

INTERNATIONAL STANDARD



Secondary cells and batteries containing alkaline or other non-acid electrolytes – ~~Portable sealed rechargeable single cells~~ Secondary sealed cells and batteries for portable applications –
Part 2: Nickel-metal hydride



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Secondary cells and batteries containing alkaline or other non-acid electrolytes – ~~Portable sealed rechargeable single cells~~ Secondary sealed cells and batteries for portable applications –
Part 2: Nickel-metal hydride

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SECONDARY CELLS AND BATTERIES CONTAINING
ALKALINE OR OTHER NON-ACID ELECTROLYTES –
~~PORTABLE SEALED RECHARGEABLE SINGLE CELLS~~ SECONDARY
SEALED CELLS AND BATTERIES FOR PORTABLE APPLICATIONS –**

Part 2: Nickel-metal hydride

FOREWORD

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International Standard IEC 61951-2 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 fourth edition cancels and replaces the third edition published in 2011 of which it constitutes a technical revision.

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

- addition of battery type;
- addition of 'F' (high recovery type) designation for cells and batteries;
- addition of 'I' (low self-discharge type) designation for cells;
- revision of Figure 3 (6.1.3.1);
- addition of "optional pip" note to positive contact;
- changed leader line position from pip to flats of positive contact (B and G).

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

FDIS	Report on voting
21A/623/FDIS	21A/629/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.

A list of all parts of the IEC 61951 series can be found, under the general title *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary sealed cells and batteries for portable applications*, on the IEC website.

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.

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SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – ~~PORTABLE SEALED RECHARGEABLE SINGLE CELLS~~ SECONDARY SEALED CELLS AND BATTERIES FOR PORTABLE APPLICATIONS –

Part 2: Nickel-metal hydride

1 Scope

This part of IEC 61951 specifies marking, designation, dimensions, tests and requirements for ~~portable~~ secondary sealed nickel-metal hydride small prismatic, cylindrical and button ~~rechargeable single~~ cells and batteries, suitable for use in any orientation, for portable applications.

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 (IEV) – Part 482: Primary and secondary cells and batteries*

~~IEC 60086 (all parts), Primary batteries~~

IEC 60086-1 ~~(2006)~~, *Primary batteries – Part 1: General*

IEC 60086-2 ~~(2006)~~, *Primary batteries – Part 2: Physical and electrical specifications*

~~IEC 60410, Sampling plans and procedures for inspection by attributes~~

IEC 61959, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Mechanical tests for sealed portable secondary cells and batteries*

IEC 62133-1, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells and for batteries made from them, for use in portable applications – Part 1: Nickel systems*

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

nominal voltage

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

Note 1 to entry: The nominal voltage of a sealed nickel-metal hydride 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 – Addition of Notes 1 and 2 to entry.]

3.2

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.

Note 2 to entry: The capacity of a battery is the quantity of electricity C_5 Ah (ampere-hours) declared by the manufacturer which a battery can deliver during a 5 h period, when charged, stored and discharged under the procedure described in 7.3.2.

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – Addition of Notes 1 and 2 to entry.]

3.3

small prismatic cell

cell in the form of a rectangular parallelepiped whose width and thickness dimensions are not more than 25 mm

3.4

cylindrical cell

cell of circular cross-section in which the overall height is equal to, or greater than the overall diameter

3.5

button cell

cell of circular cross-section in which the overall height is less than the overall diameter

3.6

nickel-metal hydride cell

cell containing a nickel hydroxide compound for the positive electrode, a hydrogen absorbing alloy for the negative electrode, and potassium hydroxide or other alkaline solution as electrolyte

Note 1 to entry: Positive electrodes are isolated from negative electrodes by a separator

3.7

nickel-metal hydride battery

assembly of secondary cell(s) as a source of electrical energy characterized by its voltage, size, terminal arrangement, capacity and rate capability

3.8

sealed cell

cell which remains closed and does not release either gas or liquid when operated within the limits of charge and temperature specified by the manufacturer

Note 1 to entry: The cell is equipped with a safety device to prevent dangerously high internal pressure.

Note 2 to entry: The cell does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

Note 3 to entry: The nickel-metal hydride cell, however, may release gas towards the end of its life due to the accumulation of hydrogen in the cell.

[SOURCE: IEC 60050-482:2004, 482-05-17, modified – The existing note has been developed into Notes 1, 2 and 3 to entry.]

3.9

portable cell

cell designed mainly for use in an easily hand-carried battery

3.10

battery for portable applications

battery for use in device or appliance which is conveniently hand-carried

3.11

surface temperature limited cell

cell which performs a function that prevents the temperature increase from a certain standard point even at the moment of ~~anomaly~~ an abnormal occurrence such as short circuit of cell

3.12

high recovery type cell or battery

cell or battery which has lower "permanent capacity loss" than normal type after storage

Note 1 to entry: It is defined as "high recovery type" in 7.10.2, Table 22.

3.13

low self-discharge type cell

cell which is able to retain higher charge capacity than normal type after storage by reducing self-discharge

Note 1 to entry: It is defined as "low self-discharge type" in 7.4.

3.14

9 V type nickel-metal hydride battery

nickel-metal hydride battery which is interchangeable with 9 V primary batteries and is composed of cylindrical cells, small prismatic cells or button cells

4 Parameter measurement tolerances

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

- a) ± 1 % for voltage;
- b) ± 1 % for current;
- c) ± 1 % for capacity;
- d) ± 2 °C for temperature;
- e) $\pm 0,1$ % for time;
- f) $\pm 0,1$ mm for dimensions;
- g) $\pm 2,5$ % for humidity.

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 each report of results.

5 Cell and battery designation and marking

5.1 Cell and battery designation

5.1.1 Small prismatic cells and cylindrical cells

5.1.1.1 General

Sealed nickel-metal hydride small prismatic rechargeable single cells and cylindrical rechargeable single cells shall be designated by a letter L, M, J, H or X which signifies:

- low rate of discharge (L);
- medium rate of discharge (M);
- medium high rate of discharge (J);
- high rate of discharge (H);
- very high rate of discharge (X).

NOTE 1 These 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;
- J up to $5,0 I_t$ 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).

When a cell is intended for permanent charge at elevated temperatures, typically higher than 40 °C, a letter "T" is placed after the letter L, M, J, H or X.

When a cell is intended for permanent charge at elevated temperatures, typically higher than 50 °C, a letter "U" is placed after the letter L, M, J, H or X.

When a cell is intended for surface temperature limitation, a letter "S" is placed after the letter L or M.

When a cell is intended for rapid charge, typically at $1,0 I_t$ A, a letter "R" is placed after the letter L, M, J, H or X.

When a cell or battery is intended as a high recovery type, a letter "F" is placed after the letter L, M, J, H or X.

When a cell is intended as a low self-discharge cell, a letter "I" is placed after the letter L, M, J, H or X.

5.1.1.2 Small prismatic cells

Sealed nickel-metal hydride small prismatic rechargeable single cells shall be designated by the letters "HF" followed by a letter L, M, J, H or X followed by letter F, followed by, if designated, letter I, followed by three groups of figures, each group being separated by a solidus, as follows:

- a) The two figures to the left of the first solidus shall indicate the maximum width specified for the cell, expressed in millimetres, rounded up to the next whole number.
- b) The two figures in the middle shall indicate the maximum thickness specified for the cell, expressed in millimetres, rounded up to the next whole number.

- c) The two figures to the right of the second solidus shall indicate the maximum height specified for the cell, expressed in millimetres, rounded up to the next whole number.

EXAMPLE HFLF 18/07/49 designation identifies a small prismatic cell of low discharge rate capability, **high recovery type** with a maximum width of 18 mm, a maximum thickness of 7 mm and a maximum height of 49 mm.

5.1.1.3 Cylindrical cells

Sealed nickel-metal hydride cylindrical rechargeable single cells shall be designated by the letters "HR" followed by a letter L, M, J, H or X **followed by letter F, followed by, if designated, letter I**, followed by two groups of figures, each group being separated by a solidus, as follows:

- The two figures to the left of the solidus shall indicate the maximum diameter specified for the cell, expressed in millimetres, rounded up to the next whole number.
- The two figures to the right of the solidus shall indicate the maximum height specified for the cell, expressed in millimetres, rounded up to the next whole number.

When a manufacturer designs a cell with dimensions and tolerances which make it interchangeable with a primary cell, the designation of Table 2 shall also be marked on the cell.

EXAMPLE 1 HRLF 33/62 designation identifies a cylindrical cell of low discharge rate capability, **high recovery type** with a maximum diameter of 33 mm and a maximum height of 61,5 mm.

EXAMPLE 2 HRLTF 33/62 designation identifies a cylindrical cell of low discharge rate capability, intended for permanent charge at elevated temperatures, **high recovery type**, with a maximum diameter of 33 mm and a maximum height of 61,5 mm.

EXAMPLE 3 HRXRFI 23/43 designation identifies a cylindrical cell of very high discharge rate capability, intended for rapid charge, **high recovery type, low self-discharge type** with a maximum diameter of 23 mm and a maximum height of 43 mm.

For cells dimensionally interchangeable with primary cells, the following single or double figures following the letter ~~L, M, R or S~~ **F or I** may indicate:

- 20- Size D;
- 14- Size C;
- 6- Size AA;
- 03- Size AAA.

NOTE Cells dimensionally interchangeable with primary cells correspond to M type unless otherwise specified

For the purpose of this explanation, an example is given below.

EXAMPLE 4 HRMRFI03 designation identifies a sealed nickel-metal hydride cylindrical rechargeable single cell, of medium discharge rate capability, also intended for rapid charge, **high recovery type and low self-discharge type**, dimensionally interchangeable with primary cell and whose type designation is AAA.

5.1.2 Button cells

Sealed nickel-metal hydride button rechargeable single cells shall be designated by the letters "HB" **followed by letter F, followed by, if designated, letter I**, followed by two groups of figures, **each group being** separated by a solidus, as follows:

- The three figures to the left of the solidus shall indicate the maximum diameter specified for the cell, expressed in tenths of millimetres, rounded up to the next whole number.
- The three figures to the right of the solidus shall indicate the maximum height specified for the cell, expressed in tenths of millimetres, rounded up to the next whole number.

EXAMPLE HBFI 116/054 designation identifies a button cell, **intended as a high recovery type, low self-discharge type**, with a maximum diameter of 11,6 mm and a maximum height of 5,4 mm.

5.1.3 Batteries

Sealed nickel-metal hydride rechargeable batteries shall be designated with the following form:

N1 single cell designation – N2

where

N1 is the number of series connected cells in the battery;

N2 is the number of parallel connected cells if 2 or greater (not shown if value is 1).

Sealed nickel-metal hydride battery designation will be identified based on single cells within the series and not the battery as a whole.

- Small prismatic cells in battery

EXAMPLE 1 2HFLF 18/07/49 designation identifies a small prismatic cell of low discharge rate capability, high recovery type with a maximum width of 18 mm, a maximum thickness of 7 mm and a maximum height of 49 mm with two series connected cells.

- Cylindrical cells in battery

EXAMPLE 2 3HRLF 33/62 designation identifies a cylindrical cell of low discharge rate capability, high recovery type with a maximum diameter of 33 mm and a maximum height of 61,5 mm with three series connected cells.

EXAMPLE 3 4HRLTF 33/62 designation identifies a cylindrical cell of low discharge rate capability, intended for permanent charge at elevated temperatures, high recovery type, with a maximum diameter of 33 mm and a maximum height of 61,5 mm with four series connected cells.

EXAMPLE 4 HRXRFI 23/43 -2 designation identifies a cylindrical cell of very high discharge rate capability, intended for rapid charge, high recovery type, low self-discharge type with a maximum diameter of 23 mm and a maximum height of 43 mm with two parallel connected cells.

- Cells interchangeable with primary cells in batteries

EXAMPLE 5 HRMRFI03-3 designation identifies a sealed nickel-metal hydride cylindrical rechargeable single cell, of medium discharge rate capability, also intended for rapid charge, high recovery type and low self-discharge type, dimensionally interchangeable with primary cell whose type designation is AAA with three parallel connected cells.

- Button cells in battery

EXAMPLE 6 HB 116/054-3 designation identifies a button cell, with a maximum diameter of 11,6 mm and a maximum height of 5,4 mm with three parallel connected cells.

5.2 Cell or battery termination

This standard does not specify cell or battery termination.

5.3 Marking

5.3.1 Small prismatic cells and cylindrical cells

Each jacketed cell supplied without connections shall carry durable markings giving the following minimum information:

- sealed rechargeable nickel-metal hydride or Ni-MH;
- ~~designation as specified in 5.1 (in addition, it is permissible for a manufacturer to use his own type designation);~~
- rated capacity;
- nominal voltage;
- ~~recommended charge rate and time or permanent charge current for "T" cells;~~
- polarity (+ and –);
- date of manufacture (which may be in code);
- name or identification of manufacturer or supplier;
- mark for promoting useful use of cell resources.

NOTE 1 This mark is applied where a recycling programme is available.

NOTE 2 In general, sealed nickel-metal hydride rechargeable single cells with connection tabs need no labels if they form an integral part of a battery, in which case, the battery itself is marked with the above information.

5.3.2 Button cells

Each button cell supplied without connection shall carry durable markings giving the following minimum information:

- designation as specified in 5.1;
- polarity (+ and –);
- date of manufacture (which may be in code);
- name or identification of manufacturer or supplier.

5.3.3 Batteries

Each battery shall carry durable markings giving the following minimum information:

- rated capacity;
- nominal voltage;
- date of manufacture (which may be in code).

5.4 Exemption of wording

Each cell or battery shall include minimum information on the label as specified in 5.3.1 to 5.3.3. Therefore, additional information such as safety cautions should be included in the form of a manual not on the cell or battery label.

Each cell or battery shall include minimum information on the label as specified in 5.3.1 to 5.3.3. Therefore, cells or batteries encased in soft or hard plastic with the safety cautions printed on the outside should not include caution details on the cell or battery label.

6 Dimensions

6.1 Small prismatic cells and cylindrical cells

6.1.1 General

Figures 1 and 2 show the shape of the cells.

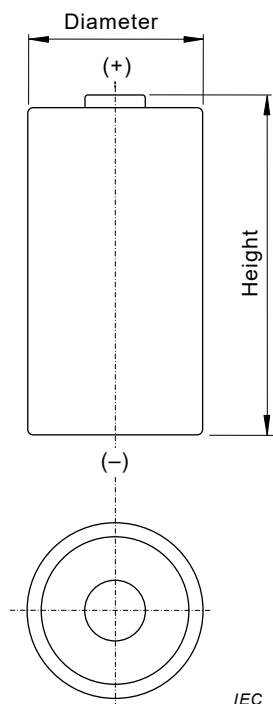


Figure 1 – Jacketed cylindrical cells

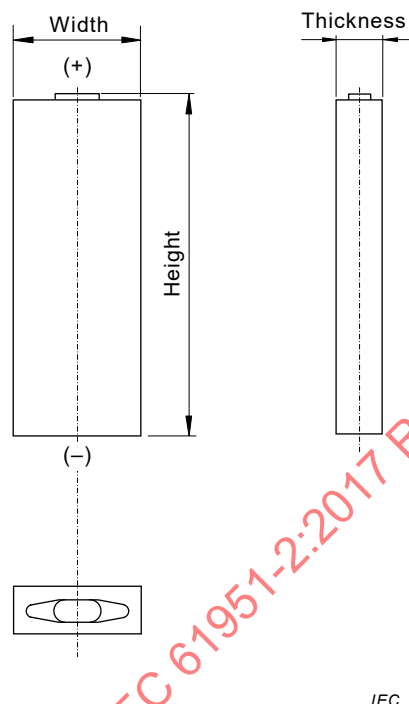


Figure 2 – Jacketed small prismatic cells

6.1.2 Small prismatic cells

Table 1 shows the dimensions for jacketed small prismatic cells.

Table 1 – Dimensions of jacketed small prismatic cells

Cell designation	Width mm	Thickness mm	Height mm
HF 15/08/49	14,5	7,4	48,2
HF 15/09/49	14,5	8,3	48,2
HF 16/07/34 ^a	16,0	6,6	34,0
HF 18/07/36	17,3	6,1	35,7
HF 18/07/49	17,3	6,1	48,2
HF 18/09/49	17,3	8,3	48,2
HF 18/07/68	17,3	6,1	67,3
HF 18/11/68	17,3	10,7	67,3
HF 18/18/68	17,3	17,3	67,3
HF 23/11/68	22,7	10,7	67,3
HF 23/15/68	22,7	14,5	67,3

^a—New cell.

6.1.3 Cylindrical cells

6.1.3.1 Cells dimensionally interchangeable with primary cells

Table 2 gives the requirements relative to the dimensions for jacketed cylindrical cells which are dimensionally interchangeable with primary cells (see Figure 3).

Table 2 – Dimensions of jacketed cylindrical cells dimensionally interchangeable with primary cells

Cell designation ^a	Type designation (reference) ^b	Corresponding primary cell ~~CEI 60086~~ ^c	Nominal voltage V	Dimensions mm										
				A	B	C	D ^d	E	F		G	Φ		ΦP
				Max	Min	Min	—	Max	Max	Min	Min	Max	Min	Max
HR03	AAA	R03 LR03	1,2	44,5	(43,3)	4,3		0,5	3,8	(2,0)	0,8	10,5	9,5	0,4
HR6	AA	R6 LR6		50,5	(49,2)	7,0		0,5	5,5	(4,2)	1,0	14,5	13,5	0,5
HR14	C	R14 LR14		50,0	(48,6)	13,0		0,9	7,5	(5,5)	1,5	26,2	24,9	1,0
HR20	D	R20 LR20		61,5	(59,5)	18,0		1,0	9,5	(7,8)	1,5	34,2	32,3	1,0

NOTE Figures in parentheses are reference values.

^a Cell designations shall be in accordance with the nomenclature rules given in IEC 60086-1.

^b In some countries these cell types are also known as AAA (R 03); AA (R 6); C (R 14); D (R 20).

^c Carbon zinc cells (R) and alkaline primary cells (LR) shall be compliant with the provisions of IEC 60086-2, respectively.

^d There is no specification for the value "D" for sealed nickel-metal-hydride cylindrical rechargeable single cells interchangeable with primary cells.

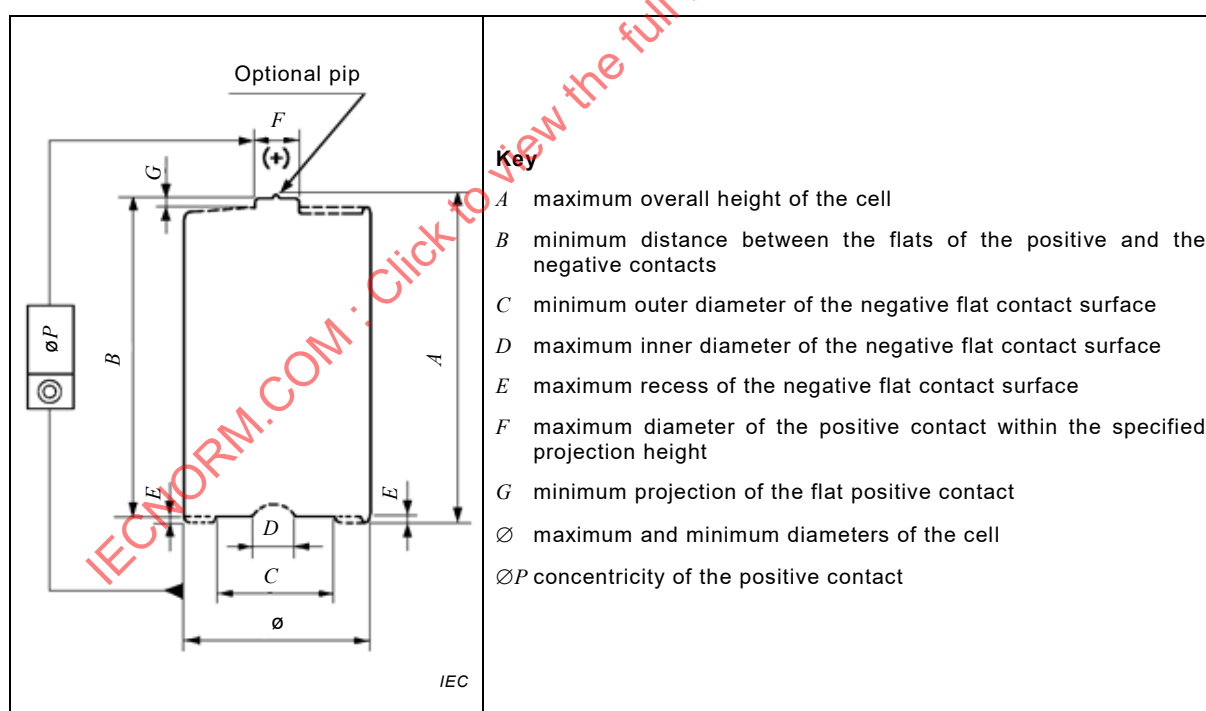


Figure 3 – Jacketed cells dimensionally interchangeable with primary cells

6.1.3.2 Cells not dimensionally interchangeable with primary cells

Table 3 shows the dimensions for jacketed cylindrical cells not dimensionally interchangeable with primary cells.

**Table 3 – Dimensions of jacketed cylindrical cells
not dimensionally interchangeable with primary cells**

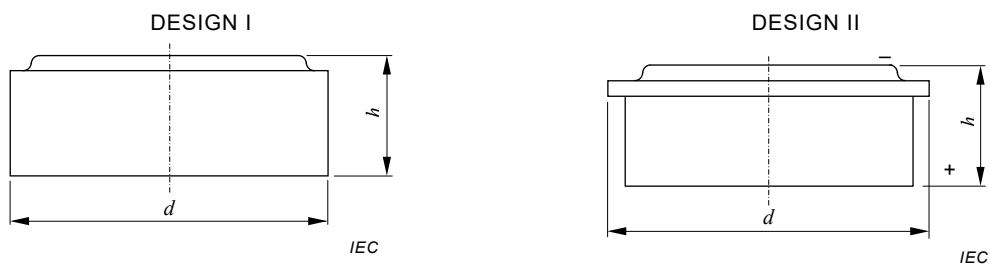
Cell designation ^a	Diameter mm	Height mm
HR 11/45	10,5	44,5
HR 11/51	10,5	50,5
HR 11/67	10,5	67,0
HR 15/43	14,5	43,0
HR 15/49	14,5	49,0
HR 15/51	14,5	50,5
^b HR 15/67	15,0	67,0
HR 17/29	17,0	28,5
HR 17/43	17,0	43,0
HR 17/50	17,0	50,0
HR 17/67	17,0	67,0
^b HR 18/44	18,0	43,5
^b HR 18/67	18,0	67,0
^b HR 19/67	19,0	67,0
HR 23/34	23,0	34,0
HR 23/43	23,0	43,0
^b HR 23/44	23,0	43,5
^b HR 23/50	23,0	50,0
^b HR 23/60	23,0	61,0
HR 26/47	25,8	47,0
HR 26/50	25,8	50,0
HR 33/36	33,0	36,0
HR 33/62	33,0	61,5
HR 33/91	33,0	91,0
^b HR 34/60	33,5	59,5

^a The letters HR to be followed by L, M, H or X and T and/or R as appropriate (see 5.1).

