BS EN 61960:2011

BSI Standards Publication

Secondary cells and batteries containing alkaline or other non-acid electrolytes — Secondary lithium cells and batteries for portable applications

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National foreword

This British Standard is the UK implementation of EN 61960:2011. It is identical to IEC 61960:2011. It supersedes BS EN 61960:2004, which will be withdrawn on 21 July 2014.

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

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

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EUROPEAN STANDARD

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EN 61960

August 2011

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English version

Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications

(IEC 61960:2011)

Accumulateurs alcalins et autres accumulateurs à électrolyte non acide - Eléments et batteries d'accumulateurs au lithium pour applications portables
(CEI 61960:2011)

Akkumulatoren und Batterien mit alkalischen oder anderen nichtsäurehaltigen Elektrolyten - Lithium-Akkumulatoren und -batterien für tragbare Geräte
(IEC 61960:2011)

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CENELEC

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

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Foreword

The text of document 21A/486/FDIS, future edition 2 of IEC 61960, prepared by SC 21A, Secondary cells and batteries containing alkaline or other non-acid electrolytes, of IEC TC 21, Secondary cells and batteries, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61960 on 2011-07-21.

This European Standard supersedes EN 61960:2004.

EN 61960:2011 includes the following significant technical changes with respect to EN 61960:2004:

— 7.6 Endurance in cycles: addition of an accelerated test procedure.

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

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-04-21
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-07-21

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61960:2011 was approved by CENELEC as a European Standard without any modification.

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

IEC 60051 series	NOTE	Harmonized in EN 60051 series.
IEC 61434	NOTE	Harmonized as EN 61434.
IEC 61959	NOTE	Harmonized as EN 61959.
IEC 62133	NOTE	Harmonized as EN 62133.
IEC 62281	NOTE	Harmonized as EN 62281.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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.

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

Publication	Year	Title	EN/HD	Year
IEC 60050-482	-	International Electrotechnical Vocabulary - Part 482: Primary and secondary cells and batteries	-	-
IEC 61000-4-2	-	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	EN 61000-4-2	-

CONTENTS

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

1 Scope

This International Standard specifies performance tests, designations, markings, dimensions and other requirements for secondary lithium single cells and batteries for portable applications.

The objective of this standard is to provide the purchasers and users of secondary lithium cells and batteries with a set of criteria with which they can judge the performance of secondary lithium cells and batteries offered by various manufacturers.

This standard defines a minimum required level of performance and a standardized methodology by which testing is performed and the results of this testing reported to the user. Hence, users will be able to establish the viability of commercially available cells and batteries via the declared specification and thus be able to select the cell or battery best suited for their intended application.

This standard covers secondary lithium cells and batteries with a range of chemistries. Each electrochemical couple has a characteristic voltage range over which it releases its electrical capacity, a characteristic nominal voltage and a characteristic end-of-discharge voltage during discharge. Users of secondary lithium cells and batteries are requested to consult the manufacturer for advice.

2 Normative references

The following referenced documents are indispensable for the application 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, *International Electrotechnical Vocabulary (IEV) – Part 482: Primary and secondary cells and batteries*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

3 Terms and definitions

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

3.1
charge recovery
capacity that a cell or battery can deliver after the charge following the charge retention test according to 3.2

3.2
charge retention
capacity retention
capacity that a cell or battery can deliver after storage, at a specific temperature, for a specific time without subsequent recharging as a percentage of the rated capacity

3.3
final voltage
end-of-discharge voltage
specified closed circuit voltage at which a discharge of a cell or battery is terminated

3.4
nominal voltage
suitable approximate value of voltage used to designate or identify a cell, or a battery

NOTE 1 The nominal voltages of secondary lithium cells are given in Table 1.

NOTE 2 The nominal voltage of a battery of *n* series connected cells is equal to *n* times the nominal voltage of a single cell.

