BS EN 60623:2017

BSI Standards Publication

Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells

bsi.

National foreword

This British Standard is the UK implementation of EN 60623:2017. It is identical to IEC 60623:2017. It supersedes BS EN 60623:2001, which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee PEL/21, Secondary cells and batteries, to Subcommittee PEL/21/1, Secondary cells and batteries containing alkaline and other non-acidic electrolytes.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2017

ISBN 978 0 580 84739 4

ICS 29.220.99

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2017.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60623

May 2017

ICS 29.220.99

Supersedes EN 60623:2001

English Version

Secondary cells and batteries containing alkaline or other non-acid electrolytes - Vented nickel-cadmium prismatic rechargeable single cells (IEC 60623:2017)

Accumulateurs alcalins et autres accumulateurs à électrolyte non acide - Eléments individuels parallélépipédiques rechargeables ouverts au nickel-cadmium
(IEC 60623:2017)

Akkumulatoren und Batterien mit alkalischen oder anderen nicht-säurehaltigen Elektrolyten - Geschlossene prismatische wiederaufladbare Nickel-Cadmium-Einzelzellen
(IEC 60623:2017)

This European Standard was approved by CENELEC on 2017-02-27. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

European foreword

The text of document 21A/610/FDIS, future edition 5 of IEC 60623, prepared by SC 21A, Secondary cells and batteries containing alkaline or other non-acid electrolytes, of IEC/TC 21 "Secondary cells and batteries" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60623:2017.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2017-11-27
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2020-02-27

This document supersedes EN 60623:2001.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60623:2017 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60051 (series)	NOTE	Harmonized as EN 60051 (series).
IEC 61434	NOTE	Harmonized as EN 61434.

Annex ZA
(normative)
Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60050-482	2004	International Electrotechnical Vocabulary (IEV) -- Part 482: Primary and secondary cells and batteries	-	-
IEC 60417	-	Graphical symbols for use on equipment. Index, survey and compilation of the single sheets.	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – VENTED NICKEL-CADMIUM PRISMATIC RECHARGEABLE SINGLE CELLS

FOREWORD

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International Standard IEC 60623 has been prepared by subcommittee 21A: Secondary cells and batteries containing alkaline or other non-acid electrolytes, of IEC technical committee 21: Secondary cells and batteries.

This fifth edition cancels and replaces the fourth edition published in 2001 and constitutes a technical revision.

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

– optional characterization of cells designed for performances at very low and/or very high temperature;
– optional characterization of cells tested with CCCV charge;
– optional characterization of cells designed for rapid charge;
– optional characterization of cells designed for high cycling.

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

FDIS	Report on voting
21A/610/FDIS	21A/621/RVD

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

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

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – VENTED NICKEL-CADMIUM PRISMATIC RECHARGEABLE SINGLE CELLS

1 Scope

IEC 60623 specifies marking, designation, dimensions, tests and requirements for vented nickel-cadmium prismatic secondary single cells.

NOTE In this context, "prismatic" refers to cells having rectangular sides and base.

When there exists an IEC standard specifying test conditions and requirements for cells used in special applications and which is in conflict with this document, the former takes precedence.

2 Normative references

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

IEC 60050-482:2004, *International Electrotechnical Vocabulary – Part 482: Primary and secondary cells and batteries*

IEC 60417, *Graphical symbols for use on equipment* (available from: *http://www.graphical-symbols.info/equipment*)

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-482 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
vented cell
secondary cell having a cover provided with an opening through which products of electrolysis and evaporation are allowed to escape freely from the cell to the atmosphere

Note 1 to entry: The opening may be fitted with a venting system.

3.2
nominal voltage
suitable approximate value of the voltage used to designate or identify a cell or a battery

Note 1 to entry: The nominal voltage of a vented nickel-cadmium rechargeable single cell is 1,2 V.

Note 2 to entry: The nominal voltage of a battery of n series connected cells is equal to n times the nominal voltage of a single cell.

[SOURCE: IEC 60050-482:2004, 482-03-31, modified – Replacement of the words "a battery or an electrochemincal system" by" "or a battery" and addition of Notes 1 and 2 to entry.]

3.3
discharge voltage
closed circuit voltage
DEPRECATED: on load voltage
<cell or battery> voltage between the terminals of a cell or battery when being discharged

[SOURCE: IEC 60050-482:2004, 482-03-28]

3.4
rated capacity
capacity value of a cell or battery determined under specified conditions and declared by the manufacturer

Note 1 to entry: The rated capacity is the quantity of electricity C_5 Ah (ampere-hours) declared by the manufacturer which a single cell can deliver during a 5 h period when charging, storing and discharging under the conditions specified in 7.3.2.