^b ~~8 new cells.~~

6.2 Button cells

Cells shall be constructed as design I or II (see Figure 4 below).



NOTE The polarity of design I is not standardized.

Figure 4 – Button cells

Table 4 shows the dimensions of sealed nickel-metal hydride button rechargeable single cells.

Table 4 – Dimensions of button cells

Cell designation	Overall Diameter, d mm	Overall Height, h mm
HB 079/054	7,9	5,4
HB 116/054	11,6	5,4
HB 156/064	15,6	6,4
HB 222/048	22,2	4,8
HB 252/061	25,2	6,1
HB 252/065	25,2	6,5
HB 252/078	25,2	7,8
HB 347/060	34,7	6,0

6.3 9 V type nickel-metal hydride batteries

Figure 5 shows the shape of 9 V type nickel-metal hydride batteries.

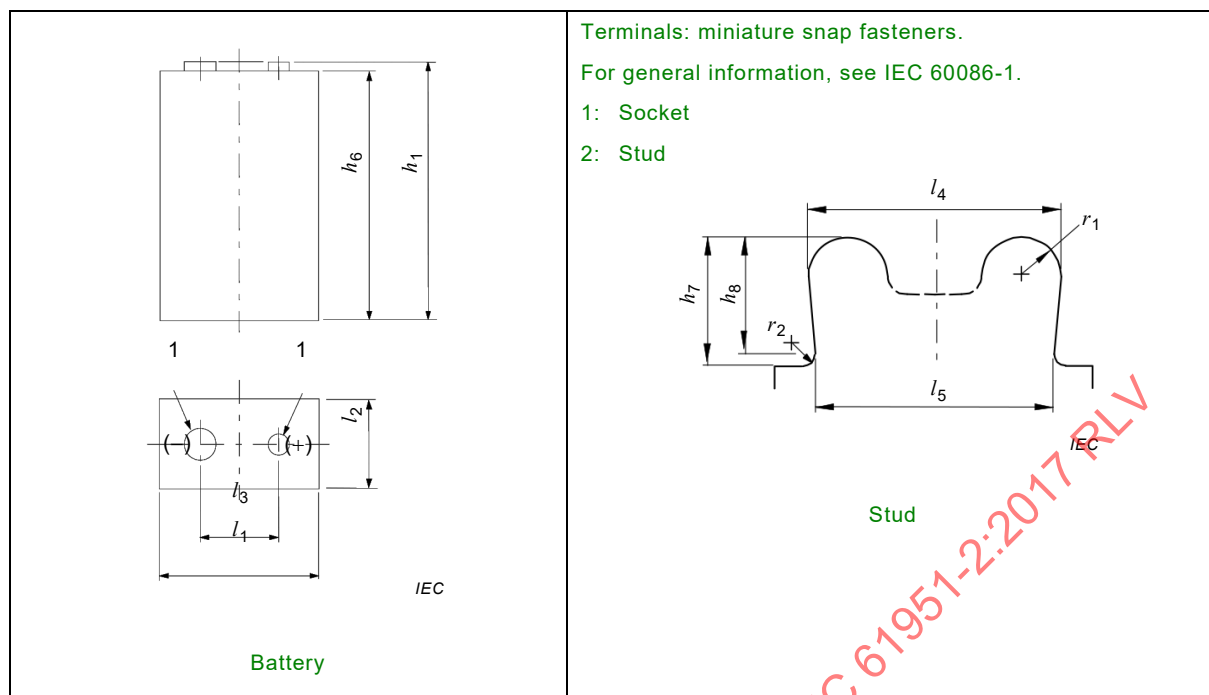


Figure 5 – 9 V type nickel-metal hydride batteries

Table 5 shows the dimensions of 9 V type nickel-metal hydride batteries.

Table 5 – Dimensions of 9 V type nickel-metal hydride batteries

Type designation	Corresponding primary battery	Nominal voltage V	Dimensions mm											
				h_1	h_6	l_1	l_2	l_3	h_7	h_8	l_4	l_5	r_1	r_2
006P	6F22	8,4	Max.	48,5	46,4	26,5	17,5	12,95	3,10		5,77			
	6LR61 6LP3146	7,2	Min.	46,5	–	24,5	15,5	12,45	2,90	(2,55)	5,67	(5,38)	(0,8)	(0,4)

7 Electrical tests

7.1 General

Charge and discharge currents for the tests in accordance with this Clause 7 and with Clause 5 shall be based on 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.

In all tests, except where noted, no leakage of electrolyte in liquid form shall be observed.

7.2 Charging procedure for test purposes

7.2.1 Charging procedure for cell

Prior to charging, the cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, down to a final voltage of 1,0 V.

Unless otherwise stated in this document, the charging procedure for test purposes shall be carried out in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, a relative humidity of $65\% \pm 20\%$, at a constant current of $0,1 I_t$ A, for 16 h. The tests shall be performed within ~~one~~ 2 months of the

~~arrival date or the purchasing~~ manufacture date. Manufacture date is determined by the manufacturer.

7.2.2 Charging procedure for battery

Prior to charging, the battery shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, ~~down to a final voltage of $1,0\text{ V}$~~ until its voltage is equal to the number in the series connected cells times $1,0\text{ V}$, unless otherwise specified by the manufacturer.

The charging procedure for the battery shall be carried out as recommended by the manufacturer in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ and a relative humidity of $65\% \pm 20\%$. The tests shall be performed within 2 months of manufacture date. The manufacture date is determined by the manufacturer.

7.3 Discharge performance

7.3.1 General

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

7.3.2 Discharge performance at $20\text{ }^{\circ}\text{C}$

7.3.2.1 General

The cell or battery shall be charged in accordance with 7.2. After charging, the cell or battery shall be stored in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for not less than 1 h and not more than 4 h.

7.3.2.2 Discharge performance for cells at $20\text{ }^{\circ}\text{C}$

The cell shall then be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ as specified in Tables 6 or Table 7. The duration of discharge shall not be less than the values specified in Tables 6 or Table 7.

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

Table 6 – Discharge performance at $20\text{ }^{\circ}\text{C}$ for small prismatic cells and cylindrical cells

Discharge conditions		Minimum discharge duration h/min			
Rate of constant current A	Final voltage V	Cell designation			
		L/LT/LU/LS	M/MT/MU/MS/J/JT	H/HT/HU	X
$0,2\text{ }I_t^a$	1,0	5 h	5 h	5 h	5 h
$1,0\text{ }I_t$	0,9	–	42 min	48 min	54 min
$5,0\text{ }I_t^b$	0,8	–	–	6 min	9 min
$10,0\text{ }I_t^b$	0,7	–	–	–	4 min

^a Five cycles are permitted per cell for this test. The test shall be terminated at the end of the first cycle of each cell which meets the requirement.

^b Prior to the $5\text{ }I_t\text{ A}$ and $10\text{ }I_t\text{ A}$ tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging at $0,1\text{ }I_t\text{ A}$ in accordance with 7.2 and discharging at $0,2\text{ }I_t\text{ A}$ in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ according to 7.3.2.

Table 7 – Discharge performance at 20 °C for button cells

Discharge conditions		Minimum discharge duration h/min
Rate of constant current A	Final voltage V	
0,2 I_t ^a	1,0	5 h
1,0 I_t	0,9	35 min

^a Five cycles are permitted for this test. The test shall be terminated at the end of the first cycle which meets the requirement.

7.3.2.3 Discharge performance for batteries at 20 °C

The battery shall then be discharged, as specified in Table 8, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $0,2\text{ }I_t\text{ A}$ until its voltage is equal to the number of series connected cells times $1,0\text{ V}$, unless otherwise specified by the manufacturer.

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

Table 8 – Discharge performance at 20 °C for batteries

Discharge conditions		Minimum discharge duration h
Rate of constant current A	Final voltage V	
0,2 I_t ^a	1,0 × N ^b	5

^a Five cycles are permitted per battery for this test. The test shall be terminated at the end of the first cycle each battery which meets the requirement.

^b N is the number of series connected cells in the battery.

7.3.2.4 Rated capacity (mAh) compliance test (example)

Table 9 is an example showing compliance of a cell or battery test sample (sample size 32) when the manufacturer declares a rated capacity of 2 000 mAh.

Table 9 – Rated capacity (mAh) compliance test (example)

Sample n°	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5 ^a	Capacity
1	1 920	1 950	1 900	2 005		2 005
2	2 000					2 000
3	1 920	1 950	2 000			2 000
4	1 860	1 890	1 900	1 950	2 000	2 000
5	2 005					2 005
Samples 6 to 31 ^b	...	...	...	...		...
32	1 970	2 010				2 010
				Rated capacity		2 000

^a Five cycles are permitted for this test.

^b Individual capacity (mAh) measurements for samples 6 to 31 are not explicitly shown in this table for brevity. When conducting discharge performance testing all 32 samples shall be tested to meet the requirements.

7.3.3 Discharge performance at 0 °C

The cell shall be charged in accordance with 7.2. After charging, the cell shall be stored, in an ambient temperature of 0 °C ± 2 °C for not less than 16 h and not more than 24 h.

The cell shall then be discharged in an ambient temperature of 0 °C ± 2 °C as specified in Tables 10 or Table 11. The duration of discharge shall not be less than the values specified in Tables 10 or Table 11.

Table 10 – Discharge performance at 0 °C for small prismatic cells and cylindrical cells

Discharge conditions		Minimum discharge duration h/min			
Rate of constant current A	Final voltage V	Cell designation			
		L/LT/LU/LS	M/MT/MU/MS/J	H/HT/HU	X
0,2 I_t	1,0	2 h	4 h	4 h	4 h 30 min
1,0 I_t	0,9	–	36 min	42 min	48 min
2,0 I_t ^a	0,8	–	–	15 min	21 min
3,0 I_t ^a	0,8	–	–	–	12 min

^a Prior to the 2,0 I_t A and 3,0 I_t A tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging at 0,1 I_t A in accordance with 7.2 and discharging at 0,2 I_t A in an ambient temperature of 20 °C ± 5 °C according to 7.3.2.

Table 11 – Discharge performance at 0 °C for button cells

Discharge conditions		Minimum discharge duration h/min
Rate of constant current A	Final voltage V	
0,2 I_t	1,0	4 h
1,0 I_t	0,9	27 min

7.3.4 Discharge performance for rapid charge cells (R cells)

R cells shall be charged at a constant current of 1,0 I_t A for 1,2 h or other appropriate charge termination method as recommended by the cell manufacturer, followed by a charge at 0,1 I_t A for 2 h, in an ambient temperature of 20 °C ± 5 °C. After charging, the cell shall be stored and discharged as specified in 7.3.2 and 7.3.3.

The duration of discharge shall not be less than the values specified in Table 6 for discharge at 20 °C ± 5 °C and in Table 9 for discharge at 0 °C ± 2 °C.

7.4 Charge (capacity) retention

The charge (capacity) retention shall be determined by the following test. After charging in accordance with 7.2, the cell shall be stored on open circuit for ~~28 days~~ a specified time. 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 be discharged under the conditions specified in 7.3.2 at a rate of 0,2 I_t A. The duration of discharge after 28 days storage at 20 °C shall not be less than:

- 3 h for small prismatic cells and cylindrical cells;
- 3 h 45 min for button cells.

For cells designated as low self-discharge type, defined in 5.1, the duration of discharge after 6 months storage at 20 °C shall not be less than:

- 3 h 45 min for cylindrical cells.

7.5 Endurance

7.5.1 Endurance in cycles

7.5.1.1 General

Prior to the endurance in cycles test, the cell shall be discharged at a constant current of $0,2 I_t$ A to a final voltage of 1,0 V.

The following endurance test shall then be carried out, irrespective of cell designation, in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$. Charge and discharge shall be carried out at constant current throughout, in accordance with the conditions specified in Tables 12, Table 13, Table 14 and Table 15. Precautions shall be taken to prevent the cell-case temperature from rising above 35 °C during the test, by providing a forced air draught if necessary.

NOTE The actual cell temperature, not the ambient temperature, determines cell performance.

7.5.1.2 Small prismatic, button and cylindrical cells not dimensionally interchangeable with primary cells

Table 12 – Endurance in cycles for small prismatic, button and cylindrical cells not dimensionally interchangeable with primary cells

Cycle number	Charge	Stand in charged condition	Discharge
1	$0,10 I_t$ A for 16 h	None	$0,25 I_t$ A for 2 h 20 min ^a
2 to 48	$0,25 I_t$ A for 3 h 10 min	None	$0,25 I_t$ A for 2 h 20 min ^a
49	$0,25 I_t$ A for 3 h 10 min	None	$0,25 I_t$ A to 1,0 V
50	$0,10 I_t$ A for 16 h	1 h to 4 h	$0,20 I_t$ A to 1,0 V ^b
^a If the cell voltage drops below 1,0 V, discharge may be discontinued. ^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400 and 450.			

Cycles 1 to 50 shall be repeated until the discharge duration on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out.

The endurance test is considered complete when two such successive capacity cycles give discharge durations of less than 3 h. The total number of cycles obtained when the test is completed shall not be less than:

- 400 for small prismatic cells;
- 500 for L/LR, M/MR, J/JR, H/HR or X/XR cells;
- 50 for LT/LU, MT/MU, JT or HT/HU cells;
- 500 for button cells.

7.5.1.3 Cylindrical cells not dimensionally interchangeable with primary cells (accelerated test procedures)

~~The cell shall be tested in accordance with 7.5.1.2. The total number of cycles obtained when the test is completed shall be not less than:~~

- ~~500 for AAA cells with a rated capacity less than 800 mAh;~~
- ~~300 for AAA cells with a rated capacity of 800 mAh or more;~~
- ~~500 for AA cells with a rated capacity less than 2 100 mAh;~~
- ~~300 for AA cells with a rated capacity of 2 100 mAh or more;~~
- ~~500 for D and C cells.~~

~~7.5.1.4 Cylindrical cells (accelerated test procedures)~~

7.5.1.3.1 General

In order to accelerate the test or to use cycling conditions approximating those in actual applications, one of the following alternative procedures, shown in Tables 13, 14 and 15, relevant to the cell may be carried out as an alternative to 7.5.1.2.

7.5.1.3.2 H or X cells

Table 13 – Endurance in cycles for H or X cells

Cycle number	Charge	Stand in charged condition	Discharge	Total duration including Subsequent rest
1	0,1 I_t A for 16 h	30 min	1,0 I_t A to 1,0 V	30 min to 90 min
2 to 48	0,3 I_t A for 4 h ^a	30 min	1,0 I_t A to 1,0 V	30 min to 90 min
49	0,3 I_t A for 4 h ^a	24 h	1,0 I_t A to 1,0 V	30 min to 90 min
50	0,1 I_t A for 16 h	1 h to 4 h	0,2 I_t A to 1,0 V	^b
^a Or appropriate charge termination, as recommended by the manufacturer.				
^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400, and 450.				

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 1,0 V on any 49th cycle becomes less than 30 min or until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again the test is terminated.

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

7.5.1.3.3 X cells

Table 14 – Endurance in cycles for X cells

Cycle number	Charge	Stand in charged condition	Discharge	Total duration including Subsequent rest
1	0,1 I_t A for 16 h	30 min	5,0 I_t A to 0,8 V	42 min 30 min to 90 min
2 to 48	1,0 I_t A for 1 h ^a	30 min	5,0 I_t A to 0,8 V	42 min 30 min to 90 min
49	1,0 I_t A for 1 h ^a	24 h	5,0 I_t A to 0,8 V	42 min 30 min to 90 min
50	0,1 I_t A for 16 h	1 h to 4 h	0,2 I_t A to 1,0 V ^b	^b

- ^a Or appropriate charge termination, as recommended by the manufacturer.
- ^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400 and 450.

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 0,8 V on any 49th cycle becomes less than 5 min or until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again the test is terminated.

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

7.5.1.3.4 HR or XR cells

Table 15 – Endurance in cycles for HR or XR cells

Cycle number	Charge	Stand in charged condition	Discharge	
			Conditions	Total duration including subsequent rest
1	0,1 I_t A for 16 h	30 min	1,0 V A to 1,0 V	90 min
2 1 to 48	1,0 I_t A for ^a	20 to 30 min	1,0 I_t A to 1,0 V	90 min 10 min to 30 min
49	1,0 I_t A for ^a	24 h	1,0 I_t A to 1,0 V	90 min 10 min to 30 min
50	1,0 I_t A for ^a plus 0,1 I_t A for 2 h	1 h to 4 h	0,2 I_t A to 1,0 V ^b	^b
^a With appropriate charge termination, as recommended by the manufacturer, for example use $-\Delta V$ or $\Delta T/\Delta t$ control method. ^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400 and 450.				

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 1,0 V on any 49th cycle becomes less than 30 min or until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again the test is shall be terminated.

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

7.5.1.4 Cylindrical cells dimensionally interchangeable with primary cells

In order to use cycling conditions realistic to actual consumer usage of cylindrical cells dimensionally interchangeable with primary cells, one of the following procedures, shown in Table 16 shall be carried out.

Table 16 – Endurance in cycles for cylindrical cells dimensionally interchangeable with primary cells

Cycle number	Charge	Stand in charged condition	Discharge	Subsequent rest
1 to 49	0,5 I_t A for ^a	20 min to 30 min	0,5 I_t A to 1,0 V	10 min to 90 min
50	0,10 I_t A for 16 h	1 h to 4 h	0,2 I_t A to 1,0 V	^b

^a Charge termination is $-\Delta V = 5$ mV to 10 mV or 132 min. Additionally, if charge termination does not comply with the aforementioned condition, testing shall be terminated.

^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150.

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement condition as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again, the test shall be terminated.

The total number of cycles obtained when the test is completed shall not be less than:

- 200 for AAA cells with a rated capacity less than 800 mAh;
- 100 for AAA cells with a rated capacity of 800 mAh or more;
- 200 for AA cells with a rated capacity less than 2 100 mAh;
- 100 for AA cells with a rated capacity of 2 100 mAh or more;
- 200 for D and C cells.

7.5.2 Permanent charge endurance

7.5.2.1 Small prismatic and button cells

There is no requirement for permanent charge endurance tests on small prismatic and button cells.

7.5.2.2 L, M, H or X cylindrical cells

Prior to this test, the cell shall be discharged at 0,2 I_t A to a final voltage of 1,0 V.

The following permanent charge endurance test shall be carried out in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$. Charge and discharge shall be carried out at constant current throughout, using the conditions specified in Table 17.

Table 17 – Permanent charge endurance for L, M, H or X cells

Cycle number	Charge	Discharge ^a
1	0,05 I_t A for 91 days	0,2 I_t A to 1,0 V
2	0,05 I_t A for 91 days	0,2 I_t A to 1,0 V
3	0,05 I_t A for 91 days	0,2 I_t A to 1,0 V
4	0,05 I_t A for 91 days	0,2 I_t A to 1,0 V

^a The discharge is carried out immediately on completion of charging.

Precautions shall be taken to prevent the cell-case temperature from rising above $25\text{ }^{\circ}\text{C}$ during the test by providing a forced air draught if necessary.

The discharge duration at cycle 4 for cells shall not be less than 3 h.

7.5.2.3 LT, MT or HT cylindrical cells

The permanent charge endurance test shall be performed in three steps according to the conditions specified in Table 18.

It consists of:

- a charge acceptance test at +40 °C;
- an ageing period of six months at +70 °C;
- a final charge acceptance test to check the cell's performance after ageing.

NOTE 1 The six months ageing period and the temperature of +70 °C have been selected to simulate four years of permanent charge operation at +40 °C.

Prior to this test, the cell shall be discharged at $20\text{ °C} \pm 5\text{ °C}$, at $0,2\text{ }I_t\text{ A}$, to a final voltage of 1,0 V and stored, in an ambient temperature of $+40\text{ °C} \pm 2\text{ °C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged and discharged at constant current under the conditions specified in Table 18 while maintained in an ambient temperature of $+40\text{ °C} \pm 2\text{ °C}$ or $+70\text{ °C} \pm 2\text{ °C}$ respectively as appropriate.

The discharge conditions A or B may be chosen to suit the user's requirements. The discharge is carried out immediately on completion of charging.

After performing the first charge acceptance test at +40 °C the cell is stored in an ambient temperature of $+70\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h.

During the ageing period of six months at +70 °C, precautions shall be taken to prevent the cell-~~case~~ temperature from rising above +75 °C, by providing a forced air draught, if necessary.

NOTE 2 The actual cell-~~case~~ temperature, not the ambient temperature, determines cell performance.

The discharge duration of the three cycles at +70 °C shall be recorded. Leakage of electrolyte shall not occur during this test.

After completion of the ageing period, the cell shall be stored in an ambient temperature of $+40\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h. The three cycles at +40 °C of the initial charge acceptance test are then repeated using the conditions specified in Table 18. The duration of discharge for cells shall not be less than the values specified in Table 18.

Table 18 – Permanent charge endurance for LT, MT or HT cells

Cycle number	Ambient temperature	Charge	Discharge A or B ^a	Minimum discharge duration
1	+40 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
2		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	3 h 45 min
3		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	42 min
4	+70 °C ± 2 °C	0,05 I_t A for 60 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
5		0,05 I_t A for 60 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
6		0,05 I_t A for 60 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
7	+40 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
8		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	2 h 30 min
9		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	24 min

^a Discharge A-for is used with LT, MT or HT cells.
Discharge B-for is used with MT or HT cells only.

7.5.2.4 JT cylindrical cells

The following permanent charge endurance test shall be carried out in order to establish the number of charge/discharge cycles that a cell may accumulate under the following conditions.

Prior to this test, the cell shall be discharged at 0,2 I_t A at 20 °C ± 5 °C to a final voltage of 1,0 V and stored, in an ambient temperature of +55 °C ± 2 °C, for not less than 16 h and not more than 24 h.

The cell shall then be charged at a constant current of 0,033 I_t A for 28 days while maintained in an ambient temperature of +55 °C ± 2 °C and discharged, in the same ambient temperature, at 1,0 I_t A to a final voltage of 1,1 V.

The endurance test is considered complete when two successive capacity measurement cycles give discharge durations of less than 30 min. The total number of cycles successfully completed shall not be less than 6.

7.5.2.5 LU, MU or HU cylindrical cells

The permanent charge endurance test shall be performed in three steps according to the conditions specified in Table 19.

It consists of:

- a charge acceptance test at +50 °C;
- an ageing period of twelve months at +70 °C;
- a final charge acceptance test to check the cell's performance after ageing.

