cell**
190 **lithium button battery**
191 small round cell or battery where the overall height is less than the diameter, containing non-
192 aqueous electrolyte.

193 Note 1 to entry: The nominal voltage of lithium batteries is typically greater than 2 V.

194 [SOURCE: IEC 60050-482:2004 482-02-40, modified (terms modified, NOTE "In practice
195 terms, the term coin is used exclusively for non-aqueous lithium cells." replaced with a
196 different note)]

197 **3.6**
198 **cylindrical cell**
199 **cylindrical battery**
200 round cell or battery in which the overall height is equal to or greater than the diameter

201 [SOURCE: IEC 60050-482:2004, 482-02-39, modified ("cell with a cylindrical shape" replaced
202 by "round cell or battery")]

203 **3.7**
204 **prismatic cell**
205 **prismatic battery**
206 qualifies a cell or a battery having the shape of a parallelepiped whose faces are rectangular

207 [SOURCE: IEC 60050-482:2004, 482-02-38]

208 **3.8**
209 **large cell**
210 cell with a gross mass of more than 500 g

211 **3.9**
212 **large battery**
213 battery with a gross mass of more than 12 kg

214 **3.10**
215 **nominal voltage**
216 suitable approximate value of the voltage used to designate or identify a cell, a battery or an
217 electrochemical system

218 [SOURCE: IEC 60050-482:2004, 482-03-31]

219 **3.11**

220 **open circuit voltage**

221 OCV, U_{OC} , off-load voltage

222 voltage across the terminals of a cell or battery when no external current is flowing

223 [SOURCE: IEC 60050-482:2004, 482-03-32, modified (alternative terms “OCV, U_{OC} , off-load
224 voltage” added, “across the terminals” added, “when the discharge current is zero” replaced
225 with “when no external current is flowing”)]

226 **3.12**

227 **rated capacity**

228 capacity value of a cell or battery determined under specified conditions and declared by the
229 manufacturer

230 [SOURCE: IEC 60050-482:2004, 482-03-15, modified (“cell or” added)]

231 **3.13**

232 **depth of discharge**

233 DOD

234 percentage of rated capacity discharged from a cell or battery

235 **3.14**

236 **undischarged**

237 state of a primary cell or battery at 0 % depth of discharge

238 **3.15**

239 **fully discharged**

240 state of a cell or battery at 100 % depth of discharge

241 **3.16**

242 **harm**

243 injury or damage to the health of people, or damage to property or the environment

244 [SOURCE: ISO/IEC Guide 51:2014, 3.1]

245 **3.17**

246 **hazard**

247 potential source of harm

248 [SOURCE: ISO/IEC Guide 51:2014, 3.2]

249 **3.18**

250 **risk**

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

252 [SOURCE: ISO/IEC Guide 51:2014, 3.9, modified (removal of NOTE)]

253 **3.19**

254 **safety**

255 freedom from risk which is not tolerable

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

3.20**intended use**

use in accordance with information provided with a product or system, or, in the absence of such information, by generally understood patterns of usage

[SOURCE: ISO/IEC Guide 51:2014, 3.6]

3.21**reasonably foreseeable misuse**

use of a product, process or system in a way not intended by the supplier, but which may result from readily predictable human behaviour

[SOURCE: ISO/IEC Guide 51:2014, 3.7, modified (removal of NOTES)]

3.22**protective devices**

devices such as fuses, diodes or other electric or electronic current limiters designed to interrupt the current flow, block the current flow in one direction or limit the current flow in an electrical circuit

3.23**leakage**

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

Note 1 to entry: Leakage in this sense should not be confused with the test evaluation criteria for leakage specified in Clause 6.

3.24**venting**

release of excessive internal pressure from a cell or battery in a manner intended by design

Note 1 to entry: Venting in this sense should not be confused with the test evaluation criteria for venting specified in Clause 6.

4 Requirements for safety**4.1 Design**

Lithium batteries are categorized by their chemical composition (anode, cathode, electrolyte), internal construction (bobbin, spiral) and are available in cylindrical, coin and prismatic configurations. It is necessary to consider all relevant safety aspects at the battery design stage, recognizing the fact that they can differ considerably, depending on the specific lithium system, power capability and battery configuration.

The following design concepts for safety are common to all lithium batteries:

- a) Abnormal temperature rise above the critical value defined by the manufacturer shall be prevented by design.
- b) Temperature increases in the battery shall be controlled by a design which limits current flow.
- c) Lithium cells and batteries shall be designed to relieve excessive internal pressure or to preclude a violent rupture under conditions of transport, intended use and reasonably foreseeable misuse.

If, in particular cases, this design concept cannot be implemented, the organisational requirements described in Annex G shall apply.

See Annex A for guidelines for the achievement of safety of lithium batteries.

300 4.2 Quality plan

301 The manufacturer shall prepare and implement a quality plan defining the procedures for the
302 inspection of materials, components, cells and batteries during the course of manufacture, to
303 be applied to the total process of producing a specific type of battery. Manufacturers should
304 understand their process capabilities and should institute the necessary process controls as
305 they relate to product safety.

306 5 Type testing and sampling

307 5.1 Validity of Testing

308 Lithium cells or batteries shall be subjected to the tests, as required in this document. Testing
309 remains valid until a design change or requirement revision has been made. Retesting is
310 required when:

- 311 a) a battery specification changes by more than 0,1 g or 20 % mass, whichever is greater,
312 for the cathode, anode or electrolyte;
- 313 b) a battery specification change would lead to a failure of any of the tests;
- 314 c) there is an addition of new tests or requirements; or
- 315 d) there is a requirement change that would lead to a failure of any of the tests.

316 5.2 Test samples

317 Samples should be drawn from production lots in accordance with accepted statistical
318 methods. The number of test samples is given in Table 1. The same test cells and batteries
319 are used for tests A to E in sequence. New test cells and batteries are required for each of
320 tests F to M.

321 **Table 1 – Number of test samples**

Tests	Discharge state		Cells or single cell batteries ^a	Multi-cell batteries
Tests A to E	Undischarged		10	4
	Fully discharged		10	4
Test F or G	Undischarged		5	5 component cells
	Fully discharged		5	5 component cells
Test H	Fully discharged		10	10 component cells
Tests I to K	Undischarged		5	5
Test L	Undischarged		20 ^b	n/a
Test M	50 % predischarged	CR	10 ^c	n/a
	Fully discharged	CR	10 ^d	n/a
	50 % predischarged	FR	20 ^e	n/a
	Fully discharged	FR	20 ^f	n/a
^a Single cell batteries containing one tested component cell do not require re-testing unless the change could result in a failure of any of the tests.				
^b Four batteries connected in series with one of the four batteries reversed (5 sets).				
^c Two CR-type batteries connected in series, one of which is 50 % predischarged (5 sets). Undischarged cells shall be sampled from the same production lot.				
^d Two CR-type batteries connected in series, one of which is fully discharged (5 sets). Undischarged cells shall be sampled from the same production lot.				
^e Four FR-type batteries connected in series, one of which is 50 % predischarged (5 sets). Undischarged cells shall be sampled from the same production lot.				