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – Addition of the words "a cell or" in the definition, and of Note 1 to entry.]

3.5
CCCV charge
method of charge consisting in a charge at **C**onstant **C**urrent followed by a charge at **C**onstant **V**oltage

4 Parameter measurement tolerances

The overall accuracy of controlled or measured values, relative to the specified or actual values, shall be within these tolerances:

a) ±1 % for voltage;

b) ±1 % for current;

c) ±2 °C for temperature;

d) ±0,1 % for time;

e) ±1 % for capacity.

These tolerances comprise the combined accuracy of the measuring instruments, the measurement techniques used, and all other sources of error in the test procedure.

The details of the instrumentation used shall be provided in any report of results.

5 Designation and marking

5.1 Cell designation (mandatory)

Vented nickel-cadmium prismatic secondary single cells shall be designated by the letter "K" followed by a letter L, M, H or X which signifies:

– low rate of discharge (L);

– medium rate of discharge (M);

– high rate of discharge (H);

– very high rate of discharge (X).

NOTE 1 These types of cells are typically but not exclusively used for the following discharge rates:

– L up to 0,5 I_t A;

– M up to 3,5 I_t A;

– H up to 7,0 I_t A;

– X up to and above 7,0 I_t A.

NOTE 2 These currents are expressed as multiples of I_t A, where I_t A = C_5 Ah/1 h (see IEC 61434).

This group of two letters shall be followed by a group of figures indicative of the rated capacity of the cell in ampere-hours. Cells that have been tested at 20 °C and 5 °C but not at –18 °C shall carry an additional marking of T5: for example: KH 185 or KH 185 T5.

Cells in cases of plastic material shall be designated by the letter "P" after the figures: for example: KH 185 P.

5.2 Cell designation (optional)

The additional marking shall be added to the mandatory marking. When the marking would exceed the available space on the cell, this information may be omitted on the cell but shall be provided in the documentation corresponding to the cell and in the type test report.

If there is no mention concerning the marking for temperature, the cells shall have been tested at: –18 °C, 5 °C and 20 °C. Cells tested at other temperatures shall carry an additional marking of T followed by tested temperatures. In case the cell is characterized with both low and high temperature, they shall be indicated in increasing order with a solidus separating them: for example: KH 185 P T-35/+45.

Cells tested with CCCV charges shall carry the marking of CCCV: for example, KH 185 P CCCV.

Cells tested at rapid charge shall carry the marking R and the value of the tested rapid charge current, expressed in multiple of I_t A: for example, KH 185 P R1.

High grade cycling cells shall carry an additional marking C followed by the number of cycles: for example, KH 185 P C1500.

Cells having been tested with multiple types of tests shall carry the marking for the various tests performed: for example KH 185 P T-35/+45 CCCV R1 C1500.

5.3 Cell termination

This document does not specify cell termination.

5.4 Marking

Each cell or monobloc shall carry durable markings giving the following minimum information:

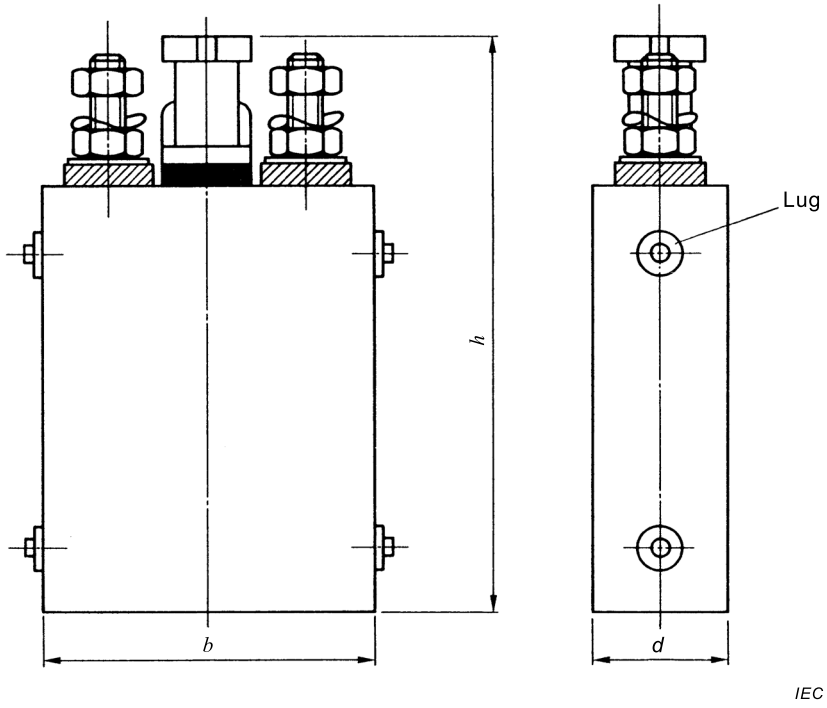
- type of cell (designation as specified in 5.1 and 5.2; in addition, it is permissible for a manufacturer to use his own type designation);
- name or identification of manufacturer or supplier;
- positive terminal: either a red washer or an indented or raised symbol (see graphical symbol IEC 60417-5005:2002-10).