NOTE 1 The twelve months ageing period and the temperature of +70 °C have been selected to simulate four years of permanent charge operation at +50 °C.

Prior to this test, the cell shall be discharged at $20\text{ °C} \pm 5\text{ °C}$, at $0,2 I_t$ A, to a final voltage of 1,0 V and stored, in an ambient temperature of $+50\text{ °C} \pm 2\text{ °C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged and discharged at constant currents under the conditions specified in Table 19 while maintained in an ambient temperature of $+50\text{ °C} \pm 2\text{ °C}$ or $+70\text{ °C} \pm 2\text{ °C}$ respectively as appropriate.

The discharge conditions A or B may be chosen to suit the user's requirements. The discharge is carried out immediately on completion of charging.

After performing the first charge acceptance test at +50 °C, the cell is stored in an ambient temperature of $+70\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h.

During the ageing period of twelve months at +70 °C, precautions shall be taken to prevent the cell-case temperature from rising above +75 °C, by providing a forced air draught, if necessary.

NOTE 2 The actual cell-case temperature, not the ambient temperature, determines cell performance.

The discharge duration of the three cycles at +70 °C shall be recorded. Leakage of electrolyte shall not occur during this test.

After completion of the ageing period, the cell shall be stored in an ambient temperature of $+50\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h. The three cycles at +50 °C of the initial charge acceptance test are then repeated using the conditions specified in Table 19. The duration of discharge for cells shall not be less than the values specified in Table 19.

Table 19 – Permanent charge endurance for LU, MU or HU cells

Cycle number	Ambient temperature	Charge	Discharge A or B ^a	Minimum discharge duration
1	+50 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
2		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	3 h 45 min
3		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	42 min
4	+70 °C ± 2 °C	0,05 I_t A for 120 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
5		0,05 I_t A for 120 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
6		0,05 I_t A for 120 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
7	+50 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
8		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	2 h 30 min
9		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	24 min

^a A: for LU, MU or HU cells.
B: for MU or HU cells only.

7.6 Charge acceptance at constant voltage

This document does not specify a charge acceptance test at constant voltage.

Charging at constant voltage is not recommended.

7.7 Overcharge

7.7.1 Small prismatic, L, M, H, X, LS or MS cylindrical, and button cells

The ability of the cell to withstand an overcharge shall be determined by the following test.

Prior to this test, the cell shall be discharged in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 I_t A, down to a final voltage of 1,0 V.

The cell shall then be charged, in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,1 I_t A for 48 h. After this charging operation, 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.

The cell shall then be discharged at 20 °C ± 5 °C at a constant current of 0,2 I_t A to a final voltage of 1,0 V.

The duration of discharge shall not be less than 5 h.

7.7.2 LT/LU, MT/MU or HT/HU cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test performed at $0\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in circulating air.

Prior to this test, the cell shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at $0,2\text{ }I_t\text{ A}$ to a final voltage of 1,0 V and stored, at $0\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

Charge and discharge shall be carried out at constant current, using the conditions specified in Table 20. The discharge condition A or B may be chosen to suit the user's requirements.

Table 20 – Overcharge at $0\text{ }^{\circ}\text{C}$

Charge	Discharge A ^a	Discharge B ^a
	LT/LU, MT/MU, HT/HU cells	MT/MU, HT/HU cells
$0,05\text{ }I_t\text{ A}$ for 28 days	$0,2\text{ }I_t\text{ A}$ to 1,0 V	$1,0\text{ }I_t\text{ A}$ to 0,9 V
^a The discharge is carried out immediately on completion of charging.		

The duration of discharge shall not be less than that specified in Table 9.

7.7.3 J cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test performed at $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in circulating air.

Prior to this test, the cell shall be discharged, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of 1,0 V and stored, at $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged, in an ambient temperature of $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, at a constant current of $0,1\text{ }I_t\text{ A}$, for 48 h. After this charging operation, the cell shall be stored, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be discharged at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $0,2\text{ }I_t\text{ A}$ to a final voltage of 1,0 V.

The duration of discharge shall not be less than 5 h.

7.7.4 JT cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test performed at $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in circulating air.

Prior to this test, the cell shall be discharged, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of 1,0 V and stored, at $5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged, in an ambient temperature of $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, at a constant current of $0,05\text{ }I_t\text{ A}$, for 96 h. After this charging operation, the cell shall be stored, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be discharged at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $1,0\text{ }I_t\text{ A}$ to a final voltage of $1,1\text{ V}$.

The duration of discharge shall not be less than 37 min.

7.7.5 R cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test.

Prior to this test, the cell shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of $1,0\text{ V}$.

The cell shall then be charged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $1,0\text{ }I_t\text{ A}$ for 1,2 h or other appropriate charge termination such as $-\Delta V$ or as recommended by the manufacturer. Then charging should be continued in the same ambient temperature at a constant current of $0,1\text{ }I_t\text{ A}$ for 48 h. After this charging operation, the cell shall be stored, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for not less than 1 h and not more than 4 h.

The cell shall then be discharged at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $0,2\text{ }I_t\text{ A}$ to a final voltage of $1,0\text{ V}$.

The duration of discharge shall not be less than 5 h.

7.8 Safety device operation

Warning: EXTREME CAUTION SHALL BE EXERCISED WHEN CARRYING OUT THIS TEST ! CELLS SHALL BE TESTED INDIVIDUALLY, AND IT SHOULD BE NOTED THAT CELLS FAILING TO MEET THE REQUIREMENT COULD BURST WITH EXPLOSIVE FORCE EVEN AFTER THE CELL HAS BEEN DISCONNECTED FROM THE CHARGE CURRENT.
FOR THIS REASON, THE TEST SHALL BE CARRIED OUT IN A PROTECTIVE CHAMBER.

The following test shall be carried out in order to establish that the safety device of the cell will operate to allow the escape of gas when the internal pressure exceeds a critical value.

NOTE Some button cells do not have a safety gas release vent. This test ~~should not be performed~~ is not applicable on this type of cell.

The cell shall undergo a forced discharge in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of $0,0\text{ V}$.

The current shall then be increased to $1,0\text{ }I_t\text{ A}$ and the forced discharge continued in the same ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for 60 min.

During and at the end of this discharge, the cell shall not disrupt or burst. Leakage of electrolyte and deformation of the cell are acceptable.

7.9 Surface temperature limitation device operation (for S cell only)

Warning: EXTREME CAUTION SHALL BE EXERCISED WHEN CARRYING OUT THIS TEST! THE CELL COULD BURST WITH EXPLOSIVE FORCE OR ITS CONTENT COULD FLOW OUT. IN ADDITION, IT SHOULD BE NOTED THAT THE CELL WILL GENERATE HEAT.
FOR THIS REASON, THE TEST SHALL BE CARRIED OUT IN A PROTECTIVE CHAMBER.

The following test shall be carried out in order to establish that the surface temperature limitation device will operate to prevent the cell temperature from excessively rising when the surface temperature limited cell is misused.

After charging in accordance with 7.2, the test shall be carried out as follows:

Test method: Four cells shall be connected in series but one of the four cells shall be placed in a reverse position. In this state, the terminals of the series string are connected by a wire to cause a short circuit. Short-circuit resistance: ~~100 mΩ or less~~ 80 mΩ +/- 20 mΩ.

The test shall be terminated, when one of the following two cases occurs ~~first~~:

- 24 hours have elapsed or
- the cell-case temperature has been reduced by 20 % from the maximum temperature increase.

Then, verify the following:

- ~~the cell has not exploded and not taken~~ there was no cell explosion or fire;
- the cell temperature increase ~~is~~ was less than 45 °C;
- no leakage shall be found by visual inspection.

7.10 Storage

7.10.1 Button cells or batteries, small prismatic cells or batteries, cylindrical cells or batteries

Storage should be carried out according to the recommendations of the manufacturer.

Prior to this test:

- the cell shall be discharged, in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 I_t A, to a final voltage of 1,0 V.
- the battery shall be discharged, in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 I_t A until its voltage is equal to the number of cells series connected times 1,0 V, unless otherwise specified by the manufacturer.

~~#~~ The cell or battery shall then be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;
- 7.3.4 for R cylindrical cells.

The cell or battery shall then be stored on open circuit, at a mean temperature of 20 °C ± 5 °C and a relative humidity of 65 % ± 20 % for ~~12 months~~ a specific period.

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 of cells or batteries stored in charged state:

- the cell shall be discharged in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 I_t A, to a final voltage of 1,0 V.
- the battery shall be discharged in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 I_t A until its voltage is equal to the number of cells series connected times 1,0 V, unless otherwise specified by the manufacturer.

The cell or battery whatever be its storage condition, shall then be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;

- 7.3.4 for R cylindrical cells.

The cell or battery shall then be discharged ~~at each rate of constant current appropriate to cell designation as specified in 7.3.2~~ in accordance with:

- the cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, to a final voltage of 1,0 V.
- the battery shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A until its voltage is equal to the number of cells series connected times 1,0 V, unless otherwise specified by the manufacturer.

Five charge-discharge cycles are permitted for this test. The test shall be terminated at the end of the first cycle which meets the requirement.

The minimum discharge duration ~~for each rate of constant current~~ after each storage time shall not be less than ~~80 % of~~ the values specified in Table 21.

Table 21 – Capacity deterioration due to storage period for cells or batteries

Storage time (T) (from date of manufacture) Ambient temperature of $20\text{ °C} \pm 5\text{ °C}$	Minimum discharge capacity h/min
$T \leq 2$ months	5 h
2 months $< T \leq 6$ months	4 h 30 min
6 months $< T \leq 12$ months	4 h
12 months $< T \leq 18$ months	3 h 30 min

NOTE In the case of a quality acceptance procedure, provisional approval of cell performance ~~may~~ can be agreed, pending satisfactory results on discharge after storage.

7.10.2 Button cells or batteries, small prismatic cells or batteries, cylindrical cells or batteries (high recovery type)

Storage should be carried out according to the recommendations of the manufacturer.

Prior to this test:

- The cell shall be discharged, in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, to a final voltage of 1,0 V.
- The battery shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A until its voltage is equal to the number in the series times 1,0 V, unless otherwise specified by the manufacturer.

High recovery type cell or battery shall then be prepared in a discharged state and a charged state before storage.

For discharged state storage, the cells and batteries shall not receive a charge after they have been discharged as per the above preparation.

For charged state storage, the cells and batteries shall be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;
- 7.3.4 for R cylindrical cells.

The cell or battery shall then be stored on open circuit, at a mean temperature of $20\text{ °C} \pm 5\text{ °C}$ and a relative humidity of $65\% \pm 20\%$ for a specific period.

During the storage period, the ambient temperature shall not, at any time, fluctuate beyond the limits of $20\text{ °C} \pm 10\text{ °C}$.

After completion of the storage period for charged state storage:

- the cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, to a final voltage of 1,0 V.
- the battery shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A until its voltage is equal to the number of cells series connected times 1,0 V, unless otherwise specified by the manufacturer.

The cell or battery, whatever the storage conditions, shall then be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;
- 7.3.4 for R cylindrical cells.

The cell or battery shall then be discharged in accordance with:

- the cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, to a final voltage of 1,0 V.
- The battery shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A until its voltage is equal to the number of cells series connected times 1,0 V, unless otherwise specified by the manufacturer.

Five charge-discharge cycles are permitted for this test. The test shall be terminated at the end of the first cycle which meets the requirement.

The minimum discharge duration after each storage time shall not be less than values specified in Table 22.

High recovery type cells or batteries are tested in a discharged state and a charged state conditions for recovery performance. The minimum discharge duration shall not be less than the criteria in Table 22.

**Table 22 – Capacity deterioration due to storage period
for cells or batteries (high recovery type)**

Storage time (<i>T</i>) (from date of manufacture) Ambient temperature of $20\text{ °C} \pm 5\text{ °C}$	Minimum discharge duration h/min
$T \leq 2$ months	5 h
$2\text{ months} < T \leq 6$ months	4 h 45 min
$6\text{ months} < T \leq 12$ months	4 h 30 min
$12\text{ months} < T \leq 18$ months	4 h 15 min

NOTE In the case of a quality acceptance procedure, provisional approval of cell performance can be agreed, pending satisfactory results on discharge after storage.

7.11 Charge acceptance at +55 °C for LT, MT or HT cylindrical cells

This test is not a requirement. It will be used as reference of performance and is applicable to LT, MT or HT cylindrical cells only.

The cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$ at a constant current of $0,2 I_t$ A to a final voltage of 1,0 V and stored in an ambient temperature of $+55\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h.

The charge acceptance test shall then be carried out in an ambient temperature of $+55\text{ °C} \pm 2\text{ °C}$. Charge and discharge shall be carried out at constant currents, using the conditions specified in Table 23. The discharge conditions A or B may be chosen to suit the user's requirements.

Table 23 – Charge and discharge at $+55\text{ °C}$

Cycle number	Charge	Discharge A or B ^a
1	$0,05\ I_t\text{ A}$ for 48 h	A: $0,2\ I_t\text{ A}$ to $1,0\text{ V}$ or B: $1,0\ I_t\text{ A}$ to $1,0\text{ V}$
2 ^b	$0,05\ I_t\text{ A}$ for 24 h	A: $0,2\ I_t\text{ A}$ to $1,0\text{ V}$ or B: $1,0\ I_t\text{ A}$ to $1,0\text{ V}$
3 ^b	$0,05\ I_t\text{ A}$ for 24 h	A: $0,2\ I_t\text{ A}$ to $1,0\text{ V}$ or B: $1,0\ I_t\text{ A}$ to $1,0\text{ V}$
^a Discharge A is used with LT, MT or HT cells. Discharge B is used with MT or HT cells.		
^b The duration of discharge of cycles 2 and 3 shall be recorded and provided in any report of results.		

7.12 Trickle charge acceptance for JT cylindrical cells

The ability of the cell to withstand a trickle charge acceptance A and B shall be determined by the following test.

The cell shall be discharged, in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2\ I_t\text{ A}$, to a final voltage of $1,0\text{ V}$ and stored, in an ambient temperature using the conditions specified in Table 24, for not less than 16 h and not more than 24 h.

The cell shall then be charged and discharged, in the same ambient temperature, at constant currents, using the conditions specified in Table 24.

The duration of discharge shall not be less than the values specified in Table 24.

Table 24 – Trickle charge acceptance for JT cylindrical cells

Condition	Ambient temperature	Charge	Discharge	Minimum discharge duration
A (45 °C)	$45\text{ °C} \pm 2\text{ °C}$	$0,033\ I_t\text{ A}$ for 48 h	$1,0\ I_t\text{ A}$ to $1,1\text{ V}$	37 min
A (5 °C)	$5\text{ °C} \pm 2\text{ °C}$	$0,033\ I_t\text{ A}$ for 48 h	$1,0\ I_t\text{ A}$ to $1,1\text{ V}$	37 min
B (45 °C)	$45\text{ °C} \pm 2\text{ °C}$	$0,04\ I_t\text{ A}$ for 24 h	$1,0\ I_t\text{ A}$ to $1,1\text{ V}$	25 min
B (5 °C)	$5\text{ °C} \pm 2\text{ °C}$	$0,04\ I_t\text{ A}$ for 24 h	$1,0\ I_t\text{ A}$ to $1,1\text{ V}$	25 min

7.13 Internal resistance

7.13.1 General

The internal resistance of sealed nickel-metal hydride small prismatic or cylindrical rechargeable single cells shall be checked either by the alternating current (AC) or by the direct current (DC) method.

Should the need arise for the internal resistance to be measured by both AC and DC methods on the same cell, then the AC method shall be used first, followed by the DC method. In this

case, it is not necessary to discharge and charge the cell between conducting AC and DC methods.

Prior to the measurements, the cell shall be discharged at $0,2 I_t$ A to a final voltage of 1,0 V. The cell shall be charged in accordance with 7.2. After charging, the cell shall be stored, in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, for not less than 1 h and not more than 4 h.

The measurement of internal resistance shall be carried out in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$.

7.13.2 Measurement of the internal AC resistance

The alternating RMS voltage, U_a , shall be measured when applying to the cell an alternating RMS current, I_a , at the frequency of $1,0\text{ kHz} \pm 0,1\text{ kHz}$ for a period of 1 s to 5 s.

The internal AC resistance, R_{ac} , is given by

$$R_{ac} = \frac{U_a}{I_a} \Omega$$

where

U_a is the alternating RMS voltage;

I_a is the alternating RMS current.

NOTE 1 The alternating current ~~should be~~ is selected so that the peak voltage stays below 20 mV.

NOTE 2 This method will measure the impedance which, in the range of frequency specified, is approximately equal to the resistance.

NOTE 3 Connections to the battery terminals ~~should be~~ are made in such a way that voltage measurement contacts are separate from contacts used to carry current.

7.13.3 Measurement of the internal DC resistance

The cell shall be discharged at a constant current of value I_1 as specified in Table 25. At the end of a discharge period of 10 s, the voltage U_1 during discharge shall be measured and recorded. The discharge current shall then be immediately increased to a constant value of I_2 as specified in Table 25 and the corresponding voltage U_2 during discharge shall be measured and recorded again at the end of a discharge period of 3 s.

All voltage measurements shall be made at the terminals of the cell independently of contacts used to carry current.

The internal DC resistance, R_{dc} , of the cell shall be calculated using the following formula:

$$R_{dc} = \frac{U_1 - U_2}{I_2 - I_1} \Omega$$

where

I_1, I_2 are the constant discharge currents;

U_1, U_2 are the appropriate voltages measured during discharge.

**Table 25 – Constant discharge currents used
for measurement of DC resistance**

Current	Cell designation		
	HRL ^a	HRM ^a HRH ^a	HRX
I_1	0,2 I_t A	0,5 I_t A	1,0 I_t A
I_2	2,0 I_t A	5,0 I_t A	10,0 I_t A

^a And corresponding "T", "S" and "R" cells.

8 Mechanical tests

Mechanical tests shall be performed according to IEC 61959.

9 Safety requirements

Safety requirements shall be fulfilled according to IEC 62133-1.

10 Type approval and batch acceptance

10.1 General

Content of type approval and batch acceptance shall be agreed between supplier and purchaser. Unless otherwise agreed between supplier and purchaser, the following tests shall be performed.

10.2 Type approval

10.2.1 Type approval for small prismatic cells and button cells

For type approval, the sequence of tests and sample sizes given in Tables 26, 27, 28 and 29 shall be used. Six groups of cells denominated A, B, C, D, E and F respectively, shall be tested. The total number of cells required for type approval is 41, 61, 41 and 61. This total includes an extra cell, permitting a repeat test to cover any incident which may occur outside the supplier's responsibility.

Tests shall be carried out in sequence within each group of cells. All cells are subjected to the tests in group A, after which they are divided into five groups at random according to the sample sizes shown in Tables 26, 27, 28 and 29.

The number of defective cells tolerated per group, and in total, is given in Tables 26, 27, 28 and 29. 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 26 – Sequence of tests for type approval for small prismatic ~~and for button~~ cells

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	27 41	5.3 6.1 7.3.2 7.3.2	Marking Dimensions Discharge at 20 °C at 0,2 I _t A Discharge at 20 °C at 1,0 I _t A (M, J, H and X cells) 5,0 I _t A (H and X cells) 10,0 I _t A (X cells only)	0	3
B	5	7.3.3 7.3.3	Discharge at 0 °C, at 0,2 I _t A Discharge at 0 °C, at 1,0 I _t A (M, J, H and X cells) 2,0 I _t A (H and X cells) 3,0 I _t A (X cells only)	1	
C	5	7.7 7.8	Overcharge Safety Gas release device operation	0	
D	5	7.5	Endurance in cycles	1	
E	6 5	7.4	Charge (capacity) retention	1	
F	5 20	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C, at 0,2 I _t A	1	

**Table 27 – Sequence of tests for type approval
for small prismatic cells (high recovery type)**

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	61	5.3	Marking	0	3
		6.1	Dimensions		
		7.3.2	Discharge at 20 °C, at 0,2 I _t A		
		7.3.2	Discharge at 20 °C, at		
			1,0 I _t A (M, J, H and X cells) 5,0 I _t A (H and X cells) 10,0 I _t A (X cells only)		
B	5	7.3.3	Discharge at 0 °C, at 0,2 I _t A	1	
		7.3.3	Discharge at 0 °C, at		
			1,0 I _t A (M, J, H and X cells) 2,0 I _t A (H and X cells) 3,0 I _t A (X cells only)		
C	5	7.7	Overcharge	0	
		7.8	Gas release device operation		
D	5	7.5	Endurance in cycles	1	
E	5	7.4	Charge (capacity) retention	1	
F	40	7.10	Storage	1	
			Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months		
		7.3.2	Discharge at 20 °C, at 0,2 I _t A		

Table 28 – Sequence of tests for type approval for button cells

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	41	5.3	Marking	0	3
		Clause 6	Dimensions		
		7.3.2	Discharge at 20 °C, at 0,2 I_t A		
		7.3.2	Discharge at 20 °C, at 1,0 I_t A		
B	5	7.3.3	Discharge at 0 °C, at 0,2 I_t A	1	
		7.3.3	Discharge at 0 °C, at 1,0 I_t A (M, J, H and X cells) 2,0 I_t A (H and X cells) 3,0 I_t A (X cells only)		
C	5	7.7	Overcharge	0	
		7.8	Gas release device operation		
D	5	7.5	Endurance in cycles	1	
E	5	7.4	Charge (capacity) retention	1	
F	20	7.10	Storage	1	
			Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months		
		7.3.2	Discharge at 20 °C, at 0,2 I_t A		

**Table 29 – Sequence of tests for type approval for button cells
(high recovery type)**

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	61	5.3	Marking	0	3
		6.2	Dimensions		
		7.3.2	Discharge at 20 °C, at 0,2 I_t A		
		7.3.2	Discharge at 20 °C, at 1,0 I_t A		
B	5	7.3.3	Discharge at 0 °C, at 0,2 I_t A	1	
		7.3.3	Discharge at 0 °C, at 1,0 I_t A (M, J, H and X cells) 2,0 I_t A (H and X cells) 3,0 I_t A (X cells only)		
C	5	7.7	Overcharge	0	
		7.8	Gas release device operation		
D	5	7.5	Endurance in cycles	1	
E	5	7.4	Charge (capacity) retention	1	
F	40	7.10	Storage	1	
			Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months		
		7.3.2	Discharge at 20 °C, at 0,2 I_t A		

10.2.2 Type approval for cylindrical cells

For type approval, the sequence of tests and sample sizes given in Tables 30 and 31 shall be used. Seven groups of cells denominated A, B, C, D, E, F and G respectively, shall be tested. The total number of cells required for type approval is 46 and 66. This total includes an extra cell, permitting a repeat test to cover any incident which may occur outside the supplier's responsibility.

