Informal working group: Large Lithium batteries testing

RECHARGE

Washington, Aug 26-28, 2015

Content:

1. Clarification table for testing.
2. What needs to be defined
3. Existing definitions review

UN 38-3 table of test

Summary table describing the existing testing requirements (based on Brussels meeting discussions):

		reference	***Primary, and Rechargeable without overcharge protection***	***Rechargeable with overcharge protection***
1-Cells tests	component cell (not transported seprately)	*38.3.2.1 scope*	T6 and T8	
	cell with non tested component cell	*38.3.3.d*	T1-T6 and T8	T1-T6 and T8
	Cell with tested component cell	*38.3.2.1 scope*	T1-T5	T1-T5 and T7
	Single cell battery with non tested cells or component cells	*38.3.2.3 definition*	T1-T6 and T8	T1-T8
	Single cell battery with tested cells	*38.3.3.d*		T7
	Single cell battery with tested component cell	*38.3.2.1*	T1-T5	T7
2 Battery tests	battery	*38.3.2.1 scope*	T1-T5	T1-T5 and T7
	Assembled battery with tested batteries	*38.3.3 (f)*	T3-T5	T3-T5 and T7
	large assembled battery	*38.3.3. (g)*	no testing if preventing overcharge short circuit and over discharge	no testing if preventing overcharge short circuit and over discharge

1. It should be clarified in the definition that a component cell cannot be proposed for transport separately from a battery.

2- A single cell battery is different from a cell **only** if it is equipped with an overcharge protection: in this case it shall be tested with T7. In other cases, the tests applicable are the same than for a cell. This should be clarified in the table and/or in the definitions?

UN 38-3 table of test

Summary table describing the existing testing requirements (based on Brussels meeting discussions):

		reference	***Tests***
1-Cells tests	component cell (not transported seprately)	*38.3.2.1 scope*	T6 and T8
	cell	*38.3.3.d*	T1-15, T6 and T8 (1)
	Single cell battery	*38.3.2.3 definition*	T1-15 (3), T6 and T8 (3), T7 (2)
2 Battery tests	battery	*38.3.2.1 scope*	T1-T5, T7 (2)
	Assembled	*38.3.3 (f)*	T3-T5 , T7 (2)
	large assembled battery	*38.3.3. (g)*	no testing if preventing overcharge short circuit and over discharge

(1) not applicable if already tested with the component cell

(2) not applicable for primary cells, or in case of exemption of 38.3.3.(d) for absence of overcharge protection

(3) not applicable if tested with the cell or the component cell

Simplified table, with notes (1) to (3) to avoid duplication of the already tested components

UN 38-3 table of test : primary cells and batteries

Proposals of more detailed information (last meeting):

-list of tests (SRICI)

-Number of batteries tested in each case (IEC standard)

- It requires 2 different tables for Primary and Secondary batteries.
- Notes (1) and (3) have been added to avoid duplication of categories with already tested component cells.

Primary cells and batteries		**T1** Altitude simulation	**T2** thermal test	**T3** Vibration	**T4** shock	**T5** External Short circuit	**T6** Impact/crush	**T8** Forced discharge
component cell (not transported seprately)	undischarged state						5	
	fully discharged state						5	10
Cell	undischarged state	10					5 (1)	
	fully discharged state	10					5 (1)	10 (1)
Single cell battery	undischarged state	10 (3)					5 (3)	
	fully discharged state	10 (3)					5 (3)	10 (3)
Small and large battery	undischarged state	4					5 (1)	
	fully discharged state	4					5 (1)	10 (1)
assembled battery with tested batteries	undischarged state			1				
Large assembled batteries		no testing if preventing overcharge short circuit and over discharge						

(1) not applicable if already tested with the component cell

(3) not applicable if tested with the cell or the component cell

UN 38-3 table of test: rechargeable cells and batteries

Need to clarify definition of Component cell and single cell battery in order to differentiate from cell