5.5 Safety recommendations

The manufacturer shall provide recommendations for the safe handling of the cell. See also IEC TR 61438.

6 Dimensions

Dimensions of cells, shown in Figure 1, are given in Tables 1 and 2.



NOTE 1 Cells in steel container can have two or more terminals and four or more lugs.

NOTE 2 Cells in plastic container can have two or more terminals and no lugs.

Figure 1 – Example of a vented prismatic cell in steel container with two terminals and four lugs

Table 1 – Dimensions for vented nickel-cadmium prismatic cells in steel containers

Width, *b* mm	**Maximum height**, *h* mm	**Lengths**, *d* mm
81	291	83
105	350	91, 130
131	409	36, 50, 56, 66, 78, 94
148	409	52, 76, 100
157	409	66, 84, 95, 116, 134, 143, 147, 166, 200, 225, 242, 410
188	409	128

Table 2 – Dimensions for vented nickel-cadmium prismatic cells in plastic containers

Width, b mm	**Maximum height**, h mm	**Lengths**, d mm
62	178	28
78	285	50
81	241	28, 36, 43, 48
87	273	47, 86
123	273	28, 40, 50, 61
138	406	48, 55, 61, 70, 77, 85, 105, 115, 265
147	285	53, 78, 102
165	406	42, 66, 75, 105, 110, 130, 160
173	375	122, 197, 287, 392, 517
195	406	29, 34, 40, 50, 64, 80, 94, 115

NOTE 1 The dimensions given in Tables 1 and 2 represent preferred values. For cells with deviating size, dimensions as per Figure 1 are indicated.

NOTE 2 The widths relate to the overall width dimension of the cell excluding the thickness of the lug flanges. The values for widths and lengths given in Tables 1 and 2 are maximum values; their negative tolerances are given in Table 3.

NOTE 3 The values for height given in Tables 1 and 2 relate to the maximum height over the terminals or the closed cell vent, whichever is the greater. No lower limits are stated.

NOTE 4 The dimensions shown in Tables 1 and 2 are not associated to particular cell capacities. They apply to all kinds of vented nickel-cadmium prismatic cells, i.e. L, M, H and X types.

Table 3 – Measurement tolerances in millimetres (valid for widths and lengths)

Up to and including 60 mm	0 to –2
Above 60 mm, up to and including 120 mm	0 to –3
Above 120 mm	0 to –4

7 Electrical tests

7.1 General

Charge and discharge currents for the tests in accordance with 7.1 to 7.9 inclusive shall be based on the value of the rated capacity (C_5 Ah). These currents are expressed as multiples of I_t A, where I_t A = C_5 Ah/1 h.

7.2 Charging procedure for test purposes

7.2.1 General

Prior to charging, the cells shall have been discharged at 20 °C ± 5 °C, at a constant current of 0,2 I_t A, down to a final voltage of 1,0 V.

Two charging methods are possible, to be selected by the cell manufacturers, in order to define their cells characteristics:

– charge based on constant current;

– charge based on constant voltage, with a value of possible charging current (CCCV).

7.2.2 Charge procedure based on constant current

Unless otherwise specified in this standard, the charge preceding the various discharge tests scheduled, shall be carried out in an ambient temperature of 20 °C ± 5 °C and at a constant current of 0,2 I_t A. The duration of the charge shall be 7 h to 8 h.

7.2.3 Charge procedure based on constant voltage at a given current

This charge method is based on a constant current followed by constant voltage procedure (CCCV). The choice for the charge methodology for performance determination shall be defined before the start of the tests, and kept throughout all the testing procedures where indicated.

For such charging methodology, two parameters are adjustable: current and voltage. They shall be clearly identified by the cell manufacturer in the description of the cell characteristics, as well as in the cell marking: for example KH 185 P CCCV R1.

The charging methodology CCCV is described in Annex A.

7.2.4 Rapid charge current

The charging current value for performance determination shall be selected before the start of the tests, and kept throughout all the tests where indicated.