Tests shall be carried out in sequence within each group of cells. All cells are subjected to the test in group A, after which they are divided into six groups at random according to the sample sizes shown in Tables 30 and 31.

The number of defective cells tolerated per group, and in total, is given in Tables 30 and 31. 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 30 – Sequence of tests for type approval for cylindrical cells

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	32 46	5.3 6.1 7.3.2 7.3.2	Marking Dimensions Discharge at 20 °C at 0,2 I_t A Discharge at 20 °C at 1,0 I_t A (M, H, J and X cells) ^a 5,0 I_t A (H and X cells) ^a 10,0 I_t A (X cells only)	0	3
B	5	7.3.3 7.3.3	Discharge at 0 °C at 0,2 I_t A Discharge at 0 °C, at 1,0 I_t A (M, J, H and X cells) ^a 2,0 I_t A (H and X cells) ^a 3,0 I_t A (X cells only)	1	
C	5	7.7 7.8	Overcharge Safety device operation	0	
D	5	7.5.1	Endurance in cycles	1	
E	5	7.5.2 7.8	Permanent charge endurance Safety Gas release device operation	1 0	
F	6 5	7.4	Charge (capacity) retention	1	
G	5 20	7.10 7.3.2 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C at 0,2 I_t A Discharge at 20 °C at ~~1,0 I_t A (M, H and X cells) ^a~~ ~~5,0 I_t A (H and X cells) ^a~~ ~~10,0 I_t A (X cells only)~~	1	

^a And corresponding "T", "U" and "R" cells.

Table 31 – Sequence of tests for type approval for cylindrical cells (high recovery type)

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	66	5.3	Marking	0	3
		6.1	Dimensions		
		7.3.2	Discharge at 20 °C at 0,2 I_t A		
		7.3.2	Discharge at 20 °C at		
			1,0 I_t A (M, H, J and X cells) ^a 5,0 I_t A (H and X cells) ^a 10,0 I_t A (X cells only)		
B	5	7.3.3	Discharge at 0 °C at 0,2 I_t A	1	
		7.3.3	Discharge at 0 °C, at		
			1,0 I_t A (M, J, H and X cells) ^a 2,0 I_t A (H and X cells) ^a 3,0 I_t A (X cells only)		
C	5	7.7	Overcharge	0	
		7.8	Gas release device operation		
D	5	7.5.1	Endurance in cycles	1	
E	5	7.5.2	Permanent charge endurance	1	
		7.8	Safety device operation	0	
F	5	7.4	Charge (capacity) retention	1	
G	40	7.10	Storage	1	
			Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months		
		7.3.2	Discharge at 20 °C at 0,2 I_t A		
^a And corresponding "T", "U" and "R" cells.					

^a And corresponding "T", "U" and "R" cells.

10.2.3 Type approval for batteries

For type approval, the sequence of tests and sample sizes given in Table 32 and 33 shall be used. Two groups of batteries, denominated A and B respectively, shall be tested. The total number of batteries required for type approval is 21 and 41. This total includes an extra battery, permitting a repeat test to cover any incident which may occur outside the supplier's responsibility.

Tests shall be carried out in sequence within each group of batteries. All batteries are subjected to the tests in group A, after which they are designated group B excluding an extra battery at random according to the sample sizes shown in Table 32 and 33.

The number of defective batteries tolerated per group, and in total, is given in Table 32 and 33. A battery is considered to be defective if it does not meet the requirements of all or part of the tests of a group.

Table 32 – Sequence of tests for type approval for batteries

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	21	5.3	Marking	0	1
		7.3.2	Discharge at 20 °C at 0,2 I _t A		
B	20	7.10	Storage	1	
			Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months		
		7.3.2	Discharge at 20 °C at 0,2 I _t A		

Table 33 – Sequence of tests for type approval for batteries (high recovery type)

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	41	5.3	Marking	0	1
		7.3.2	Discharge at 20 °C at 0,2 I _t A		
B	40	7.10	Storage	1	
			Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months		
		7.3.2	Discharge at 20 °C at 0,2 I _t A		

10.3 Batch acceptance

These tests are applicable to deliveries of individual cells.

The sampling procedure ~~shall~~ **should** be established in accordance with IEC 60410. Unless otherwise agreed between supplier and purchaser, inspections and tests shall be performed using inspection levels and AQLs (acceptable quality level) recommended in Table 34.

Table 34 – Recommended test sequence for batch acceptance

Group	Clause or subclause	Inspection/tests	Recommendation	
			Inspection level	AQL %
A	As agreed	Visual inspection		
		– absence of mechanical damage	II	4
		– absence of corrosion on case and terminals	II	4
		– number, position and secure fittings of connection tabs	S3	1
B	Clause 6 As agreed 5.3	– absence of liquid electrolyte on case and terminals	II	0,65
		Physical inspection		
		– dimensions	S3	1
		– weight	S3	1
C	7.3.2 7.3.2	– marking	S3	1
		Electrical inspection		
		– open-circuit voltage and polarity	II	0,65
		– discharge at 20 °C at 0,2 I_t A	S3	1
		– discharge at 20 °C at 1,0 I_t A	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.				

Bibliography

IEC 60051 (all parts), *Direct acting indicating analogue electrical measuring instruments and their accessories*

IEC 60086 (all parts), *Primary batteries*

IEC 60410, *Sampling plans and procedures for inspection by attributes*¹

IEC 60485, *Digital electronic d.c. voltmeters and d.c. electronic analogue-to-digital convertors*²

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

¹ This publication was withdrawn.

² This publication was withdrawn.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary sealed cells and batteries for portable applications – Part 2: Nickel-metal hydride

Accumulateurs alcalins et autres accumulateurs à électrolyte non acide – Accumulateurs étanches pour applications portables – Partie 2: Nickel-métal hydrure

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SECONDARY CELLS AND BATTERIES CONTAINING
ALKALINE OR OTHER NON-ACID ELECTROLYTES –
SECONDARY SEALED CELLS AND BATTERIES
FOR PORTABLE APPLICATIONS –****Part 2: Nickel-metal hydride****FOREWORD**

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International Standard IEC 61951-2 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 fourth edition cancels and replaces the third edition published in 2011 of which it constitutes a technical revision.

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

- addition of battery type;
- addition of 'F' (high recovery type) designation for cells and batteries;
- addition of 'I' (low self-discharge type) designation for cells;

- revision of Figure 3 (6.1.3.1);
- addition of “optional pip” note to positive contact;
- changed leader line position from pip to flats of positive contact (B and G).

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

FDIS	Report on voting
21A/623/FDIS	21A/629/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.

A list of all parts of the IEC 61951 series can be found, under the general title *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary sealed cells and batteries for portable applications*, on the IEC website.

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.

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SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – SECONDARY SEALED CELLS AND BATTERIES FOR PORTABLE APPLICATIONS –

Part 2: Nickel-metal hydride

1 Scope

This part of IEC 61951 specifies marking, designation, dimensions, tests and requirements for secondary sealed nickel-metal hydride small prismatic, cylindrical and button cells and batteries, suitable for use in any orientation, for portable applications.

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 (IEV) – Part 482: Primary and secondary cells and batteries*

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

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

IEC 61959, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Mechanical tests for sealed portable secondary cells and batteries*

IEC 62133-1, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells and for batteries made from them, for use in portable applications – Part 1: Nickel systems*

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

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 sealed nickel-metal hydride 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 – Addition of Notes 1 and 2 to entry.]

3.2

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.

Note 2 to entry: The capacity of a battery is the quantity of electricity C_5 Ah (ampere-hours) declared by the manufacturer which a battery can deliver during a 5 h period, when charged, stored and discharged under the procedure described in 7.3.2.

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – Addition of Notes 1 and 2 to entry.]

3.3

small prismatic cell

cell in the form of a rectangular parallelepiped whose width and thickness dimensions are not more than 25 mm

3.4

cylindrical cell

cell of circular cross-section in which the overall height is equal to, or greater than the overall diameter

3.5

button cell

cell of circular cross-section in which the overall height is less than the overall diameter

3.6

nickel-metal hydride cell

cell containing a nickel hydroxide compound for the positive electrode, a hydrogen absorbing alloy for the negative electrode, and potassium hydroxide or other alkaline solution as electrolyte

Note 1 to entry: Positive electrodes are isolated from negative electrodes by a separator

3.7

nickel-metal hydride battery

assembly of secondary cell(s) as a source of electrical energy characterized by its voltage, size, terminal arrangement, capacity and rate capability

3.8

sealed cell

cell which remains closed and does not release either gas or liquid when operated within the limits of charge and temperature specified by the manufacturer

Note 1 to entry: The cell is equipped with a safety device to prevent dangerously high internal pressure.

Note 2 to entry: The cell does not require addition to the electrolyte and is designed to operate during its life in its original sealed state.

Note 3 to entry: The nickel-metal hydride cell, however, may release gas towards the end of its life due to the accumulation of hydrogen in the cell.

[SOURCE: IEC 60050-482:2004, 482-05-17, modified – The existing note has been developed into Notes 1, 2 and 3 to entry.]

3.9**portable cell**

cell designed mainly for use in an easily hand-carried battery

3.10**battery for portable applications**

battery for use in device or appliance which is conveniently hand-carried

3.11**surface temperature limited cell**

cell which performs a function that prevents the temperature increase from a certain standard point even at the moment of an abnormal occurrence such as short circuit of cell

3.12**high recovery type cell or battery**

cell or battery which has lower "permanent capacity loss" than normal type after storage

Note 1 to entry: It is defined as "high recovery type" in 7.10.2, Table 22.

3.13**low self-discharge type cell**

cell which is able to retain higher charge capacity than normal type after storage by reducing self-discharge

Note 1 to entry: It is defined as "low self-discharge type" in 7.4.

3.14**9 V type nickel-metal hydride battery**

nickel-metal hydride battery which is interchangeable with 9 V primary batteries and is composed of cylindrical cells, small prismatic cells or button cells

4 Parameter measurement tolerances

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

- a) ± 1 % for voltage;
- b) ± 1 % for current;
- c) ± 1 % for capacity;
- d) ± 2 °C for temperature;
- e) $\pm 0,1$ % for time;
- f) $\pm 0,1$ mm for dimensions;
- g) ± 5 % for humidity.

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 each report of results.

5 Cell and battery designation and marking

5.1 Cell and battery designation

5.1.1 Small prismatic cells and cylindrical cells

5.1.1.1 General

Sealed nickel-metal hydride small prismatic rechargeable single cells and cylindrical rechargeable single cells shall be designated by a letter L, M, J, H or X which signifies:

- low rate of discharge (L);
- medium rate of discharge (M);
- medium high rate of discharge (J);
- high rate of discharge (H);
- very high rate of discharge (X).

NOTE 1 These 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;
- J up to $5,0 I_t$ 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).

When a cell is intended for permanent charge at elevated temperatures, typically higher than 40 °C, a letter "T" is placed after the letter L, M, J, H or X.

When a cell is intended for permanent charge at elevated temperatures, typically higher than 50 °C, a letter "U" is placed after the letter L, M, J, H or X.

When a cell is intended for surface temperature limitation, a letter "S" is placed after the letter L or M.

When a cell is intended for rapid charge, typically at $1,0 I_t$ A, a letter "R" is placed after the letter L, M, J, H or X.

When a cell or battery is intended as a high recovery type, a letter "F" is placed after the letter L, M, J, H or X.

When a cell is intended as a low self-discharge cell, a letter "I" is placed after the letter L, M, J, H or X.

5.1.1.2 Small prismatic cells

Sealed nickel-metal hydride small prismatic rechargeable single cells shall be designated by the letters "HF" followed by a letter L, M, J, H or X followed by letter F, followed by, if designated, letter I, followed by three groups of figures, each group being separated by a solidus, as follows:

- a) The two figures to the left of the first solidus shall indicate the maximum width specified for the cell, expressed in millimetres, rounded up to the next whole number.
- b) The two figures in the middle shall indicate the maximum thickness specified for the cell, expressed in millimetres, rounded up to the next whole number.

- c) The two figures to the right of the second solidus shall indicate the maximum height specified for the cell, expressed in millimetres, rounded up to the next whole number.

EXAMPLE HFLF 18/07/49 designation identifies a small prismatic cell of low discharge rate capability, high recovery type with a maximum width of 18 mm, a maximum thickness of 7 mm and a maximum height of 49 mm.

5.1.1.3 Cylindrical cells

Sealed nickel-metal hydride cylindrical rechargeable single cells shall be designated by the letters "HR" followed by a letter L, M, J, H or X followed by letter F, followed by, if designated, letter I, followed by two groups of figures, each group being separated by a solidus, as follows:

- a) The two figures to the left of the solidus shall indicate the maximum diameter specified for the cell, expressed in millimetres, rounded up to the next whole number.
- b) The two figures to the right of the solidus shall indicate the maximum height specified for the cell, expressed in millimetres, rounded up to the next whole number.

When a manufacturer designs a cell with dimensions and tolerances which make it interchangeable with a primary cell, the designation of Table 2 shall also be marked on the cell.

EXAMPLE 1 HRLF 33/62 designation identifies a cylindrical cell of low discharge rate capability, high recovery type with a maximum diameter of 33 mm and a maximum height of 61,5 mm.

EXAMPLE 2 HRLTF 33/62 designation identifies a cylindrical cell of low discharge rate capability, intended for permanent charge at elevated temperatures, high recovery type, with a maximum diameter of 33 mm and a maximum height of 61,5 mm.

EXAMPLE 3 HRXRFI 23/43 designation identifies a cylindrical cell of very high discharge rate capability, intended for rapid charge, high recovery type, low self-discharge type with a maximum diameter of 23 mm and a maximum height of 43 mm.

For cells dimensionally interchangeable with primary cells, the following single or double figures following the letter F or I may indicate:

- 20- Size D;
- 14- Size C;
- 6- Size AA;
- 03- Size AAA.

NOTE Cells dimensionally interchangeable with primary cells correspond to M type unless otherwise specified

For the purpose of this explanation, an example is given below.

EXAMPLE 4 HRMRFI03 designation identifies a sealed nickel-metal hydride cylindrical rechargeable single cell, of medium discharge rate capability, also intended for rapid charge, high recovery type and low self-discharge type, dimensionally interchangeable with primary cell and whose type designation is AAA.

5.1.2 Button cells

Sealed nickel-metal hydride button rechargeable single cells shall be designated by the letters "HB" followed by letter F, followed by, if designated, letter I, followed by two groups of figures, each group being separated by a solidus, as follows:

- a) The three figures to the left of the solidus shall indicate the maximum diameter specified for the cell, expressed in tenths of millimetres, rounded up to the next whole number.
- b) The three figures to the right of the solidus shall indicate the maximum height specified for the cell, expressed in tenths of millimetres, rounded up to the next whole number.

EXAMPLE HBFI 116/054 designation identifies a button cell, intended as a high recovery type, low self-discharge type, with a maximum diameter of 11,6 mm and a maximum height of 5,4 mm.

5.1.3 Batteries

Sealed nickel-metal hydride rechargeable batteries shall be designated with the following form:

N1 single cell designation – N2

where

N1 is the number of series connected cells in the battery;

N2 is the number of parallel connected cells if 2 or greater (not shown if value is 1).

Sealed nickel-metal hydride battery designation will be identified based on single cells within the series and not the battery as a whole.

- Small prismatic cells in battery

EXAMPLE 1 2HFLF 18/07/49 designation identifies a small prismatic cell of low discharge rate capability, high recovery type with a maximum width of 18 mm, a maximum thickness of 7 mm and a maximum height of 49 mm with two series connected cells.

- Cylindrical cells in battery

EXAMPLE 2 3HRLF 33/62 designation identifies a cylindrical cell of low discharge rate capability, high recovery type with a maximum diameter of 33 mm and a maximum height of 61,5 mm with three series connected cells.

EXAMPLE 3 4HRLTF 33/62 designation identifies a cylindrical cell of low discharge rate capability, intended for permanent charge at elevated temperatures, high recovery type, with a maximum diameter of 33 mm and a maximum height of 61,5 mm with four series connected cells.

EXAMPLE 4 HRXRFI 23/43 -2 designation identifies a cylindrical cell of very high discharge rate capability, intended for rapid charge, high recovery type, low self-discharge type with a maximum diameter of 23 mm and a maximum height of 43 mm with two parallel connected cells.

- Cells interchangeable with primary cells in batteries

EXAMPLE 5 HRMRFI03-3 designation identifies a sealed nickel-metal hydride cylindrical rechargeable single cell, of medium discharge rate capability, also intended for rapid charge, high recovery type and low self-discharge type, dimensionally interchangeable with primary cell whose type designation is AAA with three parallel connected cells.

- Button cells in battery

EXAMPLE 6 HB 116/054-3 designation identifies a button cell, with a maximum diameter of 11,6 mm and a maximum height of 5,4 mm with three parallel connected cells.

5.2 Cell or battery termination

This standard does not specify cell or battery termination.

5.3 Marking

5.3.1 Small prismatic cells and cylindrical cells

Each jacketed cell supplied without connections shall carry durable markings giving the following minimum information:

- sealed rechargeable nickel-metal hydride or Ni-MH;
- rated capacity;
- nominal voltage;
- polarity (+ and –);
- date of manufacture (which may be in code);
- name or identification of manufacturer or supplier;
- mark for promoting useful use of cell resources.

NOTE 1 This mark is applied where a recycling programme is available.

NOTE 2 In general, sealed nickel-metal hydride rechargeable single cells with connection tabs need no labels if they form an integral part of a battery, in which case, the battery itself is marked with the above information.

5.3.2 Button cells

Each button cell supplied without connection shall carry durable markings giving the following minimum information:

- designation as specified in 5.1;
- polarity (+ and –);
- date of manufacture (which may be in code);
- name or identification of manufacturer or supplier.

5.3.3 Batteries

Each battery shall carry durable markings giving the following minimum information:

- rated capacity;
- nominal voltage;
- date of manufacture (which may be in code).

5.4 Exemption of wording

Each cell or battery shall include minimum information on the label as specified in 5.3.1 to 5.3.3. Therefore, additional information such as safety cautions should be included in the form of a manual not on the cell or battery label.

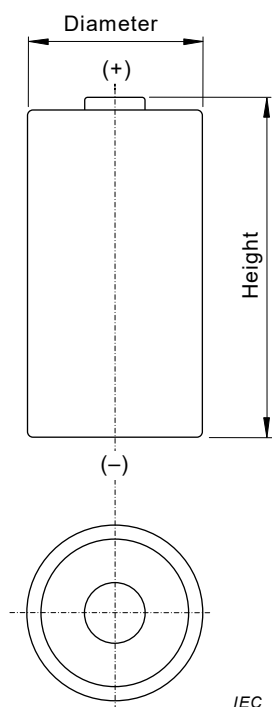
Each cell or battery shall include minimum information on the label as specified in 5.3.1 to 5.3.3. Therefore, cells or batteries encased in soft or hard plastic with the safety cautions printed on the outside should not include caution details on the cell or battery label.

6 Dimensions

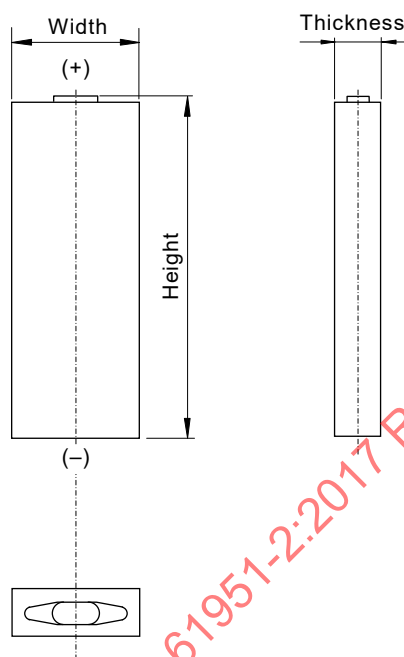
6.1 Small prismatic cells and cylindrical cells

6.1.1 General

Figures 1 and 2 show the shape of the cells.



IEC



IEC

Figure 1 – Jacketed cylindrical cells

Figure 2 – Jacketed small prismatic cells

6.1.2 Small prismatic cells

Table 1 shows the dimensions for jacketed small prismatic cells.

Table 1 – Dimensions of jacketed small prismatic cells

Cell designation	Width mm	Thickness mm	Height mm
HF 15/08/49	14,5	7,4	48,2
HF 15/09/49	14,5	8,3	48,2
HF 16/07/34	16,0	6,6	34,0
HF 18/07/36	17,3	6,1	35,7
HF 18/07/49	17,3	6,1	48,2
HF 18/09/49	17,3	8,3	48,2
HF 18/07/68	17,3	6,1	67,3
HF 18/11/68	17,3	10,7	67,3
HF 18/18/68	17,3	17,3	67,3
HF 23/11/68	22,7	10,7	67,3
HF 23/15/68	22,7	14,5	67,3

6.1.3 Cylindrical cells

6.1.3.1 Cells dimensionally interchangeable with primary cells

Table 2 gives the requirements relative to the dimensions for jacketed cylindrical cells which are dimensionally interchangeable with primary cells (see Figure 3).

Table 2 – Dimensions of jacketed cylindrical cells dimensionally interchangeable with primary cells

Cell designation ^a	Type designation (reference) ^b	Corresponding primary cell ^c	Nominal voltage V	Dimensions mm										
				A	B	C	D ^d	E	F		G	Φ		ΦP
				Max	Min	Min	—	Max	Max	Min	Min	Max	Min	Max
HR03	AAA	R03 LR03	1,2	44,5	(43,3)	4,3		0,5	3,8	(2,0)	0,8	10,5	9,5	0,4
HR6	AA	R6 LR6		50,5	(49,2)	7,0		0,5	5,5	(4,2)	1,0	14,5	13,5	0,5
HR14	C	R14 LR14		50,0	(48,6)	13,0		0,9	7,5	(5,5)	1,5	26,2	24,9	1,0
HR20	D	R20 LR20		61,5	(59,5)	18,0		1,0	9,5	(7,8)	1,5	34,2	32,3	1,0

NOTE Figures in parentheses are reference values.

^a Cell designations shall be in accordance with the nomenclature rules given in IEC 60086-1.

^b In some countries these cell types are also known as AAA (R 03); AA (R 6); C (R 14); D (R 20).

^c Carbon zinc cells (R) and alkaline primary cells (LR) shall be compliant with the provisions of IEC 60086-2, respectively.

^d There is no specification for the value “D” for sealed nickel-metal-hydride cylindrical rechargeable single cells interchangeable with primary cells.

