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 mΩ +/- 20 mΩ.

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 °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 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 in accordance with:

- 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.

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 °C ± 5 °C	**Minimum discharge capacity** h/min
T ≤ 2 months	5 h
2 months < T ≤ 6 months	4 h 30 min
6 months < T ≤ 12 months	4 h
12 months < T ≤ 18 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 °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 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 °C ± 5 °C and a relative humidity of 65 % ± 20 % for 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 for charged state storage:

- 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 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 °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.

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 °C ± 5 °C	**Minimum discharge duration** h/min
T ≤ 2 months	5 h
2 months < T ≤ 6 months	4 h 45 min
6 months < T ≤ 12 months	4 h 30 min
12 months < T ≤ 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 °C ± 5 °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 °C ± 2 °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 °C ± 2 °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 °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 °C ± 5 °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 °C ± 2 °C	0,033 I_t A for 48 h	1,0 I_t A to 1,1 V	37 min
A (5 °C)	5 °C ± 2 °C	0,033 I_t A for 48 h	1,0 I_t A to 1,1 V	37 min
B (45 °C)	45 °C ± 2 °C	0,04 I_t A for 24 h	1,0 I_t A to 1,1 V	25 min
B (5 °C)	5 °C ± 2 °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 °C ± 5 °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 °C ± 5 °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 kHz ± 0,1 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	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	20	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		

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 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		

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 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		

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.