The design charge current value shall be indicated in the manufacturer's documentation attached to the cell (e.g. 0,5 I_t A or 1 I_t A) which will be referred to as R in this standard, as well as in the approval documentation. This current is a maximum value. Table 4 shows preferred values for the rapid charge current:

Table 4 – Maximum values for rapid charge current R

Charge current for CCCV	0,5 I_t A	1,0 I_t A	2,0 I_t A	3,0 I_t A

In case no rapid charge current is defined, it shall be taken at 0,2 I_t A. Otherwise, the rapid charge current rate selected shall be clearly indicated in the report of test.

7.3 Discharge performances

7.3.1 General

The following discharge tests shall be carried out in the sequence given.

All cells shall be tested at 20 °C as well as at +5 °C and/or –18 °C.

7.3.2 Discharge performance at 20 °C

7.3.2.1 Test method

The cell shall have been charged in accordance with 7.2.2. After charging, the cell shall be stored, in an ambient temperature of 20 °C ± 5 °C, for not less than 1 h and not more than 4 h.

It shall then be discharged in the same ambient temperature and as specified in Table 5.

7.3.2.2 Acceptance criteria

The duration of discharge shall be not less than the minimum specified in Table 5.

The 0,2 I_t A discharge test is performed in order to verify the declared rated capacity of the cell.

Table 5 – Discharge performance at 20 °C

Discharge conditions		Minimum discharge duration			
Rate of constant current	Final voltage	Cell designation			
A	V	L	M	H	X
0,2 I_t [a]	1,0	5 h	5 h	5 h	5 h
1,0 I_t	1,0	–	40 min	50 min	55 min
5,0 I_t [b]	0,8	–	–	4 min	7 min
10,0 I_t [b]	0,8	–	–	–	2 min

[a] Five cycles are permitted for this test which shall, however, be terminated at the end of the first cycle which meets the requirement.

[b] Before the 5 I_t A and the 10 I_t A discharge tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging and discharging at 0,2 I_t A in accordance with 7.2.1 and 7.2.2.

7.3.3 Discharge performance at +5 °C

7.3.3.1 Test method

The cell shall have been charged in accordance with 7.2.2. After charging, the cell shall be stored, in an ambient temperature of +5 °C ± 2 °C, for 24 h. Means shall be provided to ensure that the electrolyte temperature has reached +5 °C ± 2 °C within 24 h.

It shall then be discharged in the same ambient temperature and as specified in Table 6.

7.3.3.2 Acceptance criteria

The duration of discharge shall be not less than the minimum specified in Table 6.

Table 6 – Discharge performance at +5 °C

Discharge conditions		Minimum discharge duration			
Rate of constant current	Final voltage	Cell designation			
A	V	L	M	H	X
0,2 I_t	1,0	4 h 15 min	4 h 25 min	4 h 35 min	4 h 45 min
1,0 I_t	1,0	–	31 min	43 min	52 min
2,0 I_t [a]	1,0	–	–	12 min	22 min
5,0 I_t [a]	0,8	–	–	–	5 min 30 s

[a] Before the 2 I_t A and 5 I_t A tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging and discharging at 0,2 I_t A, in an ambient temperature of 20 °C ± 5 °C, according to 7.2.1and 7.2.2.

7.3.4 Discharge performance at –18 °C

7.3.4.1 Test method

The cell shall have been charged in accordance with 7.2.2. After charging, the cell shall be stored in an ambient temperature of –18 °C ± 2 °C, for 24 h. Means shall be provided to ensure that the electrolyte temperature has reached –18 °C ± 2 °C within 24 h.

It shall then be discharged in the same ambient temperature and as specified in Table 7.

7.3.4.2 Acceptance criteria

The duration of discharge shall be not less than the minimum specified in Table 7.

Table 7 – Discharge performance at –18 °C

Discharge conditions		Minimum discharge duration			
Rate of constant current	Final voltage	Cell designation			
A	V	L	M	H	X
0,2 I_t	1,0	2 h 30 min	3 h	3 h 30 min	4 h
1,0 I_t	0,9	–	15 min	25 min	35 min
2,0 I_t [a]	0,9	–	–	7 min 30 s	12 min
5,0 I_t [a]	0,8	–	–	–	3 min 30 s

[a] Before the 2 I_t A and 5 I_t A discharge tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging and discharging at 0,2 I_t A, in an ambient temperature of 20 °C ± 5 °C, according to 7.2.1 and 7.2.2.

7.3.5 Discharge performance at low temperature

7.3.5.1 General

This test is optional. This test is performed in order to identify the rated low temperature T_L and the level of performance of the cell at this temperature.

7.3.5.2 Test method

The temperature should be expressed at 5 °C intervals, such as –25 °C, –30 °C, –35 °C, –40 °C, referred to as T_L in the following. The test shall be done at the targeted low temperature T_L (no need for intermediate temperatures) to verify the discharge performance as specified in Table 8.