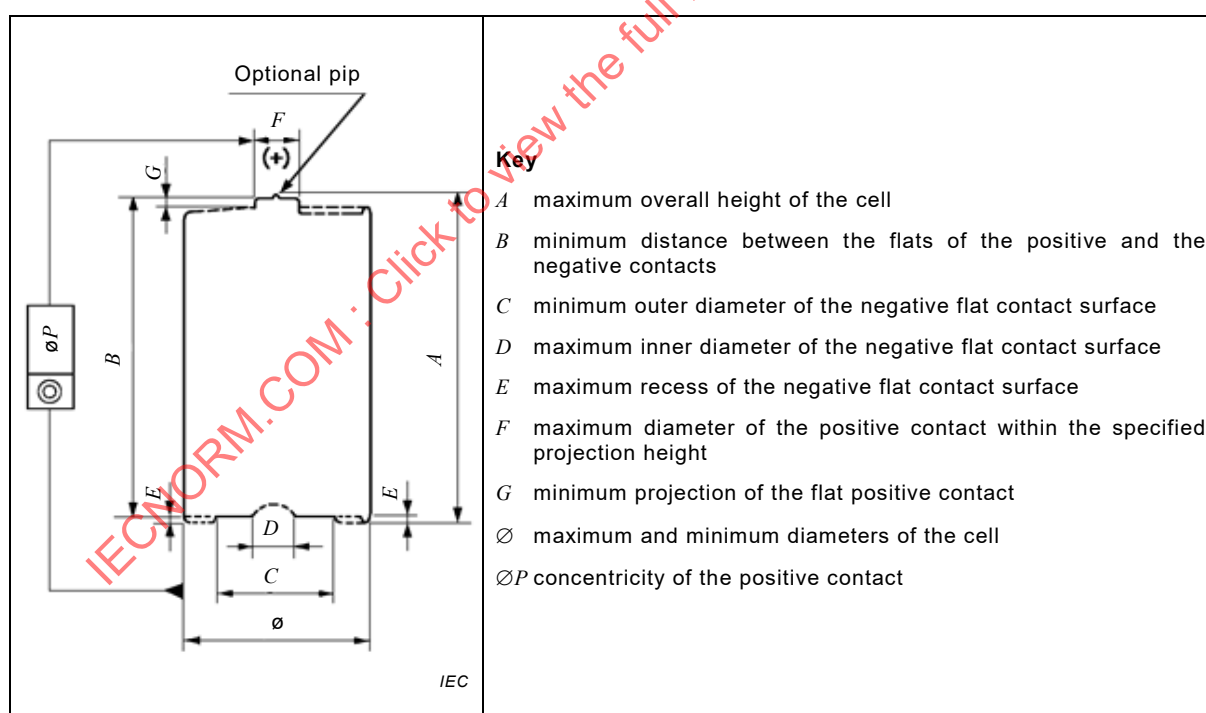


Figure 3 – Jacketed cells dimensionally interchangeable with primary cells

6.1.3.2 Cells not dimensionally interchangeable with primary cells

Table 3 shows the dimensions for jacketed cylindrical cells not dimensionally interchangeable with primary cells.

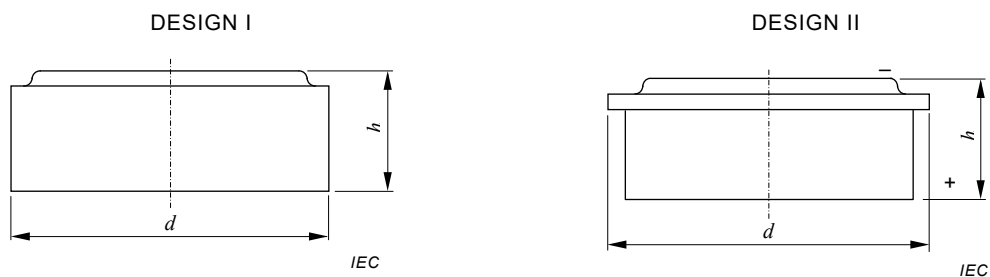
**Table 3 – Dimensions of jacketed cylindrical cells
not dimensionally interchangeable with primary cells**

Cell designation ^a	Diameter mm	Height mm
HR 11/45	10,5	44,5
HR 11/51	10,5	50,5
HR 11/67	10,5	67,0
HR 15/43	14,5	43,0
HR 15/49	14,5	49,0
HR 15/51	14,5	50,5
HR 15/67	15,0	67,0
HR 17/29	17,0	28,5
HR 17/43	17,0	43,0
HR 17/50	17,0	50,0
HR 17/67	17,0	67,0
HR 18/44	18,0	43,5
HR 18/67	18,0	67,0
HR 19/67	19,0	67,0
HR 23/34	23,0	34,0
HR 23/43	23,0	43,0
HR 23/44	23,0	43,5
HR 23/50	23,0	50,0
HR 23/60	23,0	61,0
HR 26/47	25,8	47,0
HR 26/50	25,8	50,0
HR 33/36	33,0	36,0
HR 33/62	33,0	61,5
HR 33/91	33,0	91,0
HR 34/60	33,5	59,5

^a The letters HR to be followed by L, M, H or X and T and/or R as appropriate (see 5.1).

6.2 Button cells

Cells shall be constructed as design I or II (see Figure 4 below).



NOTE The polarity of design I is not standardized.

Figure 4 – Button cells

Table 4 shows the dimensions of sealed nickel-metal hydride button rechargeable single cells.

Table 4 – Dimensions of button cells

Cell designation	Diameter, d mm		Height, h mm	
HB 079/054	7,9	0 -1,0	5,4	0 -0,6
HB 116/054	11,6		5,4	
HB 156/064	15,6	0 -0,3	6,4	
HB 222/048	22,2		4,8	
HB 252/061	25,2		6,1	
HB 252/065	25,2		6,5	
HB 252/078	25,2		7,8	
HB 347/060	34,7		6,0	

6.3 9 V type nickel-metal hydride batteries

Figure 5 shows the shape of 9 V type nickel-metal hydride batteries.

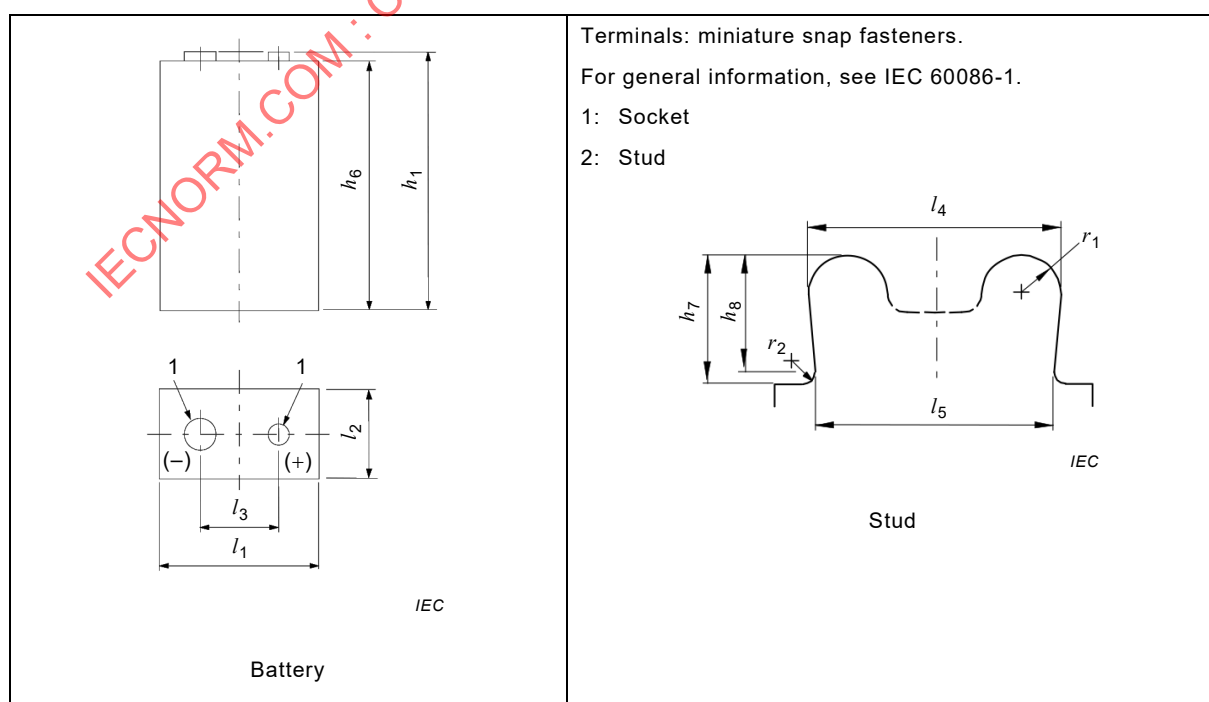


Figure 5 – 9 V type nickel-metal hydride batteries

Table 5 shows the dimensions of 9 V type nickel-metal hydride batteries.

Table 5 – Dimensions of 9 V type nickel-metal hydride batteries

Type designation	Corresponding primary battery	Nominal voltage V	Dimensions mm											
				h_1	h_6	l_1	l_2	l_3	h_7	h_8	l_4	l_5	r_1	r_2
006P	6F22	8,4	Max	48,5	46,4	26,5	17,5	12,95	3,10		5,77			
	6LR61 6LP3146	7,2	Min.	46,5	–	24,5	15,5	12,45	2,90	(2,55)	5,67	(5,38)	(0,8)	(0,4)

7 Electrical tests

7.1 General

Charge and discharge currents for the tests in accordance with this Clause 7 and with Clause 5 shall be based on 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.

In all tests, except where noted, no leakage of electrolyte in liquid form shall be observed.

7.2 Charging procedure for test purposes

7.2.1 Charging procedure for cell

Prior to charging, the cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, down to a final voltage of 1,0 V.

Unless otherwise stated in this document, the charging procedure for test purposes shall be carried out in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, a relative humidity of $65\% \pm 20\%$, at a constant current of $0,1 I_t$ A, for 16 h. The tests shall be performed within 2 months of the manufacture date. Manufacture date is determined by the manufacturer.

7.2.2 Charging procedure for battery

Prior to charging, the battery shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A until its voltage is equal to the number in the series connected cells times 1,0 V, unless otherwise specified by the manufacturer.

The charging procedure for the battery shall be carried out as recommended by the manufacturer in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$ and a relative humidity of $65\% \pm 20\%$. The tests shall be performed within 2 months of manufacture date. The manufacture date is determined by the manufacturer.

7.3 Discharge performance

7.3.1 General

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

7.3.2 Discharge performance at 20 °C

7.3.2.1 General

The cell or battery shall be charged in accordance with 7.2. After charging, the cell or battery shall be stored in an ambient temperature of 20 °C ± 5 °C, for not less than 1 h and not more than 4 h.

7.3.2.2 Discharge performance for cells at 20 °C

The cell shall then be discharged in an ambient temperature of 20 °C ± 5 °C as specified in Tables 6 or Table 7. The duration of discharge shall not be less than the values specified in Tables 6 or Table 7.

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

Table 6 – Discharge performance at 20 °C for small prismatic cells and cylindrical cells

Discharge conditions		Minimum discharge duration h/min			
Rate of constant current A	Final voltage V	Cell designation			
		L/LT/LU/LS	M/MT/MU/MS/J/JT	H/HT/HU	X
0,2 I_t ^a	1,0	5 h	5 h	5 h	5 h
1,0 I_t	0,9	–	42 min	48 min	54 min
5,0 I_t ^b	0,8	–	–	6 min	9 min
10,0 I_t ^b	0,7	–	–	–	4 min

^a Five cycles are permitted per cell for this test. The test shall be terminated at the end of the first cycle of each cell which meets the requirement.

^b Prior to the 5 I_t A and 10 I_t A tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging at 0,1 I_t A in accordance with 7.2 and discharging at 0,2 I_t A in an ambient temperature of 20 °C ± 5 °C according to 7.3.2.

Table 7 – Discharge performance at 20 °C for button cells

Discharge conditions		Minimum discharge duration h/min
Rate of constant current A	Final voltage V	
0,2 I_t ^a	1,0	5 h
1,0 I_t	0,9	35 min

^a Five cycles are permitted for this test. The test shall be terminated at the end of the first cycle which meets the requirement.

7.3.2.3 Discharge performance for batteries at 20 °C

The battery shall then be discharged, as specified in Table 8, in an ambient temperature of 20 °C ± 5 °C at a constant current of 0,2 I_t A until its voltage is equal to the number of series connected cells times 1,0 V, unless otherwise specified by the manufacturer.

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

Table 8 – Discharge performance at 20 °C for batteries

Discharge conditions		Minimum discharge duration h
Rate of constant current A	Final voltage V	
$0,2 I_t^a$	$1,0 \times N^b$	5
^a Five cycles are permitted per battery for this test. The test shall be terminated at the end of the first cycle each battery which meets the requirement. ^b N is the number of series connected cells in the battery.		

7.3.2.4 Rated capacity (mAh) compliance test (example)

Table 9 is an example showing compliance of a cell or battery test sample (sample size 32) when the manufacturer declares a rated capacity of 2 000 mAh.

Table 9 – Rated capacity (mAh) compliance test (example)

Sample n°	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5 ^a	Capacity
1	1 920	1 950	1 900	2 005		2 005
2	2 000					2 000
3	1 920	1 950	2 000			2 000
4	1 860	1 890	1 900	1 950	2 000	2 000
5	2 005					2 005
Samples 6 to 31 ^b	...	...	...	...		...
32	1 970	2 010				2 010
				Rated capacity		2 000
^a Five cycles are permitted for this test.						
^b Individual capacity (mAh) measurements for samples 6 to 31 are not explicitly shown in this table for brevity. When conducting discharge performance testing all 32 samples shall be tested to meet the requirements.						

7.3.3 Discharge performance at 0 °C

The cell shall be charged in accordance with 7.2. After charging, the cell shall be stored, in an ambient temperature of 0 °C ± 2 °C for not less than 16 h and not more than 24 h.

The cell shall then be discharged in an ambient temperature of 0 °C ± 2 °C as specified in Tables 10 or Table 11. The duration of discharge shall not be less than the values specified in Tables 10 or Table 11.

Table 10 – Discharge performance at 0 °C for small prismatic cells and cylindrical cells

Discharge conditions		Minimum discharge duration h/min			
Rate of constant current A	Final voltage V	Cell designation			
		L/LT/LU/LS	M/MT/MU/MS/J	H/HT/HU	X
0,2 I_t	1,0	2 h	4 h	4 h	4 h 30 min
1,0 I_t	0,9	–	36 min	42 min	48 min
2,0 I_t^a	0,8	–	–	15 min	21 min
3,0 I_t^a	0,8	–	–	–	12 min

^a Prior to the 2,0 I_t A and 3,0 I_t A tests, a conditioning cycle may be included if necessary. This cycle shall consist of charging at 0,1 I_t A in accordance with 7.2 and discharging at 0,2 I_t A in an ambient temperature of 20 °C ± 5 °C according to 7.3.2.

Table 11 – Discharge performance at 0 °C for button cells

Discharge conditions		Minimum discharge duration
Rate of constant current A	Final voltage V	h/min
0,2 I_t	1,0	4 h
1,0 I_t	0,9	27 min

7.3.4 Discharge performance for rapid charge cells (R cells)

R cells shall be charged at a constant current of 1,0 I_t A for 1,2 h or other appropriate charge termination method as recommended by the cell manufacturer, followed by a charge at 0,1 I_t A for 2 h, in an ambient temperature of 20 °C ± 5 °C. After charging, the cell shall be stored and discharged as specified in 7.3.2 and 7.3.3.

The duration of discharge shall not be less than the values specified in Table 6 for discharge at 20 °C ± 5 °C and in Table 9 for discharge at 0 °C ± 2 °C.

7.4 Charge (capacity) retention

The charge (capacity) retention shall be determined by the following test. After charging in accordance with 7.2, the cell shall be stored on open circuit for a specified time. 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 be discharged under the conditions specified in 7.3.2 at a rate of 0,2 I_t A. The duration of discharge after 28 days storage at 20 °C shall not be less than:

- 3 h for small prismatic cells and cylindrical cells;
- 3 h 45 min for button cells.

For cells designated as low self-discharge type, defined in 5.1, the duration of discharge after 6 months storage at 20 °C shall not be less than:

- 3 h 45 min for cylindrical cells.

7.5 Endurance

7.5.1 Endurance in cycles

7.5.1.1 General

Prior to the endurance in cycles test, the cell shall be discharged at a constant current of $0,2 I_t$ A to a final voltage of 1,0 V.

The following endurance test shall then be carried out, irrespective of cell designation, in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$. Charge and discharge shall be carried out at constant current throughout, in accordance with the conditions specified in Tables 12, Table 13, Table 14 and Table 15. Precautions shall be taken to prevent the cell-case temperature from rising above 35 °C during the test, by providing a forced air draught if necessary.

NOTE The actual cell temperature, not the ambient temperature, determines cell performance.

7.5.1.2 Small prismatic, button and cylindrical cells not dimensionally interchangeable with primary cells

Table 12 – Endurance in cycles for small prismatic, button and cylindrical cells not dimensionally interchangeable with primary cells

Cycle number	Charge	Stand in charged condition	Discharge
1	$0,10 I_t$ A for 16 h	None	$0,25 I_t$ A for 2 h 20 min ^a
2 to 48	$0,25 I_t$ A for 3 h 10 min	None	$0,25 I_t$ A for 2 h 20 min ^a
49	$0,25 I_t$ A for 3 h 10 min	None	$0,25 I_t$ A to 1,0 V
50	$0,10 I_t$ A for 16 h	1 h to 4 h	$0,20 I_t$ A to 1,0 V ^b
^a If the cell voltage drops below 1,0 V, discharge may be discontinued.			
^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400 and 450.			

Cycles 1 to 50 shall be repeated until the discharge duration on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out.

The endurance test is considered complete when two such successive capacity cycles give discharge durations of less than 3 h. The total number of cycles obtained when the test is completed shall not be less than:

- 400 for small prismatic cells;
- 500 for L/LR, M/MR, J/JR, H/HR or X/XR cells;
- 50 for LT/LU, MT/MU, JT or HT/HU cells;
- 500 for button cells.

7.5.1.3 Cylindrical cells not dimensionally interchangeable with primary cells (accelerated test procedures)

7.5.1.3.1 General

In order to accelerate the test or to use cycling conditions approximating those in actual applications, one of the following alternative procedures, shown in Tables 13, 14 and 15, relevant to the cell may be carried out as an alternative to 7.5.1.2.

7.5.1.3.2 H or X cells

Table 13 – Endurance in cycles for H or X cells

Cycle number	Charge	Stand in charged condition	Discharge	Subsequent rest
1	0,1 I_t A for 16 h	30 min	1,0 I_t A to 1,0 V	30 min to 90 min
2 to 48	0,3 I_t A for 4 h ^a	30 min	1,0 I_t A to 1,0 V	30 min to 90 min
49	0,3 I_t A for 4 h ^a	24 h	1,0 I_t A to 1,0 V	30 min to 90 min
50	0,1 I_t A for 16 h	1 h to 4 h	0,2 I_t A to 1,0 V	^b

^a Or appropriate charge termination, as recommended by the manufacturer.

^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400, and 450.

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 1,0 V on any 49th cycle becomes less than 30 min or until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again the test is terminated.

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

7.5.1.3.3 X cells

Table 14 – Endurance in cycles for X cells

Cycle number	Charge	Stand in charged condition	Discharge	Subsequent rest
1	0,1 I_t A for 16 h	30 min	5,0 I_t A to 0,8 V	30 min to 90 min
2 to 48	1,0 I_t A for 1 h ^a	30 min	5,0 I_t A to 0,8 V	30 min to 90 min
49	1,0 I_t A for 1 h ^a	24 h	5,0 I_t A to 0,8 V	30 min to 90 min
50	0,1 I_t A for 16 h	1 h to 4 h	0,2 I_t A to 1,0 V ^b	^b

^a Or appropriate charge termination, as recommended by the manufacturer.

^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400 and 450.

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 0,8 V on any 49th cycle becomes less than 5 min or until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again the test is terminated.

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

7.5.1.3.4 HR or XR cells

Table 15 – Endurance in cycles for HR or XR cells

Cycle number	Charge	Stand in charged condition	Discharge	Subsequent rest
1 to 48	1,0 I_t A for ^a	20 to 30 min	1,0 I_t A to 1,0 V	10 min to 30 min
49	1,0 I_t A for ^a	24 h	1,0 I_t A to 1,0 V	10 min to 30 min
50	1,0 I_t A for ^a plus 0,1 I_t A for 2 h	1 h to 4 h	0,2 I_t A to 1,0 V ^b	^b
^a With appropriate charge termination, as recommended by the manufacturer, for example use $-\Delta V$ or $\Delta T/\Delta t$ control method. ^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150, 200, 250, 300, 350, 400 and 450.				

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 1,0 V on any 49th cycle becomes less than 30 min or until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again, the test shall be terminated.

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

7.5.1.4 Cylindrical cells dimensionally interchangeable with primary cells

In order to use cycling conditions realistic to actual consumer usage of cylindrical cells dimensionally interchangeable with primary cells, one of the following procedures, shown in Table 16 shall be carried out.

Table 16 – Endurance in cycles for cylindrical cells dimensionally interchangeable with primary cells

Cycle number	Charge	Stand in charged condition	Discharge	Subsequent rest
1 to 49	0,5 I_t A for ^a	20 min to 30 min	0,5 I_t A to 1,0 V	10 min to 90 min
50	0,10 I_t A for 16 h	1 h to 4 h	0,2 I_t A to 1,0 V	^b
^a Charge termination is $-\Delta V = 5$ mV to 10 mV or 132 min. Additionally, if charge termination does not comply with the aforementioned condition, testing shall be terminated. ^b It is permissible to allow sufficient open-circuit rest time after the completion of discharge at cycle 50, so as to start cycle 51 at a convenient time. A similar procedure may be adopted at cycles 100, 150.				

Cycles 1 to 50 shall be repeated until the discharge duration to the final voltage of 1,0 V on any 50th cycle becomes less than 3 h. At this stage, a repeat capacity measurement condition as specified for cycle 50 shall be carried out and if the discharge time is less than 3 h again, the test shall be terminated.

The total number of cycles obtained when the test is completed shall not be less than:

- 200 for AAA cells with a rated capacity less than 800 mAh;
- 100 for AAA cells with a rated capacity of 800 mAh or more;
- 200 for AA cells with a rated capacity less than 2 100 mAh;
- 100 for AA cells with a rated capacity of 2 100 mAh or more;
- 200 for D and C cells.

7.5.2 Permanent charge endurance

7.5.2.1 Small prismatic and button cells

There is no requirement for permanent charge endurance tests on small prismatic and button cells.

7.5.2.2 L, M, H or X cylindrical cells

Prior to this test, the cell shall be discharged at $0,2 I_t$ A to a final voltage of 1,0 V.

The following permanent charge endurance test shall be carried out in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$. Charge and discharge shall be carried out at constant current throughout, using the conditions specified in Table 17.