3.5
rated capacity
quantity of electricity C_5 Ah (ampere-hours) declared by the manufacturer which a single cell or battery can deliver during a 5-h period, when charged, stored and discharged under the conditions specified in 7.3.1

3.6
secondary lithium battery
unit which incorporates one or more secondary lithium cells and which is ready for use. It incorporates adequate housing and a terminal arrangement and may have electronic control devices

3.7
secondary lithium cell
secondary single cell whose electrical energy is derived from the oxidation and the reduction of lithium. It is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device

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) ± 0,1 % for time;

f) ± 0,1 % for mass;

g) ± 0,1 mm for dimensions.

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

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

5 Cell designation and marking

5.1 Cell and battery designation

Batteries shall be designated with following form:

$$N_1 A_1 A_2 A_3 N_2 / N_3 / N_4 - N_5$$

Cells shall be designated with following form:

$$A_1\ A_2\ A_3\ N_2\ /\ N_3\ /\ N_4$$

where

N_1 is the number of series connected cells in the battery;

A_1 designates the negative electrode system in which

I is lithium ion;

L is lithium metal or lithium alloy;

A_2 designates the positive electrode basis in which

C is cobalt;

N is nickel;

M is manganese;

V is vanadium;

T is titanium;

A_3 designates the shape of the cell in which

R is cylindrical;

P is prismatic;

N_2 is the maximum diameter (if R) or the maximum thickness (if P) in mm rounded up to the next whole number;

N_3 is the maximum width (if P) in mm rounded up to the next whole number (N_3 not shown if R);

N_4 is the maximum overall height in mm rounded up to the next whole number;

NOTE If any dimension is less than 1 mm, the units used are tenths of millimetres and the single number is written tN.

N_5 is the number of parallel connected cells if 2 or greater (not shown if value is 1).

EXAMPLE 1 ICR19/66 would designate a cylindrical Li-ion secondary cell, with a cobalt-based positive electrode, a maximum diameter between 18 mm and 19 mm, and a maximum overall height between 65 mm and 66 mm.

EXAMPLE 2 ICP9/35/150 would designate a prismatic Li-ion secondary lithium cell, with a cobalt-based positive electrode, a maximum thickness between 8 mm and 9 mm, a maximum width between 34 mm and 35 mm, and a maximum overall height between 149 mm and 150 mm.

EXAMPLE 3 ICPt9/35/48 would designate a prismatic Li-ion secondary lithium cell, with a cobalt-based positive electrode, a maximum thickness between 0,8 mm and 0,9 mm, a maximum width between 34 mm and 35 mm, and a maximum overall height between 47 mm and 48 mm.

EXAMPLE 4 1ICR20/70 would designate a cylindrical Li-ion secondary battery with one single cell, a cobalt-based positive electrode, a maximum diameter between 19 mm and 20 mm, and a maximum overall height between 69 mm and 70 mm.

EXAMPLE 5 2ICP20/34/70 would designate a prismatic Li-ion secondary battery with two series connected cells, a cobalt-based positive electrode, a maximum thickness between 19 mm and 20 mm, a maximum width between 33 mm and 34 mm, and a maximum overall height between 69 mm and 70 mm.

EXAMPLE 6 1ICP20/68/70-2 would designate a prismatic Li-ion secondary battery with two parallel connected cells, a cobalt-based positive electrode, a maximum thickness between 19 mm and 20 mm, a maximum width between 67 mm and 68 mm, and a maximum overall height between 69 mm and 70 mm.

5.2 Cell or battery termination

This standard does not specify cell or battery termination.

5.3 Marking

Each cell or battery shall carry clear and durable markings giving the following information:

- secondary (rechargeable) Li or Li-ion;
- battery or cell designation as specified in 5.1;
- polarity;
- date of manufacture (which may be in code);
- name or identification of manufacturer or supplier.

Battery markings shall provide the following additional information:

- rated capacity;
- nominal voltage.

6 Standard cells

Table 1 lists the secondary lithium cell(s) that are suitable for standardization and used in assembling batteries.