Table 8 – Discharge performance at low temperature

Discharge conditions		Minimum discharge duration			
Rate of constant current	Final voltage	Cell designation			
A	V	L	M	H	X
0,2 I_t	1	2 h 30 min	3 h	3 h	3 h
1,0 I_t	0,9	–	15 min	20 min	30 min
2,0 I_t	0,9	–	–	5 min	10 min
[a] Before the 1 I_t A and 2 I_t *A* discharge tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging and discharging at 0,2 I_t *A*, in an ambient temperature of 20 °C ± 5 °C, according to 7.2.1 and 7.2.2.					

Capacity shall be measured in accordance with the following steps.

Step 1 The cell shall be fully charged using the method in accordance with 7.2.2, 7.2.3 or 7.2.4 at 20 °C (whatever constant current or constant current followed by constant voltage).

Step 2 The cell shall be stored at an ambient temperature T_L for not less than 16 h and not more than 24 h

Step 3 The cell shall then be discharged at T_L and as specified in Table 8 to the corresponding final voltage.

7.3.5.3 Acceptance criteria

The capacity (Ah), delivered during step 3 shall be not less than specified for this characteristic at any discharge current. Then the cell low temperature discharge performance shall be declared as the T_L grade.

7.3.6 Discharge performance at high temperature

7.3.6.1 General

This test is optional. This test applies to cell designed for permanent operation at a temperature higher than +30 °C. This test is performed in order to identify the rated high temperature T_H, and the level of performance of the cell at this temperature.

7.3.6.2 Test method

The temperature should be expressed at 5 °C intervals, such as +30 °C, +35 °C, +40 °C, referred to as T_H in the following. The test shall be done at the targeted high temperature T_H (no need for intermediate temperatures) to verify the discharge performance as specified in Table 9.

Table 9 – Discharge performance at high temperature

Discharge conditions		Minimum discharge duration			
Rate of constant current	Final voltage	Cell designation			
A	V	L	M	H	X
0,2 I_t [a]	1,0	5 h	5 h	5 h	5 h
1,0 I_t	1,0	–	40 min	50 min	55 min
5,0 I_t [b]	0,8	–	–	4 min	7 min
10,0 I_t [b]	0,8	–	–	–	2 min

[a] Five cycles are permitted for this test (a conditioning cycle may be included between if necessary) which shall, however, be terminated at the end of the first cycle which meets the requirement.

[b] Before the 1 I_t A , 5 I_t A and the 10 I_t A discharge tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging and discharging at 0,2 I_t A in accordance with 7.2.1 and 7.2.2.

Capacity shall be measured in accordance with the following steps.

Step 1 The cell shall be fully charged using the method in accordance with 7.2.2, 7.2.3 or 7.2.4 at T_H (whatever CC or CCCV, in accordance with the cell designation).

Step 2 The cell shall be kept for not more than 4 h at an ambient temperature T_H. It is allowed to have the charger still connected in its normal function mode.

Step 3 The cell shall then be discharged at T_H and as specified in Table 9 to the corresponding final voltage.

7.3.6.3 Acceptance criteria

The capacity (Ah), delivered during step 3 shall be not less than specified for this characteristic at any discharge current. Then the cell high temperature discharge performance shall be declared as T_H grade.

7.3.7 High rate current test

7.3.7.1 General

This test is to evaluate the ability of a cell to withstand high currents.

7.3.7.2 Test method

The cell shall have been charged in accordance with 7.2.2. After charging, the cell shall be stored, in an ambient temperature of 20 °C ± 5 °C, for not less than 1 h and not more than 4 h. It shall then be discharged for 5 s in the same ambient temperature and at the currents given in Table 10. During the discharge, the terminal voltage shall be recorded.

Table 10 – High currents values

Cell type	Rate of constant current
L	6 I_t A
M	10 I_t A
H	15 I_t A
X	20 I_t A

7.3.7.3 Acceptance criteria

No fusing, no deformation of cell case, no deformation of internal cell components shall be observed. In addition, the cell voltage during the discharge should show no discontinuity.

7.4 Charge retention

The charge retention shall be verified by the following test.

After charging in accordance with 7.2.2, the cell shall be stored on open circuit for 28 days. The average ambient temperature shall be 20 °C ± 2 °C. The temperature may be allowed to vary within the range of 20 °C ± 5 °C for short periods during the storage.

The cell shall then be discharged under the conditions specified in 7.3.2 at a rate of 0,2 I_t A.

The duration of the discharge shall be not less than 4 h.