Table 17 – Permanent charge endurance for L, M, H or X cells

Cycle number	Charge	Discharge ^a
1	$0,05 I_t$ A for 91 days	$0,2 I_t$ A to 1,0 V
2	$0,05 I_t$ A for 91 days	$0,2 I_t$ A to 1,0 V
3	$0,05 I_t$ A for 91 days	$0,2 I_t$ A to 1,0 V
4	$0,05 I_t$ A for 91 days	$0,2 I_t$ A to 1,0 V
^a The discharge is carried out immediately on completion of charging.		

Precautions shall be taken to prevent the cell-case temperature from rising above 25 °C during the test by providing a forced air draught if necessary.

The discharge duration at cycle 4 for cells shall not be less than 3 h.

7.5.2.3 LT, MT or HT cylindrical cells

The permanent charge endurance test shall be performed in three steps according to the conditions specified in Table 18.

It consists of:

- a charge acceptance test at $+40\text{ °C}$;
- an ageing period of six months at $+70\text{ °C}$;
- a final charge acceptance test to check the cell's performance after ageing.

NOTE 1 The six months ageing period and the temperature of $+70\text{ °C}$ have been selected to simulate four years of permanent charge operation at $+40\text{ °C}$.

Prior to this test, the cell shall be discharged at $20\text{ °C} \pm 5\text{ °C}$, at $0,2 I_t$ A, to a final voltage of 1,0 V and stored, in an ambient temperature of $+40\text{ °C} \pm 2\text{ °C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged and discharged at constant current under the conditions specified in Table 18 while maintained in an ambient temperature of $+40\text{ °C} \pm 2\text{ °C}$ or $+70\text{ °C} \pm 2\text{ °C}$ respectively as appropriate.

The discharge conditions A or B may be chosen to suit the user's requirements. The discharge is carried out immediately on completion of charging.

After performing the first charge acceptance test at +40 °C the cell is stored in an ambient temperature of +70 °C ± 2 °C for not less than 16 h and not more than 24 h.

During the ageing period of six months at +70 °C, precautions shall be taken to prevent the cell temperature from rising above +75 °C, by providing a forced air draught, if necessary.

NOTE 2 The actual cell temperature, not the ambient temperature, determines cell performance.

The discharge duration of the three cycles at +70 °C shall be recorded. Leakage of electrolyte shall not occur during this test.

After completion of the ageing period, the cell shall be stored in an ambient temperature of +40 °C ± 2 °C for not less than 16 h and not more than 24 h. The three cycles at +40 °C of the initial charge acceptance test are then repeated using the conditions specified in Table 18. The duration of discharge for cells shall not be less than the values specified in Table 18.

Table 18 – Permanent charge endurance for LT, MT or HT cells

Cycle number	Ambient temperature	Charge	Discharge A or B ^a	Minimum discharge duration
1	+40 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
2		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	3 h 45 min
3		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	42 min
4	+70 °C ± 2 °C	0,05 I_t A for 60 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
5		0,05 I_t A for 60 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
6		0,05 I_t A for 60 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
7	+40 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
8		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	2 h 30 min
9		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	24 min

^a Discharge A is used with LT, MT or HT cells.
Discharge B is used with MT or HT cells only.

7.5.2.4 JT cylindrical cells

The following permanent charge endurance test shall be carried out in order to establish the number of charge/discharge cycles that a cell may accumulate under the following conditions.

Prior to this test, the cell shall be discharged at $0,2 I_t$ A at $20\text{ °C} \pm 5\text{ °C}$ to a final voltage of 1,0 V and stored, in an ambient temperature of $+55\text{ °C} \pm 2\text{ °C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged at a constant current of $0,033 I_t$ A for 28 days while maintained in an ambient temperature of $+55\text{ °C} \pm 2\text{ °C}$ and discharged, in the same ambient temperature, at $1,0 I_t$ A to a final voltage of 1,1 V.

The endurance test is considered complete when two successive capacity measurement cycles give discharge durations of less than 30 min. The total number of cycles successfully completed shall not be less than 6.

7.5.2.5 LU, MU or HU cylindrical cells

The permanent charge endurance test shall be performed in three steps according to the conditions specified in Table 19.

It consists of:

- a charge acceptance test at $+50\text{ °C}$;
- an ageing period of twelve months at $+70\text{ °C}$;
- a final charge acceptance test to check the cell's performance after ageing.

NOTE 1 The twelve months ageing period and the temperature of $+70\text{ °C}$ have been selected to simulate four years of permanent charge operation at $+50\text{ °C}$.

Prior to this test, the cell shall be discharged at $20\text{ °C} \pm 5\text{ °C}$, at $0,2 I_t$ A, to a final voltage of 1,0 V and stored, in an ambient temperature of $+50\text{ °C} \pm 2\text{ °C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged and discharged at constant currents under the conditions specified in Table 19 while maintained in an ambient temperature of $+50\text{ °C} \pm 2\text{ °C}$ or $+70\text{ °C} \pm 2\text{ °C}$ respectively as appropriate.

The discharge conditions A or B may be chosen to suit the user's requirements. The discharge is carried out immediately on completion of charging.

After performing the first charge acceptance test at $+50\text{ °C}$, the cell is stored in an ambient temperature of $+70\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h.

During the ageing period of twelve months at $+70\text{ °C}$, precautions shall be taken to prevent the cell temperature from rising above $+75\text{ °C}$, by providing a forced air draught, if necessary.

NOTE 2 The actual cell temperature, not the ambient temperature, determines cell performance.

The discharge duration of the three cycles at $+70\text{ °C}$ shall be recorded. Leakage of electrolyte shall not occur during this test.

After completion of the ageing period, the cell shall be stored in an ambient temperature of $+50\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h. The three cycles at $+50\text{ °C}$ of the initial charge acceptance test are then repeated using the conditions specified in Table 19. The duration of discharge for cells shall not be less than the values specified in Table 19.

Table 19 – Permanent charge endurance for LU, MU or HU cells

Cycle number	Ambient temperature	Charge	Discharge A or B ^a	Minimum discharge duration
1	+50 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
2		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	3 h 45 min 42 min
3		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	3 h 45 min 42 min
4	+70 °C ± 2 °C	0,05 I_t A for 120 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
5		0,05 I_t A for 120 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
6		0,05 I_t A for 120 days	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	
7	+50 °C ± 2 °C	0,05 I_t A for 48 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	No requirement
8		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	2 h 30 min 24 min
9		0,05 I_t A for 24 h	A: 0,2 I_t A to 1,0 V or B: 1,0 I_t A to 1,0 V	2 h 30 min 24 min
^a A: for LU, MU or HU cells. B: for MU or HU cells only.				

7.6 Charge acceptance at constant voltage

This document does not specify a charge acceptance test at constant voltage.

Charging at constant voltage is not recommended.

7.7 Overcharge

7.7.1 Small prismatic, L, M, H, X, LS or MS cylindrical, and button cells

The ability of the cell to withstand an overcharge shall be determined by the following test.

Prior to this test, the cell shall be discharged in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 I_t A, down to a final voltage of 1,0 V.

The cell shall then be charged, in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,1 I_t A for 48 h. After this charging operation, 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.

The cell shall then be discharged at 20 °C ± 5 °C at a constant current of 0,2 I_t A to a final voltage of 1,0 V.

The duration of discharge shall not be less than 5 h.

7.7.2 LT/LU, MT/MU or HT/HU cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test performed at $0\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in circulating air.

Prior to this test, the cell shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at $0,2\text{ }I_t$ A to a final voltage of 1,0 V and stored, at $0\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

Charge and discharge shall be carried out at constant current, using the conditions specified in Table 20. The discharge condition A or B may be chosen to suit the user's requirements.

Table 20 – Overcharge at $0\text{ }^{\circ}\text{C}$

Charge	Discharge A ^a	Discharge B ^a
	LT/LU, MT/MU, HT/HU cells	MT/MU, HT/HU cells
$0,05\text{ }I_t$ A for 28 days	$0,2\text{ }I_t$ A to 1,0 V	$1,0\text{ }I_t$ A to 0,9 V
^a The discharge is carried out immediately on completion of charging.		

The duration of discharge shall not be less than that specified in Table 9.

7.7.3 J cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test performed at $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in circulating air.

Prior to this test, the cell shall be discharged, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t$ A, to a final voltage of 1,0 V and stored, at $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged, in an ambient temperature of $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, at a constant current of $0,1\text{ }I_t$ A, for 48 h. After this charging operation, the cell shall be stored, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be discharged at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $0,2\text{ }I_t$ A to a final voltage of 1,0 V.

The duration of discharge shall not be less than 5 h.

7.7.4 JT cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test performed at $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ in circulating air.

Prior to this test, the cell shall be discharged, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t$ A, to a final voltage of 1,0 V and stored, at $5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be charged, in an ambient temperature of $+5\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$, at a constant current of $0,05\text{ }I_t$ A, for 96 h. After this charging operation, the cell shall be stored, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for not less than 16 h and not more than 24 h.

The cell shall then be discharged at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $1,0\text{ }I_t\text{ A}$ to a final voltage of $1,1\text{ V}$.

The duration of discharge shall not be less than 37 min.

7.7.5 R cylindrical cells

The ability of the cell to withstand an overcharge shall be determined by the following test.

Prior to this test, the cell shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of $1,0\text{ V}$.

The cell shall then be charged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $1,0\text{ }I_t\text{ A}$ for 1,2 h or other appropriate charge termination such as $-\Delta V$ or as recommended by the manufacturer. Then charging should be continued in the same ambient temperature at a constant current of $0,1\text{ }I_t\text{ A}$ for 48 h. After this charging operation, the cell shall be stored, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for not less than 1 h and not more than 4 h.

The cell shall then be discharged at $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ at a constant current of $0,2\text{ }I_t\text{ A}$ to a final voltage of $1,0\text{ V}$.

The duration of discharge shall not be less than 5 h.

7.8 Safety device operation

Warning: EXTREME CAUTION SHALL BE EXERCISED WHEN CARRYING OUT THIS TEST ! CELLS SHALL BE TESTED INDIVIDUALLY, AND IT SHOULD BE NOTED THAT CELLS FAILING TO MEET THE REQUIREMENT COULD BURST WITH EXPLOSIVE FORCE EVEN AFTER THE CELL HAS BEEN DISCONNECTED FROM THE CHARGE CURRENT.
FOR THIS REASON, THE TEST SHALL BE CARRIED OUT IN A PROTECTIVE CHAMBER.

The following test shall be carried out in order to establish that the safety device of the cell will operate to allow the escape of gas when the internal pressure exceeds a critical value.

NOTE Some button cells do not have a gas release vent. This test is not applicable on this type of cell.

The cell shall undergo a forced discharge in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of $0,0\text{ V}$.

The current shall then be increased to $1,0\text{ }I_t\text{ A}$ and the forced discharge continued in the same ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, for 60 min.

During and at the end of this discharge, the cell shall not disrupt or burst. Leakage of electrolyte and deformation of the cell are acceptable.

7.9 Surface temperature limitation device operation (for S cell only)

Warning: EXTREME CAUTION SHALL BE EXERCISED WHEN CARRYING OUT THIS TEST! THE CELL COULD BURST WITH EXPLOSIVE FORCE OR ITS CONTENT COULD FLOW OUT. IN ADDITION, IT SHOULD BE NOTED THAT THE CELL WILL GENERATE HEAT.
FOR THIS REASON, THE TEST SHALL BE CARRIED OUT IN A PROTECTIVE CHAMBER.

The following test shall be carried out in order to establish that the surface temperature limitation device will operate to prevent the cell temperature from excessively rising when the surface temperature limited cell is misused.

After charging in accordance with 7.2, the test shall be carried out as follows:

Test method: Four cells shall be connected in series but one of the four cells shall be placed in a reverse position. In this state, the terminals of the series string are connected by a wire to cause a short circuit. Short-circuit resistance: $80\text{ m}\Omega \pm 20\text{ m}\Omega$.

The test shall be terminated, when one of the following two cases occurs:

- 24 hours have elapsed or
- the cell-case temperature has been reduced by 20 % from the maximum temperature increase.

Then, verify the following:

- there was no cell explosion or fire;
- the cell temperature increase was less than $45\text{ }^{\circ}\text{C}$;
- no leakage shall be found by visual inspection.

7.10 Storage

7.10.1 Button cells or batteries, small prismatic cells or batteries, cylindrical cells or batteries

Storage should be carried out according to the recommendations of the manufacturer.

Prior to this test:

- the cell shall be discharged, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2 I_t\text{ A}$, to a final voltage of $1,0\text{ V}$.
- the battery shall be discharged, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2 I_t\text{ A}$ until its voltage is equal to the number of cells series connected times $1,0\text{ V}$, unless otherwise specified by the manufacturer.

The cell or battery shall then be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;
- 7.3.4 for R cylindrical cells.

The cell or battery shall then be stored on open circuit, at a mean temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ and a relative humidity of $65\text{ \%} \pm 20\text{ \%}$ for a specific period.

During the storage period, the ambient temperature shall not, at any time, fluctuate beyond the limits of $20\text{ }^{\circ}\text{C} \pm 10\text{ }^{\circ}\text{C}$.

After completion of the storage period of cells or batteries stored in charged state:

- the cell shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2 I_t\text{ A}$, to a final voltage of $1,0\text{ V}$.
- the battery shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2 I_t\text{ A}$ until its voltage is equal to the number of cells series connected times $1,0\text{ V}$, unless otherwise specified by the manufacturer.

The cell or battery whatever be its storage condition, shall then be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;

- 7.3.4 for R cylindrical cells.

The cell or battery shall then be discharged in accordance with:

- the cell shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of $1,0\text{ V}$.
- the battery shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$ until its voltage is equal to the number of cells series connected times $1,0\text{ V}$, unless otherwise specified by the manufacturer.

Five charge-discharge cycles are permitted for this test. The test shall be terminated at the end of the first cycle which meets the requirement.

The minimum discharge duration after each storage time shall not be less than the values specified in Table 21.

Table 21 – Capacity deterioration due to storage period for cells or batteries

Storage time (T) (from date of manufacture) Ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$	Minimum discharge capacity h/min
$T \leq 2\text{ months}$	5 h
$2\text{ months} < T \leq 6\text{ months}$	4 h 30 min
$6\text{ months} < T \leq 12\text{ months}$	4 h
$12\text{ months} < T \leq 18\text{ months}$	3 h 30 min

NOTE In the case of a quality acceptance procedure, provisional approval of cell performance can be agreed, pending satisfactory results on discharge after storage.

7.10.2 Button cells or batteries, small prismatic cells or batteries, cylindrical cells or batteries (high recovery type)

Storage should be carried out according to the recommendations of the manufacturer.

Prior to this test:

- The cell shall be discharged, in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$, to a final voltage of $1,0\text{ V}$.
- The battery shall be discharged in an ambient temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$, at a constant current of $0,2\text{ }I_t\text{ A}$ until its voltage is equal to the number in the series times $1,0\text{ V}$, unless otherwise specified by the manufacturer.

High recovery type cell or battery shall then be prepared in a discharged state and a charged state before storage.

For discharged state storage, the cells and batteries shall not receive a charge after they have been discharged as per the above preparation.

For charged state storage, the cells and batteries shall be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;
- 7.3.4 for R cylindrical cells.

The cell or battery shall then be stored on open circuit, at a mean temperature of $20\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ and a relative humidity of $65\text{ \%} \pm 20\text{ \%}$ for a specific period.

During the storage period, the ambient temperature shall not, at any time, fluctuate beyond the limits of $20\text{ °C} \pm 10\text{ °C}$.

After completion of the storage period for charged state storage:

- the cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, to a final voltage of 1,0 V.
- the battery shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A until its voltage is equal to the number of cells series connected times 1,0 V, unless otherwise specified by the manufacturer.

The cell or battery, whatever the storage conditions, shall then be charged in accordance with:

- 7.2 for button cells or batteries, small prismatic cells or batteries, L, M, H, X, LS, MS, LT/LU, MT/MU, J/JT or HT/HU cylindrical cells or batteries;
- 7.3.4 for R cylindrical cells.

The cell or battery shall then be discharged in accordance with:

- the cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, to a final voltage of 1,0 V.
- The battery shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A until its voltage is equal to the number of cells series connected times 1,0 V, unless otherwise specified by the manufacturer.

Five charge-discharge cycles are permitted for this test. The test shall be terminated at the end of the first cycle which meets the requirement.

The minimum discharge duration after each storage time shall not be less than values specified in Table 22.

High recovery type cells or batteries are tested in a discharged state and a charged state conditions for recovery performance. The minimum discharge duration shall not be less than the criteria in Table 22.

**Table 22 – Capacity deterioration due to storage period
for cells or batteries (high recovery type)**

Storage time (T) (from date of manufacture) Ambient temperature of $20\text{ °C} \pm 5\text{ °C}$	Minimum discharge duration h/min
$T \leq 2$ months	5 h
$2\text{ months} < T \leq 6\text{ months}$	4 h 45 min
$6\text{ months} < T \leq 12\text{ months}$	4 h 30 min
$12\text{ months} < T \leq 18\text{ months}$	4 h 15 min

NOTE In the case of a quality acceptance procedure, provisional approval of cell performance can be agreed, pending satisfactory results on discharge after storage.

7.11 Charge acceptance at +55 °C for LT, MT or HT cylindrical cells

This test is not a requirement. It will be used as reference of performance and is applicable to LT, MT or HT cylindrical cells only.

The cell shall be discharged in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$ at a constant current of $0,2 I_t$ A to a final voltage of 1,0 V and stored in an ambient temperature of $+55\text{ °C} \pm 2\text{ °C}$ for not less than 16 h and not more than 24 h.

The charge acceptance test shall then be carried out in an ambient temperature of $+55\text{ °C} \pm 2\text{ °C}$. Charge and discharge shall be carried out at constant currents, using the conditions specified in Table 23. The discharge conditions A or B may be chosen to suit the user's requirements.

Table 23 – Charge and discharge at $+55\text{ °C}$

Cycle number	Charge	Discharge A or B ^a
1	$0,05 I_t$ A for 48 h	A: $0,2 I_t$ A to 1,0 V or B: $1,0 I_t$ A to 1,0 V
2 ^b	$0,05 I_t$ A for 24 h	A: $0,2 I_t$ A to 1,0 V or B: $1,0 I_t$ A to 1,0 V
3 ^b	$0,05 I_t$ A for 24 h	A: $0,2 I_t$ A to 1,0 V or B: $1,0 I_t$ A to 1,0 V
^a Discharge A is used with LT, MT or HT cells. Discharge B is used with MT or HT cells.		
^b The duration of discharge of cycles 2 and 3 shall be recorded and provided in any report of results.		

7.12 Trickle charge acceptance for JT cylindrical cells

The ability of the cell to withstand a trickle charge acceptance A and B shall be determined by the following test.

The cell shall be discharged, in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, at a constant current of $0,2 I_t$ A, to a final voltage of 1,0 V and stored, in an ambient temperature using the conditions specified in Table 24, for not less than 16 h and not more than 24 h.

The cell shall then be charged and discharged, in the same ambient temperature, at constant currents, using the conditions specified in Table 24.

The duration of discharge shall not be less than the values specified in Table 24.

Table 24 – Trickle charge acceptance for JT cylindrical cells

Condition	Ambient temperature	Charge	Discharge	Minimum discharge duration
A (45 °C)	$45\text{ °C} \pm 2\text{ °C}$	$0,033 I_t$ A for 48 h	$1,0 I_t$ A to 1,1 V	37 min
A (5 °C)	$5\text{ °C} \pm 2\text{ °C}$	$0,033 I_t$ A for 48 h	$1,0 I_t$ A to 1,1 V	37 min
B (45 °C)	$45\text{ °C} \pm 2\text{ °C}$	$0,04 I_t$ A for 24 h	$1,0 I_t$ A to 1,1 V	25 min
B (5 °C)	$5\text{ °C} \pm 2\text{ °C}$	$0,04 I_t$ A for 24 h	$1,0 I_t$ A to 1,1 V	25 min

7.13 Internal resistance

7.13.1 General

The internal resistance of sealed nickel-metal hydride small prismatic or cylindrical rechargeable single cells shall be checked either by the alternating current (AC) or by the direct current (DC) method.

Should the need arise for the internal resistance to be measured by both AC and DC methods on the same cell, then the AC method shall be used first, followed by the DC method. In this

case, it is not necessary to discharge and charge the cell between conducting AC and DC methods.

Prior to the measurements, the cell shall be discharged at $0,2 I_t$ A to a final voltage of 1,0 V. The cell shall be charged in accordance with 7.2. After charging, the cell shall be stored, in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$, for not less than 1 h and not more than 4 h.

The measurement of internal resistance shall be carried out in an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$.

7.13.2 Measurement of the internal AC resistance

The alternating RMS voltage, U_a , shall be measured when applying to the cell an alternating RMS current, I_a , at the frequency of $1,0\text{ kHz} \pm 0,1\text{ kHz}$ for a period of 1 s to 5 s.

The internal AC resistance, R_{ac} , is given by

$$R_{ac} = \frac{U_a}{I_a} \Omega$$

where

U_a is the alternating RMS voltage;

I_a is the alternating RMS current.

NOTE 1 The alternating current is selected so that the peak voltage stays below 20 mV.

NOTE 2 This method will measure the impedance which, in the range of frequency specified, is approximately equal to the resistance.

NOTE 3 Connections to the battery terminals are made in such a way that voltage measurement contacts are separate from contacts used to carry current.

7.13.3 Measurement of the internal DC resistance

The cell shall be discharged at a constant current of value I_1 as specified in Table 25. At the end of a discharge period of 10 s, the voltage U_1 during discharge shall be measured and recorded. The discharge current shall then be immediately increased to a constant value of I_2 as specified in Table 25 and the corresponding voltage U_2 during discharge shall be measured and recorded again at the end of a discharge period of 3 s.

All voltage measurements shall be made at the terminals of the cell independently of contacts used to carry current.

The internal DC resistance, R_{dc} , of the cell shall be calculated using the following formula:

$$R_{dc} = \frac{U_1 - U_2}{I_2 - I_1} \Omega$$

where

I_1, I_2 are the constant discharge currents;

U_1, U_2 are the appropriate voltages measured during discharge.

**Table 25 – Constant discharge currents used
for measurement of DC resistance**

Current	Cell designation		
	HRL ^a	HRM ^a HRH ^a	HRX
I_1	0,2 I_t A	0,5 I_t A	1,0 I_t A
I_2	2,0 I_t A	5,0 I_t A	10,0 I_t A

^a And corresponding "T", "S" and "R" cells.

8 Mechanical tests

Mechanical tests shall be performed according to IEC 61959.

9 Safety requirements

Safety requirements shall be fulfilled according to IEC 62133-1.

10 Type approval and batch acceptance

10.1 General

Content of type approval and batch acceptance shall be agreed between supplier and purchaser. Unless otherwise agreed between supplier and purchaser, the following tests shall be performed.