Table 1 – Standard secondary lithium cells

	1	2	3
Secondary lithium cell	ICR19/66	ICP9/35/48	ICR18/68
Height (mm)	64,0/65,2	47,2/48,0	65,9/67,2
Diameter (mm)	17,8/18,5	NA	16,2/17,1
Width (mm)	NA	33,4/34,2	NA
Thickness (mm)	NA	7,6/8,8	NA
Nominal voltage (V)	3,6	3,6	3,6
End-of-discharge voltage (V)	2,50	2,50	2,50
End-of-discharge voltage (V) for endurance (cycle life)	2,75	2,75	2,75

NOTE The end-of-discharge voltage of a battery of *n* series connected cells is equal to *n* times the end-of discharge voltage of a single cell as given in Table 1.

7 Electrical tests

7.1 General

Unless otherwise stated, all tests that are described in this clause shall be performed in still air. Charge and discharge currents for the tests shall be based on the value of the rated capacity (C_5 Ah). These currents are expressed as a multiple of I_t A, where: I_t A = C_n Ah/1 h.

The minimum values required for each electrical test are stated in Table 5. Sample sizes and sequence of tests are described in Table 4.

7.2 Charging procedure for test purposes

Prior to charging, the cell or battery shall be discharged at 20 °C ± 5 °C at a constant current of 0,2 I_t A, down to a specified end-of-discharge voltage.

Unless otherwise stated in this standard, cells or batteries shall be charged, in an ambient temperature of 20 °C ± 5 °C, using the method declared by the manufacturer.

7.3 Discharge performance

7.3.1 Discharge performance at 20 °C (rated capacity)

This test verifies the rated capacity of a cell or battery.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – 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.

Step 3 – The cell or 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 specified end-of-discharge voltage.

Step 4 – The capacity (Ah) delivered during step 3 shall be not less than 100 % of the rated capacity declared by the manufacturer. Steps 1 to 4 may be repeated up to four additional times, as necessary to satisfy this requirement.

7.3.2 Discharge performance at –20 °C

This test determines the capacity of the cell or battery at a low temperature.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be stored, in an ambient temperature of −20 °C ± 2 °C, for not less than 16 h and not more than 24 h.

Step 3 – The cell or battery shall be discharged, in an ambient temperature of −20 °C ± 2 °C, at a constant current of 0,2 I_t A, until its voltage is equal to the specified end-of-discharge voltage.

Step 4 – The capacity (Ah), delivered during step 3, shall be not less than that specified for this characteristic in Table 5.

7.3.3 High rate discharge performance at 20 °C

This test determines the capacity of a cell or battery when discharged at a high rate. This test is not required if the cell or battery is not designed to be used at this rate.

Step 1 –The cell or battery shall be charged in accordance with 7.2.

Step 2 –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.

Step 3 –The cell or battery shall be discharged, in an ambient temperature of 20 °C ± 5 °C, at a constant current of 1,0 I_t A, until its voltage is equal to the specified end-of-discharge voltage.

Step 4 – The capacity (Ah) delivered during step 3 shall be not less than that specified for this characteristic in Table 5.

7.4 Charge (capacity) retention and recovery

This test determines firstly the capacity which a cell or battery retains after storage for an extended period of time, and secondly the capacity that can be recovered by a subsequent recharge.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be stored in an ambient temperature of 20 °C ± 5 °C, for 28 days.

Step 3 – The cell or 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 specified end-of-discharge voltage.

Step 4 – The 28-day retained capacity (Ah) delivered, during step 3, shall be not less than that specified for this characteristic in Table 5.

Step 5 – The cell or battery shall then be charged in accordance with 7.2, within 24 h following the discharge of step 3.

Step 6 – 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.

Step 7 – The cell or 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 specified end-of-discharge voltage.

Step 8 – The recovery capacity (Ah) delivered, during step 6, shall be not less than that specified for this characteristic in Table 5.