7.5 Endurance

7.5.1 Test conditions

The endurance test shall be carried out in an ambient temperature of 20 °C ± 5 °C. Precautions shall be taken to prevent the electrolyte temperature from rising above +40 °C during the test, for example by providing a forced air draught if necessary. The electrolyte may be topped up during the test with deionized or distilled water to the level recommended by the manufacturer. The electrolyte may be changed if at any time its characteristics no longer comply with the manufacturer's recommendation.

The cell shall be prepared in accordance with 7.2.2.

7.5.2 Endurance in cycles

7.5.2.1 Cycles 1 to 50

The cycling shall be carried out under the conditions specified in Table 11. Charge and discharge shall be carried out at constant current throughout. Cycling shall be continuous, except that it is permissible to allow the cell to stand for a short period at the end of discharge of each 49th and 50th cycle in order to start the next 50-cycle sequence at a convenient time.

Table 11 – Endurance in cycles

Cycle number	Charge	Discharge
1	0,25 I_t A for 6 h for CC charge Charge for R I_t A for 1/R h + 0,25 I_t A for 2 h [a]	0,25 I_t A for 2 h 30 min
2 to 48	0,25 I_t A for 3 h 30 min Charge for R I_t A for 0,6/R h + 0,25 I_t A for 1 h [a]	0,25 I_t A for 2 h 30 min
49	0,25 I_t A for 3 h 30 min Charge for R I_t A for 0,6/R h + 0,25 I_t A for 1 h [a]	0,2 I_t A to 1,0 V
50	0,2 I_t A for 7 h to 8 h	0,2 I_t A to 1,0 V
[a] For rapid charge cells, value for R is defined in 7.2.4.		

7.5.2.2 Acceptance criterion

Cycles 1 to 50 shall be repeated until the discharge duration on any 50th cycle becomes less than 3 h 30 min. At this stage, a further cycle shall be carried out in accordance with 7.3.2 at a rate of 0,2 I_t A.

The endurance test is considered complete when two such successive cycles give discharge duration less than 3 h 30 min.

The number of cycles obtained when the test is completed shall be not less than 500.

Some cells can be specifically designed in order to provide a higher number of cycles than 500.

As an option, such cell can be marked by "C" as "High grade cycling endurance cells" according to 5.2. The marking shall be less than the number of cycles obtained in this test. The number of cycles shall be truncated to the lowest multiple of 100 (e.g. 800, 1 500). It shall be indicated in the report of tests.

7.6 Charge acceptance at constant voltage

The cell shall have been discharged in accordance with 7.2.1.

The cell shall then be charged at a constant voltage as specified in Table 12 for cells having performances compliant with CC charge methodology (with a maximum charge duration of 24 h), or as specified in 7.2.3 for CCCV marked cells.

Table 12 – Constant voltage charging conditions

Cell type	Charge voltage V
KX	1,425 ± 0,005
KM and KH	1,455 ± 0,005
KL	1,495 ± 0,005

The charging current shall be limited to $R\ I_t$ A and the ambient temperature shall be 20 °C ± 5 °C. The duration of the charge shall be as described in Table 13.

Table 13 – Charge time

Charge current $R\ I_t$ A	Maximum charge time associated
0,05 I_t A	30 h
0,1 I_t A	24 h
0,2 I_t A	24 h
0,5 I_t A	12 h
1,0 I_t A	6 h
2,0 I_t A	6 h
3,0 I_t A	6 h

After charging, the cell shall be stored, in an ambient temperature of 20 °C ± 5 °C, for not less than 1 h and not more than 4 h. It shall then be discharged under the conditions specified in 7.3.2 at a rate of 0,2 I_t A.

The duration of discharge shall be not less than 4 h.

7.7 Vent plug operation

This document does not specify a vent plug operation test.

7.8 Electrolyte retention test

7.8.1 General

During charge, gases are generated within the cell, and electrolyte will be carried in a fine spray in this gas flow resulting in loss of electrolyte to the atmosphere. To prevent these losses, baffles are inserted within the cell or within the venting system that closes the cell. This test is to evaluate the ability of a cell to prevent electrolyte losses.

7.8.2 Test procedure

Prior to the test the electrolyte level shall have been adjusted to the maximum level according to the manufacturer's instructions. The cell shall be initially charged in accordance with 7.2.2 or 7.2.3.

The charge shall be continued, at a constant current of 0,05 I_t A, for 2 h. The gas coming out of the vent during the 2 h overcharge shall be collected into three collection bottles connected in series and filled with a solution of sulphuric acid of 1/200 mol/l. After the overcharge, the quantity of potassium hydroxide absorbed in the sulphuric acid solution shall be measured.

7.8.3 Acceptance criteria

There shall be no electrolyte overflow during the initial charge.