10.2 Type approval

10.2.1 Type approval for small prismatic cells and button cells

For type approval, the sequence of tests and sample sizes given in Tables 26, 27, 28 and 29 shall be used. Six groups of cells denominated A, B, C, D, E and F respectively, shall be tested. The total number of cells required for type approval is 41, 61, 41 and 61. This total includes an extra cell, permitting a repeat test to cover any incident which may occur outside the supplier's responsibility.

Tests shall be carried out in sequence within each group of cells. All cells are subjected to the tests in group A, after which they are divided into five groups at random according to the sample sizes shown in Tables 26, 27, 28 and 29.

The number of defective cells tolerated per group, and in total, is given in Tables 26, 27, 28 and 29. 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 26 – Sequence of tests for type approval for small prismatic cells

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	41	5.3 6.1 7.3.2 7.3.2	Marking Dimensions Discharge at 20 °C at 0,2 I_t A Discharge at 20 °C at 1,0 I_t A (M, J, H and X cells) 5,0 I_t A (H and X cells) 10,0 I_t A (X cells only)	0	3
B	5	7.3.3 7.3.3	Discharge at 0 °C, at 0,2 I_t A Discharge at 0 °C, at 1,0 I_t A (M, J, H and X cells) 2,0 I_t A (H and X cells) 3,0 I_t A (X cells only)	1	
C	5	7.7 7.8	Overcharge Gas release device operation	0	
D	5	7.5	Endurance in cycles	1	
E	5	7.4	Charge (capacity) retention	1	
F	20	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C, at 0,2 I_t A	1	

**Table 27 – Sequence of tests for type approval
for small prismatic cells (high recovery type)**

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	61	5.3 6.1 7.3.2 7.3.2	Marking Dimensions Discharge at 20 °C, at 0,2 I_t A Discharge at 20 °C, at 1,0 I_t A (M, J, H and X cells) 5,0 I_t A (H and X cells) 10,0 I_t A (X cells only)	0	3
B	5	7.3.3 7.3.3	Discharge at 0 °C, at 0,2 I_t A Discharge at 0 °C, at 1,0 I_t A (M, J, H and X cells) 2,0 I_t A (H and X cells) 3,0 I_t A (X cells only)	1	
C	5	7.7 7.8	Overcharge Gas release device operation	0	
D	5	7.5	Endurance in cycles	1	
E	5	7.4	Charge (capacity) retention	1	
F	40	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C, at 0,2 I_t A	1	

Table 28 – Sequence of tests for type approval for button cells

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	41	5.3 Clause 6 7.3.2 7.3.2	Marking Dimensions Discharge at 20 °C, at 0,2 I_t A Discharge at 20 °C, at 1,0 I_t A	0	3
B	5	7.3.3 7.3.3	Discharge at 0 °C, at 0,2 I_t A Discharge at 0 °C, at 1,0 I_t A (M, J, H and X cells) 2,0 I_t A (H and X cells) 3,0 I_t A (X cells only)	1	
C	5	7.7 7.8	Overcharge Gas release device operation	0	
D	5	7.5	Endurance in cycles	1	
E	5	7.4	Charge (capacity) retention	1	
F	20	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C, at 0,2 I_t A	1	

**Table 29 – Sequence of tests for type approval for button cells
(high recovery type)**

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	61	5.3	Marking	0	3
		6.2	Dimensions		
		7.3.2	Discharge at 20 °C, at 0,2 I_t A		
		7.3.2	Discharge at 20 °C, at 1,0 I_t A		
B	5	7.3.3	Discharge at 0 °C, at 0,2 I_t A	1	
		7.3.3	Discharge at 0 °C, at 1,0 I_t A (M, J, H and X cells) 2,0 I_t A (H and X cells) 3,0 I_t A (X cells only)		
C	5	7.7	Overcharge	0	
		7.8	Gas release device operation		
D	5	7.5	Endurance in cycles	1	
E	5	7.4	Charge (capacity) retention	1	
F	40	7.10	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months	1	
		7.3.2	Discharge at 20 °C, at 0,2 I_t A		

10.2.2 Type approval for cylindrical cells

For type approval, the sequence of tests and sample sizes given in Tables 30 and 31 shall be used. Seven groups of cells denominated A, B, C, D, E, F and G respectively, shall be tested. The total number of cells required for type approval is 46 and 66. This total includes an extra cell, permitting a repeat test to cover any incident which may occur outside the supplier's responsibility.

Tests shall be carried out in sequence within each group of cells. All cells are subjected to the test in group A, after which they are divided into six groups at random according to the sample sizes shown in Tables 30 and 31.

The number of defective cells tolerated per group, and in total, is given in Tables 30 and 31. 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 30 – Sequence of tests for type approval for cylindrical cells

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	46	5.3 6.1 7.3.2 7.3.2	Marking Dimensions Discharge at 20 °C at 0,2 I _t A Discharge at 20 °C at 1,0 I _t A (M, H, J and X cells) ^a 5,0 I _t A (H and X cells) ^a 10,0 I _t A (X cells only)	0	3
B	5	7.3.3 7.3.3	Discharge at 0 °C at 0,2 I _t A Discharge at 0 °C, at 1,0 I _t A (M, J, H and X cells) ^a 2,0 I _t A (H and X cells) ^a 3,0 I _t A (X cells only)	1	
C	5	7.7 7.8	Overcharge Safety device operation	0	
D	5	7.5.1	Endurance in cycles	1	
E	5	7.5.2 7.8	Permanent charge endurance Gas release device operation	1 0	
F	5	7.4	Charge (capacity) retention	1	
G	20	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C at 0,2 I _t A	1	
^a And corresponding "T", "U" and "R" cells.					

Table 31 – Sequence of tests for type approval for cylindrical cells (high recovery type)

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	66	5.3 6.1 7.3.2 7.3.2	Marking Dimensions Discharge at 20 °C at 0,2 I _t A Discharge at 20 °C at 1,0 I _t A (M, H, J and X cells) ^a 5,0 I _t A (H and X cells) ^a 10,0 I _t A (X cells only)	0	3
B	5	7.3.3 7.3.3	Discharge at 0 °C at 0,2 I _t A Discharge at 0 °C, at 1,0 I _t A (M, J, H and X cells) ^a 2,0 I _t A (H and X cells) ^a 3,0 I _t A (X cells only)	1	
C	5	7.7 7.8	Overcharge Gas release device operation	0	
D	5	7.5.1	Endurance in cycles	1	
E	5	7.5.2 7.8	Permanent charge endurance Safety device operation	1 0	
F	5	7.4	Charge (capacity) retention	1	
G	40	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C at 0,2 I _t A	1	
^a And corresponding "T", "U" and "R" cells.					

10.2.3 Type approval for batteries

For type approval, the sequence of tests and sample sizes given in Table 32 and 33 shall be used. Two groups of batteries, denominated A and B respectively, shall be tested. The total number of batteries required for type approval is 21 and 41. This total includes an extra battery, permitting a repeat test to cover any incident which may occur outside the supplier's responsibility.

Tests shall be carried out in sequence within each group of batteries. All batteries are subjected to the tests in group A, after which they are designated group B excluding an extra battery at random according to the sample sizes shown in Table 32 and 33.

The number of defective batteries tolerated per group, and in total, is given in Table 32 and 33. A battery is considered to be defective if it does not meet the requirements of all or part of the tests of a group.

Table 32 – Sequence of tests for type approval for batteries

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	21	5.3 7.3.2	Marking Discharge at 20 °C at 0,2 I_t A	0	1
B	20	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C at 0,2 I_t A	1	

Table 33 – Sequence of tests for type approval for batteries (high recovery type)

Group	Sample size	Clause or subclause	Tests	Number of defective cells tolerated	
				Per group	In total
A	41	5.3 7.3.2	Marking Discharge at 20 °C at 0,2 I_t A	0	1
B	40	7.10 7.3.2	Storage Storage time 2 months Storage time 6 months Storage time 12 months Storage time 18 months Discharge at 20 °C at 0,2 I_t A	1	

10.3 Batch acceptance

These tests are applicable to deliveries of individual cells.

The sampling procedure should be established in accordance with IEC 60410. Unless otherwise agreed between supplier and purchaser, inspections and tests shall be performed using inspection levels and AQLs (acceptable quality level) recommended in Table 34.

Table 34 – Recommended test sequence for batch acceptance

Group	Clause or subclause	Inspection/tests	Recommendation	
			Inspection level	AQL %
A	As agreed	Visual inspection		
		– absence of mechanical damage	II	4
		– absence of corrosion on case and terminals	II	4
		– number, position and secure fittings of connection tabs	S3	1
		– absence of liquid electrolyte on case and terminals	II	0,65
B	Clause 6 As agreed 5.3	Physical inspection		
		– dimensions	S3	1
		– weight	S3	1
		– marking	S3	1
C	7.3.2 7.3.2	Electrical inspection		
		– open-circuit voltage and polarity	II	0,65
		– discharge at 20 °C at 0,2 I_t A	S3	1
		– discharge at 20 °C at 1,0 I_t A	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.				

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¹ This publication was withdrawn.

² This publication was withdrawn.

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COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**ACCUMULATEURS ALCALINS ET AUTRES
ACCUMULATEURS À ÉLECTROLYTE NON ACIDE –
ACCUMULATEURS ÉTANCHES POUR APPLICATIONS PORTABLES –****Partie 2: Nickel-métal hydrure****AVANT-PROPOS**

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La Norme internationale IEC 61951-2 a été établie par le sous-comité 21A: Accumulateurs alcalins et autres accumulateurs à électrolyte non acide, du comité d'études 21 de l'IEC: Accumulateurs.

Cette quatrième édition annule et remplace la troisième édition parue en 2011. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- ajout du type de batterie;

- ajout de la désignation 'F' (type à récupération élevée) pour les éléments et batteries;
- ajout de la désignation 'I' (type à autodécharge faible) pour les éléments;
- révision de la Figure 3 (6.1.3.1);
- ajout de la note "picot facultatif" au contact positif;
- modification de la position de la ligne de repère du picot aux surfaces planes du contact positif (B et G).

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
21A/623/FDIS	21A/629/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 61951, présentées sous le titre général *Accumulateurs alcalins et autres accumulateurs à électrolyte non acide – Accumulateurs étanches pour applications portables*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

ACCUMULATEURS ALCALINS ET AUTRES ACCUMULATEURS À ÉLECTROLYTE NON ACIDE – ACCUMULATEURS ÉTANCHES POUR APPLICATIONS PORTABLES –

Partie 2: Nickel-métal hydrure

1 Domaine d'application

La présente partie de l'IEC 61951 spécifie le marquage, la désignation, les dimensions, les essais et les exigences applicables aux éléments et batteries d'accumulateurs parallélépipédiques, cylindriques et boutons, étanches, au nickel-métal hydrure, pouvant être utilisés dans toutes les orientations, pour applications portables.

2 Références normatives

Les documents suivants cités dans le texte constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 60050-482:2004, *Vocabulaire Électrotechnique International (VEI) – Partie 482: Piles et accumulateurs électriques*

IEC 60086-1, *Primary batteries – Part 1: General* (disponible en anglais seulement)

IEC 60086-2, *Piles électriques – Partie 2: Spécifications physiques et électriques*

IEC 61959, *Accumulateurs alcalins et autres accumulateurs à électrolyte non acide – Essais mécaniques pour accumulateurs portables étanches*

IEC 62133-1, *Accumulateurs alcalins et autres accumulateurs à électrolyte non acide – Exigences de sécurité pour les accumulateurs portables étanches, et pour les batteries qui en sont constituées, destinés à l'utilisation dans des applications portables – Partie 1 Systèmes au nickel*

3 Termes et définitions

Pour les besoins du présent document, les termes et les définitions de l'IEC 60050-482 ainsi que les suivants, s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse <http://www.electropedia.org/>
- ISO Online browsing platform: disponible à l'adresse <http://www.iso.org/obp>

3.1

tension nominale

valeur approchée appropriée d'une tension, utilisée pour désigner ou identifier un élément ou une batterie

Note 1 à l'article: La tension nominale d'un élément individuel rechargeable étanche au nickel-métal hydrure est 1,2 V.

Note 2 à l'article: La tension nominale d'une batterie de n éléments connectés en série est égale à n fois la tension nominale de l'élément individuel.

[SOURCE: IEC 60050-482:2004, 482-03-31, modifiée – Ajout des Notes 1 et 2 à l'article.]

3.2

capacité assignée

valeur de la capacité d'un élément ou d'une batterie déterminée dans des conditions spécifiées et déclarée par le fabricant

Note 1 à l'article: La capacité assignée est la quantité d'électricité C_5 Ah (ampères-heures) déclarée par le fabricant, qu'un élément individuel est capable de restituer en 5 h après charge, repos et décharge, dans les conditions spécifiées en 7.3.2.

Note 2 à l'article: La capacité d'une batterie est la quantité d'électricité C_5 Ah (ampères-heures) déclarée par le fabricant, qu'une batterie est capable de restituer en 5 h après charge, repos et décharge, dans les conditions spécifiées en 7.3.2.

[SOURCE: IEC 60050-482:2004, 482-03-15, modifiée – Ajout des Notes 1 et 2 à l'article.]

3.3

petit élément parallélépipédique

élément de forme parallélépipédique rectangulaire dont la largeur et l'épaisseur ne dépassent pas 25 mm

3.4

élément cylindrique

élément de section circulaire dont la hauteur hors tout est égale ou supérieure au diamètre hors tout

3.5

élément bouton

élément de section circulaire dont la hauteur totale est inférieure au diamètre total

3.6

élément au nickel-métal hydrure

élément contenant de l'hydroxyde de nickel dans l'électrode positive, un alliage absorbant l'hydrogène dans l'électrode négative, et de l'hydroxyde de potassium ou une autre solution alcaline comme électrolyte

Note 1 à l'article: Les électrodes positives sont isolées des électrodes négatives par un séparateur.

3.7

batterie au nickel-métal hydrure

ensemble composé d'un ou de plusieurs éléments d'accumulateurs comme source d'énergie électrique et caractérisé par sa tension, sa dimension, la disposition de ses bornes, sa capacité et son régime

3.8

élément étanche

élément fermé ne laissant échapper ni gaz ni liquide lorsqu'il fonctionne dans les limites de charge et de température spécifiées par le fabricant

Note 1 à l'article: L'élément est muni d'un dispositif de sécurité destiné à éviter toute pression interne dangereusement élevée.

Note 2 à l'article: L'élément ne requiert pas de complément d'électrolyte et est conçu pour fonctionner toute sa vie dans ses conditions d'étanchéité initiales.

Note 3 à l'article: L'élément au nickel-métal hydrure peut cependant libérer du gaz vers la fin de sa vie du fait de l'accumulation d'hydrogène dans l'élément.

[SOURCE: IEC 60050-482:2004, 482-05-17, modifiée – La note existante a été développée dans les Notes 1, 2 et 3 à l'article.]

3.9

élément portable

élément conçu pour être utilisé principalement dans une batterie facile à porter

3.10

batterie pour applications portables

batterie pour utilisation dans un dispositif ou un appareil qui est facilement portable à la main

3.11

élément à température de surface limitée

élément pourvu d'une fonction qui évite l'augmentation de la température à partir d'une valeur déterminée, y compris lorsque survient une anomalie telle que la mise en court-circuit de l'élément

3.12

élément ou batterie à récupération élevée

élément ou batterie caractérisé(e) par une "perte de capacité permanente" plus faible que la normale après stockage

Note 1 à l'article: Il ou elle est défini(e) comme un "type à récupération élevée" au 7.10.2 et au Tableau 22.

3.13

élément à autodécharge faible

élément capable de conserver une capacité de charge supérieure à la normale après stockage en réduisant l'autodécharge

Note 1 à l'article: Il est défini comme un "type à autodécharge faible" au 7.4.

3.14

batterie au nickel-métal hydrure de type 9 V

batterie au nickel-hydrure métallique interchangeable avec des piles 9 V et composée d'éléments cylindriques, de petits éléments parallélépipédiques ou d'éléments boutons

4 Tolérances de mesure relatives aux paramètres

L'exactitude globale des valeurs contrôlées ou mesurées, par rapport aux valeurs spécifiées ou réelles, doit respecter les tolérances suivantes:

- a) $\pm 1\%$ pour la tension;
- b) $\pm 1\%$ pour le courant;
- c) $\pm 1\%$ pour la capacité;
- d) $\pm 2\text{ }^{\circ}\text{C}$ pour la température;
- e) $\pm 0,1\%$ pour le temps;
- f) $\pm 0,1\text{ mm}$ pour les dimensions;
- g) $\pm 5\%$ pour l'humidité.

Ces tolérances comprennent l'exactitude combinée des appareils de mesure, des techniques de mesure utilisées et de toutes les autres sources d'erreur liées à la méthode d'essai.

Les caractéristiques des appareils utilisés doivent être fournies dans chaque rapport de résultats.

5 Désignation et marquage des éléments et des batteries

5.1 Désignation des éléments et batteries

5.1.1 Petits éléments parallélépipédiques et éléments cylindriques

5.1.1.1 Généralités

Les petits éléments individuels parallélépipédiques et les éléments individuels cylindriques rechargeables, étanches, au nickel-métal hydrure, doivent être désignés par une lettre L, M, J, H ou X qui indique:

- un régime de décharge faible (L);
- un régime de décharge moyen (M);
- un régime de décharge moyen élevé (J);
- un régime de décharge élevé (H);
- un régime de décharge très élevé (X).

NOTE 1 Ces éléments sont habituellement mais non exclusivement utilisés pour les régimes de décharge suivants:

- L jusqu'à $0,5 I_t$ A;
- M jusqu'à $3,5 I_t$ A;
- J jusqu'à $5,0 I_t$ A;
- H jusqu'à $7,0 I_t$ A;
- X jusqu'à $7,0 I_t$ A et au-dessus.

NOTE 2 Ces courants s'expriment en multiples de I_t A, où I_t A = C_5 Ah/1 h (voir l'IEC 61434).

Lorsqu'un élément est destiné à la charge permanente à des températures élevées, normalement supérieures à 40 °C, la lettre "T" est placée après la lettre L, M, J, H ou X.

Lorsqu'un élément est destiné à la charge permanente à des températures élevées, normalement supérieures à 50 °C, la lettre "U" est placée après la lettre L, M, J, H ou X.

Lorsqu'un élément est pourvu d'un dispositif de limitation de la température de surface, la lettre "S" est placée après la lettre L ou M.

Lorsqu'un élément est destiné à la charge rapide, normalement à $1,0 I_t$ A, la lettre "R" est placée après la lettre L, M, J, H ou X.

Lorsqu'un élément ou une batterie est caractérisé(e) par une récupération élevée, la lettre "F" est placée après la lettre L, M, J, H ou X.

Lorsqu'un élément est considéré comme un élément à autodécharge faible, la lettre "I" est placée après la lettre L, M, J, H ou X.

5.1.1.2 Petits éléments parallélépipédiques

Les petits éléments individuels parallélépipédiques rechargeables, étanches, au nickel-métal hydrure, doivent être désignés par les lettres "HF" suivies de la lettre L, M, J, H ou X, elles-mêmes suivies de la lettre F, puis de la lettre I si désignée, et enfin de trois groupes de chiffres, chaque groupe étant séparé par un trait oblique, comme suit:

- a) Les deux chiffres à gauche du premier trait oblique doivent indiquer la largeur maximale spécifiée pour l'élément, exprimée en millimètres, arrondie au nombre entier immédiatement supérieur.
- b) Les deux chiffres du milieu doivent indiquer l'épaisseur maximale spécifiée pour l'élément, exprimée en millimètres, arrondie au nombre entier immédiatement supérieur.
- c) Les deux chiffres à droite du deuxième trait oblique doivent indiquer la hauteur maximale spécifiée pour l'élément, exprimée en millimètres, arrondie au nombre entier immédiatement supérieur.

EXEMPLE La désignation HFLF 18/07/49 identifie un petit élément parallélépipédique, apte aux régimes de décharge faibles, à récupération élevée, de largeur maximale 18 mm, d'épaisseur maximale 7 mm et de hauteur maximale 49 mm.

5.1.1.3 Éléments cylindriques

Les éléments individuels cylindriques rechargeables, étanches, au nickel-métal hydrure, doivent être désignés par les lettres "HR" suivies de la lettre L, M, J, H ou X, elles-mêmes suivies de la lettre F, puis de la lettre I si désignée, et enfin de deux groupes de chiffres, chaque groupe étant séparé par un trait oblique, comme suit:

- a) Les deux chiffres à gauche du trait oblique doivent indiquer le diamètre maximal spécifié pour l'élément, exprimé en millimètres, arrondi au nombre entier immédiatement supérieur.
- b) Les deux chiffres à droite du trait oblique doivent indiquer la hauteur maximale spécifiée pour l'élément, exprimée en millimètres, arrondie au nombre entier immédiatement supérieur.

Quand un fabricant réalise un élément avec des dimensions et des tolérances qui le rendent interchangeable avec une pile, la désignation du Tableau 2 doit aussi figurer sur l'élément.

EXEMPLE 1 La désignation HRLF 33/62 identifie un élément cylindrique, apte aux régimes de décharge faibles, à récupération élevée, de diamètre maximal 33 mm et de hauteur maximale 61,5 mm.

EXEMPLE 2 La désignation HRLTF 33/62 identifie un élément cylindrique, apte aux régimes de décharge faibles, destiné à la charge permanente à des températures élevées, à récupération élevée, de diamètre maximal 33 mm et de hauteur maximale 61,5 mm.

EXEMPLE 3 La désignation HRXRFI 23/43 identifie un élément cylindrique, apte aux régimes de décharge très élevés, destiné à la charge rapide, à récupération élevée, à autodécharge faible, de diamètre maximal 23 mm et de hauteur maximale 43 mm.

Pour les éléments dimensionnellement interchangeables avec des piles, un nombre à un ou deux chiffres placé après la lettre F ou I peut signifier:

- 20- Format D;
- 14- Format C;
- 6- Format AA;
- 03- Format AAA.

NOTE Les éléments dimensionnellement interchangeables avec des piles sont de type M sauf spécification contraire

Pour plus de clarté, un exemple est fourni ci-dessous.

EXEMPLE 4 La désignation HRMRFI03 identifie un élément cylindrique individuel rechargeable étanche au nickel-métal hydrure, apte aux régimes de décharge moyens, conçu pour la charge rapide, à récupération élevée et à autodécharge faible, dimensionnellement interchangeable avec une pile, et dont le format type est AAA.

5.1.2 Éléments boutons

Les éléments boutons individuels rechargeables, étanches, au nickel-métal hydrure, doivent être désignés par les lettres "HB" suivies de la lettre F, elle-même suivie de la lettre I si désignée, puis de deux groupes de chiffres, chaque groupe étant séparé par un trait oblique, comme suit:

- a) Les trois chiffres à gauche du trait oblique doivent indiquer le diamètre maximal spécifié pour l'élément, exprimé en dixièmes de millimètres, arrondi au nombre entier immédiatement supérieur.
- b) Les trois chiffres à droite du trait oblique doivent indiquer la hauteur maximale spécifiée pour l'élément, exprimée en dixièmes de millimètres, arrondie au nombre entier immédiatement supérieur.