7.5 Charge (capacity) recovery after long term storage

This test determines the capacity of a cell or battery after extended storage at 50 % state of charge, followed by a subsequent charge.

Step 1 – The cell or battery shall be charged in accordance with 7.2.

Step 2 – The cell or battery shall be discharged, in an ambient temperature of 20 °C ± 5 °C, at a constant current of 0,2 I_t A, for 2,5 h.

Step 3 – The cell or battery shall be stored in an ambient temperature of 40 °C ± 2 °C, for 90 days.

Step 4 – The cell or battery shall be charged, in an ambient temperature of 20 °C ± 5 °C, using the method declared by the manufacturer.

Step 5 – 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.

Step 6 – The cell or 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 specified end-of-discharge voltage.

Step 7 – The capacity (Ah) delivered during step 5 shall be not less than that specified for this characteristic in Table 5. Steps 4 and 5 may be repeated up to four additional times, as necessary to satisfy this requirement.

7.6 Endurance in cycles

7.6.1 General

This test determines the number of charge/discharge cycles which a cell or battery can endure before its useful capacity has been significantly depleted or the remaining capacity after a specified number of cycles.

Prior to charging, the cell or battery shall be discharged at 20 °C ± 5 °C at a constant current of 0,2 I_t A, down to a specified end-of-discharge voltage.

The following endurance test shall then be carried out, irrespective of cell designation, in an ambient temperature of 20 °C ± 5 °C. Charge and discharge shall be carried out in accordance with the conditions specified in either Tables 4 or 5.

7.6.2 Endurance in cycles at a rate of 0,2 I_t A

Table 2 – Endurance in cycles at a rate of 0,2 I_t A

Cycle number	Charge	Stand in charged condition	Discharge
Until capacity delivered is less than 60 % of the rated capacity	Method declared by the manufacturer	0-1 h	0,2 I_t A to final voltage

The total number of cycles obtained when the test is completed shall be not less than that specified for this characteristic in Table 5.

7.6.3 Endurance in cycles at a rate of 0,5 I_t A (accelerated test procedure)

In order to accelerate the test, following alternative procedures may be carried out as an alternative to 7.6.2.

Table 3 – Endurance in cycles at a rate of 0,5 I_t A

Cycle number [a]	Charge	Stand in charged condition	Discharge
A: 1-400 or B: 1-300	Method declared by the manufacturer	0-1 h	0,5 I_t A to final voltage
[a] A: for cells, B: for batteries.			

The remaining capacity obtained when the test is completed shall be not less than that specified for this characteristic in Table 5.

7.7 Battery internal resistance

7.7.1 General

This test determines the internal resistance of a secondary lithium battery by either the alternating current (a.c.) or by the direct current (d.c.) method.

Should the need arise for the internal resistance to be measured by both a.c. and d.c. methods on the same battery, then the a.c. method shall be used first followed by the d.c. method. It is not necessary to discharge and charge the battery between conducting a.c. and d.c. measurements.

Step 1 – The battery shall be charged in accordance with 7.2.

Step 2 – The 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.

Step 3 – The measurement of internal resistance shall be performed in accordance with 7.7.2 or 7.7.3 in an ambient temperature of 20 °C ± 5 °C.

7.7.2 Measurement of the internal a.c. resistance

7.7.2.1 Measurement

The alternating r.m.s. voltage, U_a, shall be measured while applying an alternating r.m.s. current, I_a, at the frequency of 1,0 kHz ± 0,1 kHz, to the battery, for a period of 1 s to 5 s.

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

The internal a.c. resistance, R_{ac}, is given by:

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

where

U_a is the alternating r.m.s. voltage;

I_a is the alternating r.m.s. current.

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

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

7.7.2.2 Acceptance criterion

The internal a.c. resistance of the battery shall be not greater than the value of R_{ac}, declared by the manufacturer.