The total amount of entrained potassium hydroxide shall be not more than 0,05 mg/Ah overcharged.

7.9 Storage

The cells shall be prepared for storage according to the manufacturer's instructions. The cells shall then be stored for a period of 12 months in an average ambient temperature of 20 °C ± 5 °C and at a relative humidity of 65 % ± 20 %. During the storage period the ambient temperature shall not at any time fluctuate beyond the limits of 20 °C ± 10 °C.

After completion of the storage period, the cells shall be prepared for use according to the manufacturer's instructions. The cells are then subjected to the tests specified in 7.3.2 and shall meet all the requirements of that subclause.

8 Mechanical tests

Mechanical tests should be designed in relation to the intended application. This document does not therefore specify mechanical tests, which should be the subject of agreement between the customer and the manufacturer.

9 Physical appearance

Visual inspection shall be performed on cells. No cracking, damage or corrosion shall be apparent. Any deformation shall be within the tolerances of the dimensions specified in the manufacturer's drawings.

10 Conditions for approval and acceptance

10.1 Type approval

For type approval the sample sizes and sequence of tests given in Table 14 shall be used. The total number of cells required for type approval is 21. Cells used for the testing shall be new cells.

All cells shall be subjected to the tests in group A. Then they are divided randomly into four groups of five cells each, denominated B, C, D and E respectively. This allows one spare cell which permits a repeat test to cover any incident occurring outside the supplier's responsibility. Tests shall be carried out in sequence within each group of cells.

The number of defective cells tolerated per group, and in total, is given in Table 14. A cell is considered to be defective if it does not meet the requirements of all or part of the tests of a group.

Table 14 – Sequence of tests for type approval

Group	Sample size	Clause or subclause	Tests	Number of defective cells	
				Per group	In total
A	21	5.4	Marking	0	2
		6	Dimensions		
		7.3.2	Discharge at 20 °C		
B	5	7.3.3 and/or 7.3.4	Discharge at +5 °C and/or –18 °C HT / LT testing	1	
		7.3.5	Discharge performance at low temperature		
		7.3.6	Discharge performance at high temperature		
		7.3.7	High rate currents		
C	5	7.5.2	Endurance in cycles	1	
D	5	7.6	Charge acceptance at constant voltage	1	
		7.4	Charge retention		
		7.8	Electrolyte retention		
E	5	7.9	Storage	1	
		9	Physical appearance		

10.2 Batch acceptance

These tests are applicable to deliveries of individual cells.

Unless otherwise agreed between supplier and purchaser, inspections and tests shall be performed using inspection levels and AQLs (acceptable quality level) recommended in Table 15. The sampling procedure should be established in accordance with IEC 60410.

Table 15 – Recommended test sequence for batch acceptance

Group	Clause or sub-clause	Inspection/Tests	Recommendation	
			Inspection level	AQL %
A		Visual inspection	II	4
B		Physical inspection		
	6	Dimensions	S3	1
		Weight	S3	1
	5.4	Marking	S3	1
C		Electrical inspection		
		Open circuit voltage and polarity	II	0,65
	7.3.2	Discharge at 20 °C	S3	1
NOTE Two or more failures on a single cell are not cumulative. Only the failure corresponding to the lowest AQL is taken into consideration.				

Annex A
(normative)

CCCV charge methodology

This charge method is based on a charge at constant current followed by a charge at constant voltage (CCCV). The chosen charge parameters shall be mentioned in the type approval certificate.

The parameters for the CCCV charge are the charging current and the charging voltage per cell with a temperature correction factor. This annex is describing how to apply those parameters.

The maximum charge time is defined depending upon charging current acceptable by the cell during regular charging as defined in Table 13. The charge time duration will then be adjusted for the characterization as per the following values (in case of charge current between the recommended steps, the highest duration between the limit values will be used).

Two parameters have to be defined.

- The constant voltage value is the voltage value at which the current shall be reduced in order not to exceed the recommended voltage described below. This value is defined at 20 °C.
- The voltage correction factor shall be selected in dependence of the temperature and as described below (voltage correction depending upon the temperature).

Charge characteristics are to be selected in a way to ensure high state of charge under normal operating conditions, and lowest possible water consumption (for vented systems).