EXEMPLE La désignation HBFI 116/054 identifie un élément bouton caractérisé par une récupération élevée et une autodécharge faible, de diamètre maximal 11,6 mm et de hauteur maximale 5,4 mm.

5.1.3 Batteries

Les batteries rechargeables, étanches au nickel-métal hydrure doivent être désignées sous la forme suivante:

N1 désignation d'un élément individuel -N2

où

N1 est le nombre d'éléments connectés en série dans la batterie;

N2 est le nombre d'éléments connectés en parallèle si 2 ou plus (non indiqué si la valeur est 1).

La désignation des batteries étanches au nickel-métal hydrure est identifiée sur la base des éléments individuels connectés en série et non sur la base de la batterie dans son ensemble.

- Petits éléments parallélépipédiques dans la batterie

EXEMPLE 1 La désignation 2HFLF 18/07/49 identifie un petit élément parallélépipédique, apte aux régimes de décharge faibles, à récupération élevée, de largeur maximale 18 mm, d'épaisseur maximale 7 mm et de hauteur maximale 49 mm avec deux éléments connectés en série.

- Éléments cylindriques dans la batterie

EXEMPLE 2 La désignation 3HRLF 33/62 identifie un élément cylindrique, apte aux régimes de décharge faibles, à récupération élevée, de diamètre maximal 33 mm et de hauteur maximale 61,5 mm avec trois éléments connectés en série.

EXEMPLE 3 La désignation 4HRLTF 33/62 identifie un élément cylindrique, apte aux régimes de décharge faibles, destiné à la charge permanente à des températures élevées, à récupération élevée, de diamètre maximal 33 mm et de hauteur maximale 61,5 mm avec quatre éléments connectés en série.

EXEMPLE 4 La désignation HRXRFI 23/43 -2 identifie un élément cylindrique, apte aux régimes de décharge très élevés, destiné à la charge rapide, à récupération élevée, à autodécharge faible, de diamètre maximal 23 mm et de hauteur maximale 43 mm avec deux éléments connectés en parallèle.

- Éléments interchangeables avec des piles dans les batteries

EXEMPLE 5 La désignation HRMRFI03-3 identifie un élément cylindrique individuel rechargeable étanche au nickel-métal hydrure, apte aux régimes de décharge moyens, conçu pour la charge rapide, à récupération élevée et à autodécharge faible, dimensionnellement interchangeable avec une pile dont le format type est AAA avec trois éléments connectés en parallèle.

- Éléments boutons dans la batterie

EXEMPLE 6 La désignation HB 116/054-3 identifie un élément bouton de diamètre maximal 11,6 mm et de hauteur maximale 5,4 mm avec trois éléments connectés en parallèle.

5.2 Sorties électriques des éléments ou batteries

La présente norme ne spécifie pas de sorties électriques pour les éléments ou batteries.

5.3 Marquage

5.3.1 Petits éléments parallélépipédiques et éléments cylindriques

Chaque élément gainé, fourni sans cosses, doit comporter un marquage durable donnant au minimum les indications suivantes:

- étanche, rechargeable, au nickel-métal hydrure ou Ni-MH;
- capacité assignée;

- tension nominale;
- polarité (+ et –);
- date de fabrication (un code est admis);
- nom ou marque d'identification du fabricant ou du fournisseur;
- marque pour favoriser la réutilisation des constituants des éléments.

NOTE 1 Cette marque est appliquée lorsqu'un programme de recyclage est disponible.

NOTE 2 En général, les éléments individuels rechargeables, étanches, au nickel-métal hydrure, munis de languettes de connexion ne nécessitent pas d'étiquettes s'ils font partie intégrante d'une batterie. Dans ce cas, la batterie elle-même comporte le marquage indiqué ci-dessus.

5.3.2 Éléments boutons

Chaque élément bouton fourni sans cosses doit comporter un marquage durable donnant au minimum les indications suivantes:

- désignation conforme à 5.1;
- polarité (+ et –);
- date de fabrication (un code est admis);
- nom ou marque d'identification du fabricant ou du fournisseur.

5.3.3 Batteries

Chaque batterie doit comporter un marquage durable donnant au minimum les indications suivantes:

- capacité assignée;
- tension nominale;
- date de fabrication (un code est admis).

5.4 Exemption de formulation

L'étiquette de chaque élément ou batterie doit comporter un minimum d'informations comme spécifié au 5.3.1 à 5.3.3. Par conséquent, il convient de fournir des informations supplémentaires, telles que des consignes de sécurité, dans un manuel et non sur l'étiquette de l'élément ou de la batterie.

L'étiquette de chaque élément ou batterie doit comporter un minimum d'informations comme spécifié au 5.3.1 à 5.3.3. Par conséquent, il convient de ne pas reporter les informations de précaution sur l'étiquette des éléments ou batteries recouverts de plastique souple ou rigide pour lesquels les consignes de sécurité sont imprimées à l'extérieur.

6 Dimensions

6.1 Petits éléments parallélépipédiques et éléments cylindriques

6.1.1 Généralités

Les Figures 1 et 2 représentent la forme des éléments.

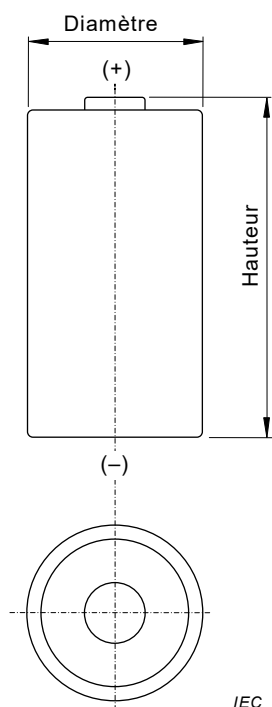


Figure 1 – Éléments cylindriques gainés

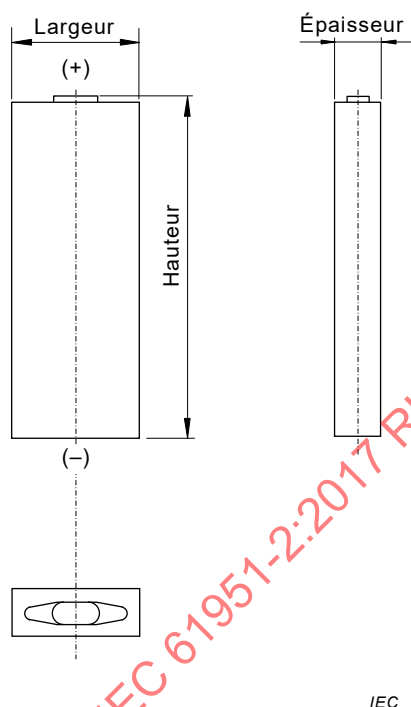


Figure 2 – Petits éléments parallélépipédiques gainés

6.1.2 Petits éléments parallélépipédiques

Le Tableau 1 représente les dimensions des petits éléments parallélépipédiques gainés.

Tableau 1 – Dimensions des petits éléments parallélépipédiques gainés

Désignation des éléments	Largeur mm	Épaisseur mm	Hauteur mm
HF 15/08/49	14,5	7,4	48,2
HF 15/09/49	14,5	8,3	48,2
HF 16/07/34	16,0	6,6	34,0
HF 18/07/36	17,3	6,1	35,7
HF 18/07/49	17,3	6,1	48,2
HF 18/09/49	17,3	8,3	48,2
HF 18/07/68	17,3	6,1	67,3
HF 18/11/68	17,3	10,7	67,3
HF 18/18/68	17,3	17,3	67,3
HF 23/11/68	22,7	10,7	67,3
HF 23/15/68	22,7	14,5	67,3

6.1.3 Éléments cylindriques

6.1.3.1 Éléments dimensionnellement interchangeables avec des piles

Le Tableau 2 donne les exigences relatives aux dimensions des éléments cylindriques gainés dimensionnellement interchangeables avec des piles (voir Figure 3).

Tableau 2 – Dimensions des éléments cylindriques gainés dimensionnellement interchangeables avec des piles

Dési- gna- tion des éléments ^a	Désigna- tion de type (référé- nce) ^b	Pile corres- pondan- -te ^c	Ten- sion nomi- nale V	Dimensions mm										
				A	B	C	D ^d	E	F		G	Φ		ΦP
				Max	Min	Min	–	Max	Max	Min	Min	Max	Min	Max
HR03	AAA	R03 LR03	1,2	44,5	(43,3)	4,3		0,5	3,8	(2,0)	0,8	10,5	9,5	0,4
HR6	AA	R6 LR6		50,5	(49,2)	7,0		0,5	5,5	(4,2)	1,0	14,5	13,5	0,5
HR14	C	R14 LR14		50,0	(48,6)	13,0		0,9	7,5	(5,5)	1,5	26,2	24,9	1,0
HR20	D	R20 LR20		61,5	(59,5)	18,0		1,0	9,5	(7,8)	1,5	34,2	32,3	1,0

NOTE Les nombres entre parenthèses sont des valeurs de référence.

^a La désignation des éléments doit être conforme à la nomenclature de l'IEC 60086-1.

^b Dans certains pays, ces types d'éléments sont aussi connus selon les désignations suivantes: AAA (R 03); AA (R 6); C (R 14); D (R 20).

^c Les piles salines (R) et les piles alcalines (LR) doivent être conformes aux dispositions de l'IEC 60086-2.

^d Il n'y a aucune spécification pour la valeur "D" pour les éléments individuels cylindriques rechargeables, étanches, au nickel-métal hydrure interchangeables avec des piles.

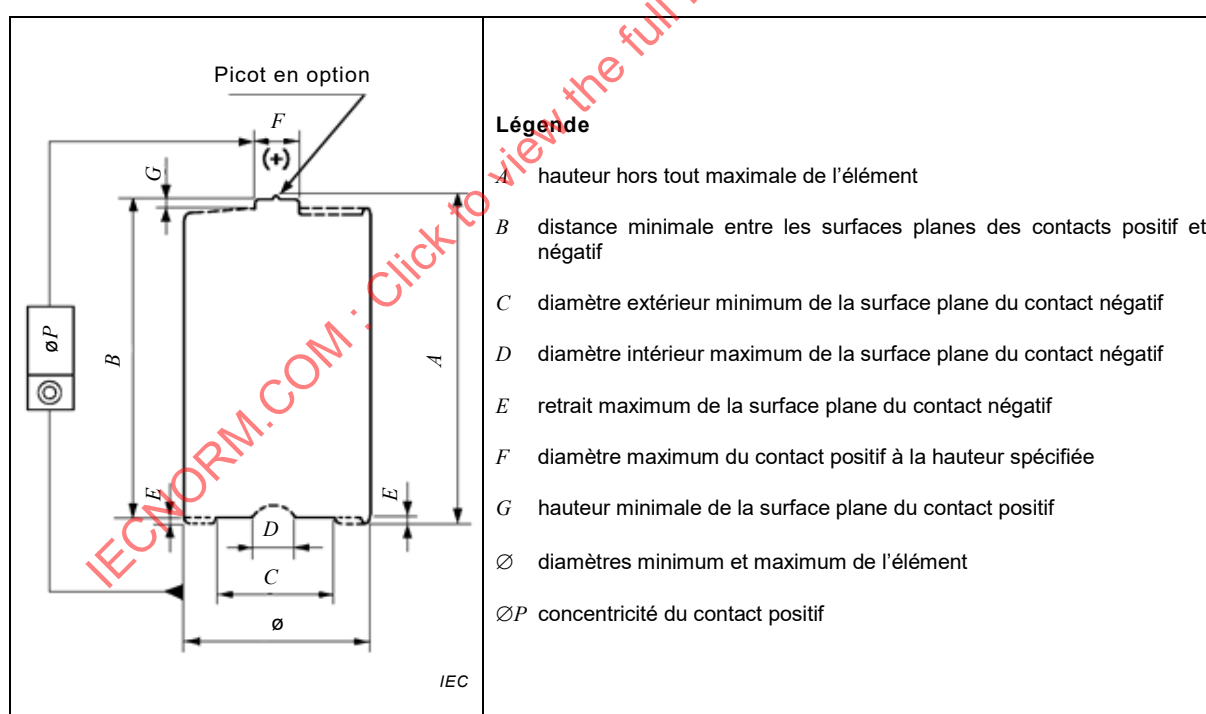


Figure 3 – Éléments gainés dimensionnellement interchangeables avec des piles

6.1.3.2 Éléments non-dimensionnellement interchangeables avec des piles

Le Tableau 3 présente les dimensions des éléments gainés cylindriques non dimensionnellement interchangeables avec des piles.

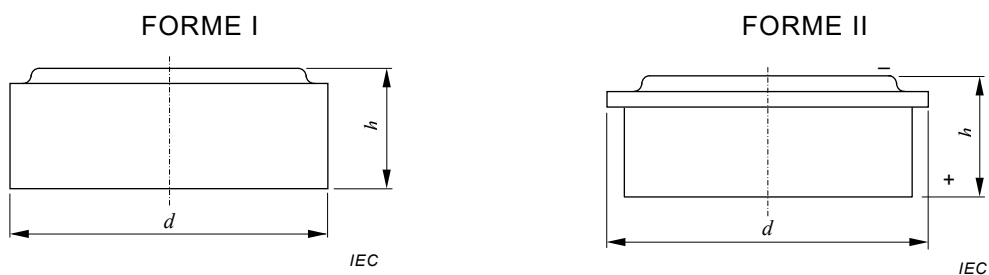
**Tableau 3 – Dimensions des éléments cylindriques gainés
non dimensionnellement interchangeables avec des piles**

Désignation des éléments ^a	Diamètre mm	Hauteur mm
HR 11/45	10,5	44,5
HR 11/51	10,5	50,5
HR 11/67	10,5	67,0
HR 15/43	14,5	43,0
HR 15/49	14,5	49,0
HR 15/51	14,5	50,5
HR 15/67	15,0	67,0
HR 17/29	17,0	28,5
HR 17/43	17,0	43,0
HR 17/50	17,0	50,0
HR 17/67	17,0	67,0
HR 18/44	18,0	43,5
HR 18/67	18,0	67,0
HR 19/67	19,0	67,0
HR 23/34	23,0	34,0
HR 23/43	23,0	43,0
HR 23/44	23,0	43,5
HR 23/50	23,0	50,0
HR 23/60	23,0	61,0
HR 26/47	25,8	47,0
HR 26/50	25,8	50,0
HR 33/36	33,0	36,0
HR 33/62	33,0	61,5
HR 33/91	33,0	91,0
HR 34/60	33,5	59,5

^a Les lettres HR sont suivies de L, M, H ou X et T et/ou R selon le cas (voir 5.1).

6.2 Éléments boutons

Les éléments doivent avoir la forme I ou II (voir Figure 4 ci-dessous).



NOTE La polarité de la forme I n'est pas normalisée.

Figure 4 – Éléments boutons

7 Essais électriques

7.1 Généralités

Les courants de charge et de décharge mis en œuvre pour les essais conformément à cet Article 7 et dans l'Article 5 doivent être basés sur la capacité assignée (C_5 Ah). Ces courants sont exprimés en multiples de I_t A, où I_t A = C_5 Ah/1 h.

Pour tous les essais, excepté où cela est indiqué, aucune fuite d'électrolyte, sous forme liquide, ne doit être observée.

7.2 Mode de charge pour les essais

7.2.1 Mode de charge des éléments

Avant la charge, l'élément doit avoir été déchargé à une température ambiante de $20\text{ °C} \pm 5\text{ °C}$, à un courant constant de $0,2 I_t$ A, jusqu'à une tension finale de 1,0 V.

Sauf indication contraire du présent document, la charge pour les différents essais prévus doit être effectuée à une température ambiante de $20\text{ °C} \pm 5\text{ °C}$, à une humidité relative de $65\% \pm 20\%$, et à un courant constant de $0,1 I_t$ A, pendant 16 h. Les essais doivent être effectués dans les deux mois qui suivent la date de fabrication. La date de fabrication est déterminée par le fabricant.

7.2.2 Mode de charge des batteries

Avant la charge, la batterie doit être déchargée à une température ambiante de $20\text{ °C} \pm 5\text{ °C}$, à un courant constant de $0,2 I_t$ A jusqu'à ce que sa tension soit égale au nombre d'éléments connectés en série multiplié par 1,0 V, sauf spécification contraire du fabricant.

Le mode de charge de la batterie doit être effectué selon les recommandations du fabricant à une température ambiante de $20\text{ °C} \pm 5\text{ °C}$ et à une humidité relative de $65\% \pm 20\%$. Les essais doivent être effectués dans les deux mois qui suivent la date de fabrication. La date de fabrication est déterminée par le fabricant.

7.3 Caractéristiques de décharge

7.3.1 Généralités

Les essais de décharge décrits ci-après doivent être effectués dans l'ordre indiqué.

7.3.2 Caractéristiques de décharge à 20 °C

7.3.2.1 Généralités

L'élément ou la batterie doit être chargé(e) conformément à 7.2. Après la charge, l'élément ou la batterie doit être mis(e) au repos, à une température ambiante de $20\text{ °C} \pm 5\text{ °C}$, pendant au moins 1 h et au plus 4 h.

7.3.2.2 Caractéristiques de décharge des éléments à 20 °C

L'élément doit ensuite être déchargé à une température ambiante de $20\text{ °C} \pm 5\text{ °C}$ et comme spécifié aux Tableau 6 ou Table 7. La durée de décharge ne doit pas être inférieure aux valeurs spécifiées aux Tableau 6 ou Table 7.

L'essai de décharge à $0,2 I_t$ A est effectué pour vérifier la capacité assignée déclarée de l'élément.

Tableau 6 – Caractéristiques de décharge à 20 °C des petits éléments parallélépipédiques et des éléments cylindriques

Conditions de décharge		Durée minimale de la décharge h/min			
Valeur du courant constant A	Tension finale V	Désignation des éléments			
		L/LT/LU/LS	M/MT/MU/MS/J/JT	H/HT/HU	X
0,2 I_t ^a	1,0	5 h	5 h	5 h	5 h
1,0 I_t	0,9	–	42 min	48 min	54 min
5,0 I_t ^b	0,8	–	–	6 min	9 min
10,0 I_t ^b	0,7	–	–	–	4 min

^a Cinq cycles sont admis par élément pour cet essai. L'essai doit être terminé à l'issue du premier cycle de chaque élément qui satisfait à l'exigence.

^b Avant les essais de décharge aux régimes de 5 I_t A et de 10 I_t A, un cycle de conditionnement peut être effectué si cela est nécessaire. Ce cycle doit consister en une charge à 0,1 I_t A conformément à 7.2 et une décharge à 0,2 I_t A à la température ambiante de 20 °C ± 5 °C conformément à 7.3.2.

Tableau 7 – Caractéristiques de décharge à 20 °C des éléments boutons

Conditions de décharge		Durée minimale de la décharge h/min
Valeur du courant constant A	Tension finale V	
0,2 I_t ^a	1,0	5 h
1,0 I_t	0,9	35 min

^a Cinq cycles sont admis pour cet essai. L'essai doit être terminé à l'issue du premier cycle qui satisfait à l'exigence.

7.3.2.3 Caractéristiques de décharge des batteries à 20 °C

La batterie doit ensuite être déchargée, comme indiqué en Table 8, à une température ambiante de 20 °C ± 5 °C à un courant constant de 0,2 I_t A jusqu'à ce que sa tension soit égale au nombre d'éléments connectés en série multiplié par 1,0 V, sauf spécification contraire du fabricant.

L'essai de décharge à 0,2 I_t A est effectué pour vérifier la capacité assignée déclarée de l'élément.

Tableau 8 – Caractéristiques de décharge à 20 °C des batteries

Conditions de décharge		Durée minimale de décharge h
Valeur du courant constant A	Tension finale V	
0,2 I_t ^a	1,0 × N ^b	5

^a Cinq cycles sont admis par batterie pour cet essai. L'essai doit être terminé à l'issue du premier cycle de chaque batterie qui satisfait à l'exigence.

^b N est le nombre d'éléments connectés en série dans la batterie.

7.3.2.4 Essai de conformité de la capacité assignée (mAh) (exemple)

Le Tableau 9 donne un exemple de la conformité de l'échantillon d'essai d'un élément ou d'une batterie (effectif d'échantillon de 32) lorsque le fabricant déclare une capacité assignée de 2 000 mAh.

Tableau 9 – Essai de conformité de la capacité assignée (mAh) (exemple)

Échantillon n°	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5 ^a	Capacité
1	1 920	1 950	1 900	2 005		2 005
2	2 000					2 000
3	1 920	1 950	2 000			2 000
4	1 860	1 890	1 900	1 950	2 000	2 000
5	2 005					2 005
Échantillons 6 à 31 ^b	–	–	–	–	–	–
32	1 970	2 010				2 010
				Capacité assignée		2 000

^a Cinq cycles sont admis pour cet essai.

^b Les mesures individuelles de capacité (mAh) des échantillons 6 à 31 ne sont pas représentés explicitement dans ce tableau par souci de concision. Lors des essais relatifs aux caractéristiques de décharge, les 32 échantillons doivent être soumis à l'essai pour vérifier qu'ils satisfont aux exigences.

7.3.3 Caractéristiques de décharge à 0 °C

L'élément doit être chargé conformément à 7.2. Après la charge, l'élément doit être mis au repos, à une température ambiante de 0 °C ± 2 °C pendant au moins 16 h et au plus 24 h.

L'élément doit ensuite être déchargé à une température ambiante de 0 °C ± 2 °C et comme spécifié aux Tableau 10 ou Table 11. La durée de décharge ne doit pas être inférieure aux valeurs spécifiées aux Tableau 10 ou Table 11.

Tableau 10 – Caractéristiques de décharge à 0 °C des petits éléments parallélépipédiques et des éléments cylindriques

Conditions de décharge		Durée minimale de la décharge h/min			
Valeur du courant constant A	Tension finale V	Désignation des éléments			
		L/LT/LU/LS	M/MT/MU/MS/J	H/HT/HU	X
0,2 I _t	1,0	2 h	4 h	4 h	4 h 30 min
1,0 I _t	0,9	–	36 min	42 min	48 min
2,0 I _t ^a	0,8	–	–	15 min	21 min
3,0 I _t ^a	0,8	–	–	–	12 min

^a Avant les essais de décharge aux régimes de 2,0 I_t A et 3,0 I_t A, un cycle de conditionnement peut être effectué si cela est nécessaire. Ce cycle doit consister en une charge à 0,1 I_t A conformément à 7.2 et une décharge à 0,2 I_t A à la température ambiante de 20 °C ± 5 °C conformément à 7.3.2.