7.7.3 Measurement of the internal d.c. resistance

7.7.3.1 Measurement

The battery shall be discharged at a constant current of I_1 = 0,2 I_t A. At the end of a discharge period of 10 s, the discharge voltage U_1 under load shall be measured and recorded. The discharge current shall then be immediately increased to a value of I_2 = 1,0 I_t A and the corresponding discharge voltage U_2 measured under load and recorded again at the end of a discharge period of 1 s.

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

The internal d.c. 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.

7.7.3.2 Acceptance criterion

The internal d.c. resistance of the battery shall be not greater than the value of R_{dc}, declared by the manufacturer.

7.8 Electrostatic discharge (ESD)

7.8.1 General

This test is to evaluate the ability of a battery to withstand electrostatic discharge.

This test shall be conducted on a battery containing electronic protection devices, such as diodes, transistors or integrated circuits.

7.8.2 Test procedure

This test shall be carried out in accordance with IEC 61000-4-2, which concerns electronic discharge requirements (see Clauses 1 to 8).

The batteries shall be tested for contact discharge at 4 kV and air discharge at 8 kV.

7.8.3 Acceptance criterion

The battery shall operate with all protection circuits operational.

8 Test protocol and conditions for type approval

8.1 Test protocol

The sample size and protocol for conducting the electrical tests in Clause 7 are given in Table 4.

8.2 Conditions for type approval

8.2.1 Dimensions

The dimensions of the cell or battery shall not exceed the manufacturers' specified values and those values listed in Table 1.

8.2.2 Electrical tests

8.2.2.1 The manufacturer shall declare the rated capacity (C_5 Ah) of the cell or battery based on its performance under the conditions specified in 7.3.1 and in Table 5.

8.2.2.2 In order to meet the requirements of this standard, all samples shall meet all the performances specified in Table 5. The minimum levels for meeting the requirements of the electrical tests are expressed as percentages of the rated capacity.

8.2.2.3 If the test results do not meet the conditions of 8.2.2.2, the test can be repeated with new samples, provided that, on any test, not more than one sample failed to reach the performance specified in Table 5.

8.2.2.4 As an alternative to repeating the tests, a manufacturer may reduce the declared rated capacity of the battery to a value such that all test results do meet the conditions of 8.2.2.2.