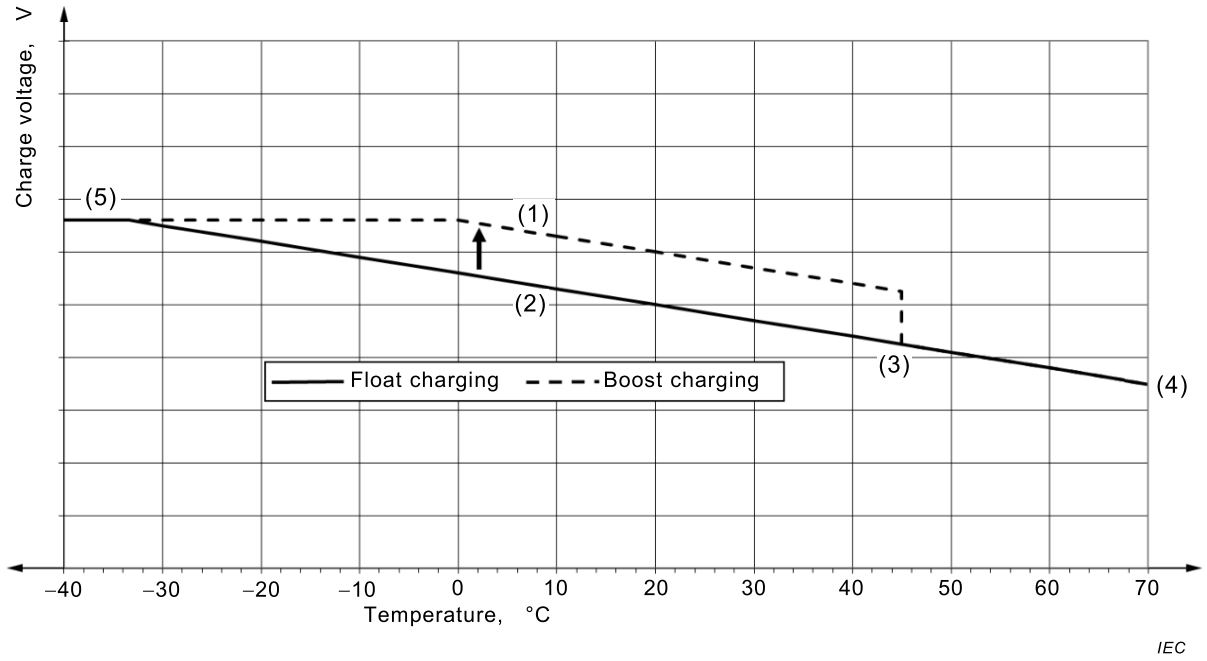
Ni-Cd cells can be charged with a charging current based on a ratio of its rated capacity C_5 Ah, with single or dual level of constant voltage, depending on the considered technology, as specified in Table A.1.

Table A.1 – Ni-Cd batteries charging characteristics

Ni-Cd batteries charging characteristics		Float charging voltage at 20 °C	Boost charge at 20 °C	Remarks
Basic data for single level charging	Float charging voltage at 20 °C	1,47 V / cell[a]	NA	See point (2) on Figure A.1
Basic data for 2 levels charging (boost charge)	Float charging voltage at 20 °C	1,45 V / cell[a]	1,65 V / cell[a]	See point (2) on Figure A.1
	Mandatory, change from boost to float charging	NA	45 °C	See point (3) on Figure A.1
Temperature correction		–3 mV / cell / °C[b]		See Figure A.1
Switching set points (all charge modes)	Mandatory stop charging of battery	70 °C		See point (4) on Figure A.1
	Standard, from boost to float charging	NA	I < 0,05 I_t A[a]	Current measurement necessary
	Standard, from float to boost charging	I > 0,05 I_t A[a]	NA	Current measurement necessary

[a] The values of the charging voltages for the different charge modes are indicative values. The manufacturer may choose different values for reaching a certain state of charge. Those values shall be clearly indicated in the cell documentation, as well as on the approval certificate. The voltage tolerance should be taken at maximum ±1 %.

[b] A temperature compensation is necessary. A typical value is of -0,003 V / °C / cell. In case the numerical value shall be adjusted for some type of cells specified as CCCV, it shall be clearly indicated in the manufacturer‘s documentation and in the approval documents. It is possible to have 2 values: one for temperatures lower than 20 °C and one for temperature higher than 20 °C.



NOTE This figure shows a temperature compensated charging of –3 mV/ °C per cell based on 20 °C for Ni-Cd technologies batteries constant voltage charging (1 or 2 levels) with a current limit.

Figure A.1 – Overview of charging characteristic of Ni-Cd

The typical charging voltage for most applications is as shown (per cell), temperature corrected, bringing higher or lower voltage values (at more or less than charge voltage at 20 °C).

A maximum voltage limit (as described on point (5) in Figure A.1) is shown for information, and cannot be taken into consideration for testing, as dependent upon the application.

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IEC 61434, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Guide to designation of current in alkaline secondary cell and battery standards*

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[1] This publication was withdrawn.

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