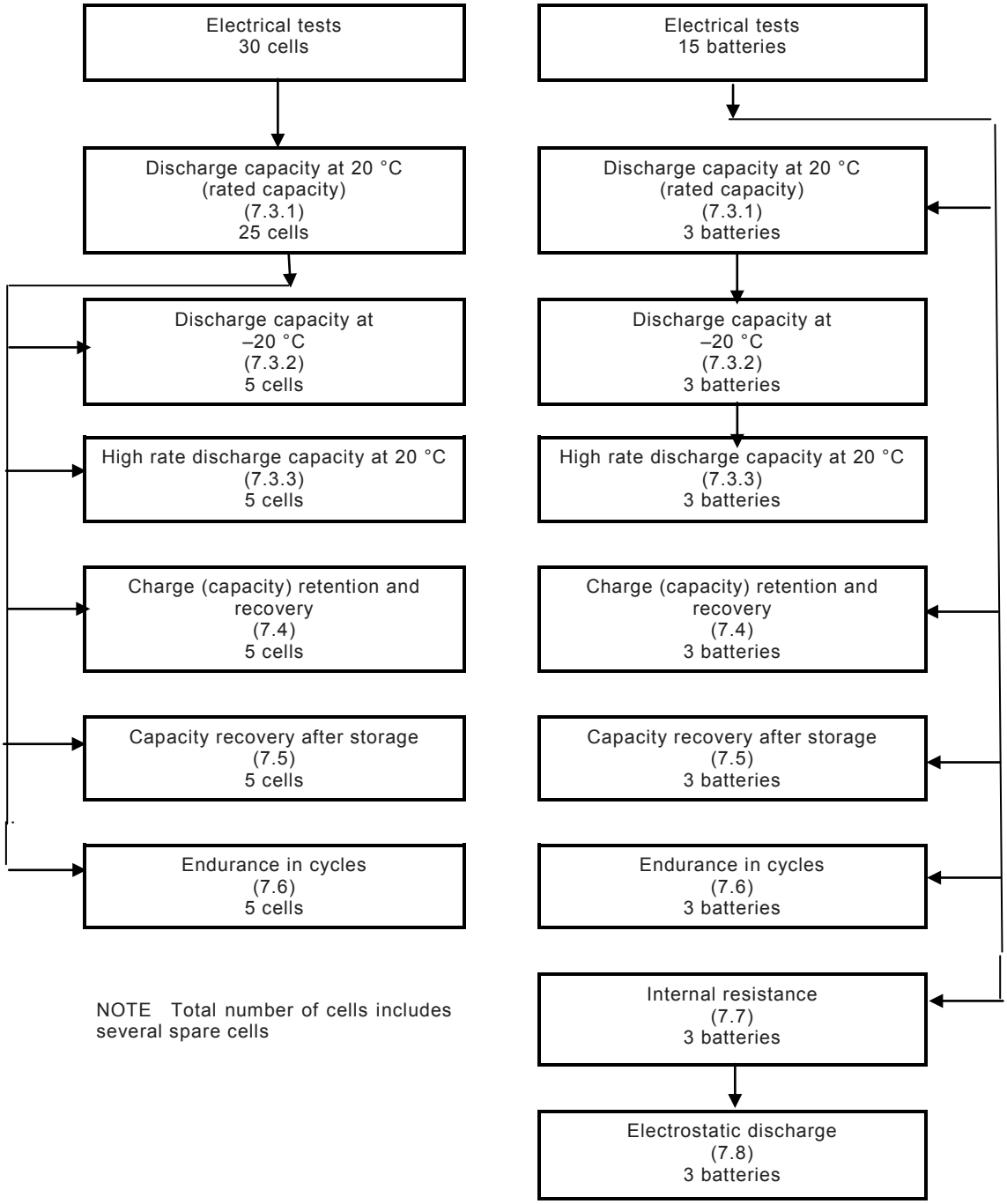
8.2.3 Conditional type approval

The cell or battery can be considered conditionally type approved prior to the completion of the charge (capacity) recovery after storage test specified in 7.5 and the endurance in cycles test specified in 7.6.2 if:

a) 20 % of the required cycles of the endurance test have been completed and the capacity delivered during any discharge remains above 85 % of the rated capacity, and

b) the requirements of all the other tests specified in Clause 7 have been met.

Table 4 – Sample sizes and sequence of tests



NOTE Total number of cells includes several spare cells

Table 5 – Minimum requirements for each type of standard secondary lithium cells and batteries

Parameter	Reference subclause	Acceptance criteria – cells	Acceptance criteria – batteries
Capacity at 20 °C ± 5 °C (rated capacity)	7.3.1	100 % C_5 Ah	100 % C_5 Ah
Capacity at -20 °C ± 2 °C	7.3.2	30 % C_5 Ah	30 % C_5 Ah
High rate discharge capacity at 20 °C ± 5 °C	7.3.3	70 % C_5 Ah	60 % C_5 Ah
Charge (capacity) retention	7.4	70 % C_5 Ah	60 % C_5 Ah
Charge (capacity) recovery	7.4	85 % C_5 Ah	85 % C_5 Ah
Capacity recovery after storage	7.5	50 % C_5 Ah	50 % C_5 Ah
Endurance in cycles	7.6.2	400 cycles	300 cycles
Endurance in cycles (accelerated)	7.6.3	60 % C_5 Ah	60 % C_5 Ah
Electrostatic discharge	7.8	n.a.	Operational

Bibliography

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IEC 60485, *Digital electronic d.c. voltmeters and d.c. electronic analogue-to-digital convertors*[1]

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*

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

IEC 62133, *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*

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

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[1] This publication was withdrawn.

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