Rechargeable Cells and batteries		T1	T2	T3	T4	T5	T6	T7	T8
		Altitude simulation	thermal test	Vibration	shock	External Short circuit	Impact/crush	Overcharge	Forced discharge
component cell (not transported separately)	First cycle, 50% discharged						5		
	First cycle fully discharged								10
	50th cycle, fully discharged								10
Cell	First cycle, fully charged	10							
	First cycle fully discharged								10 (1)
	First cycle, 50% discharged						5 (1)		
	50th cycle, fully discharged						5 (1)		10 (1)
	50th cycle, Fully charged								
Single cell battery	First cycle, fully charged	10 (3)						4	
	First cycle fully discharged	10 (3)							10 (3)
	First cycle, 50% discharged						5 (3)		
	50th cycle, fully discharged						5 (3)		10 (3)
	50th cycle, Fully charged							4	
Small battery	First cycle, fully charged	4						4(2)	
	50th cycle, Fully charged	4						4(2)	
Large batteries	First cycle, fully charged	2						2 (2)	
	25th cycle, Fully charged	2						2 (2)	
assembled battery with tested batteries	First cycle, fully charged			1					
Large assembled batteries		no testing if preventing overcharge short circuit and over discharge							

(1) not applicable if already tested with the component cell

(2) not applicable in case of exemption of 38.3.3.(d) for lack of overcharge protection

(3) not applicable if tested with the cell or the component cell

What needs to be defined

"UN Manual 38.3.2.3 : For the purposes of classification, the following definitions apply: …."

-for UN 38.3: identify clear categories of products allowing un-ambiguous testing categories: example: small cell is defined with weight limit 500g.

- For UN model regulation: product categories to identify the transport conditions: example: small cell size for SP188 is defined as lower then 20 Wh.

Definition purpose should be clearly identified to correctly define:

- **the granularity of the categories:**
- **The boundaries definitions and coherence according the used characteristics**

Existing definitions:

- battery size: Wh, Kg, dimensions (for example in T6 are defined batteries less than 20 mm in diameter).
- Battery complexity
- Battery chemistry (based on UN numbers)

What needs to be defined

- **Objective: a single simplified table, no overlap, no alternative options for cells or batteries, each test linked to a definition.**

→ **Need to clarify definition of Component cell and single cell battery in order to differentiate from cell**

- **Question : is a multicell battery in a single casing acceptable for transport without T6 and T8 test? Decision to be included in the definition.**

Content:

1. UN 38-3 Definitions purpose.
2. What needs to be defined
3. Existing definitions review

Purpose 1: Electrochemical system identification

- **Existing definitions at general description level (but not in UN 38.3, as already identified in the [38.3.1 purpose])**

[European Battery Directive 2006/66/EC]
Battery or Accumulator: means any source of electrical energy generated by direct conversion of chemical energy and consisting of one or more primary battery cells (non-rechargeable) or consisting of one or more secondary battery cells (rechargeable).
Battery Pack means any set of batteries that are connected together and/or encapsulated within an outer casing so as to form a complete unit that the end-user is not intended to split up or open.

[IEV ref 151-12-11]
... bank
battery of ...
set of devices of the same type so connected as to act together
Note – Example of use of this concept are: capacitor bank, filter bank, battery of cells.

[IEV ref 811-20-01]
(electrochemical) cell
battery
an electrochemical system capable of storing in chemical *from* the electric energy received and which can give it back by reconversion

Identification of electrochemical system

Purpose 2: Cell (not battery)

- **Existing definitions**

Design description

[UN 38.3 definitions]
Cell means a single encased electrochemical unit (one positive and one negative electrode) which exhibits a voltage differential across its two terminals. Under the Model Regulations and this Manual, to the extent the encased electrochemical unit meets the definition of "cell" herein, it is a "cell", not a "battery", regardless of whether the unit is termed a "battery" or a "single cell battery" outside of the Model Regulations and this Manual.

Component cell means a cell contained in a battery.

Overlaps risks

Single cell battery means a single electrochemical unit fitted with devices necessary for use, for example, case, terminals, marking and protective devices

[IEV ref 482-01-01]
cell
basic functional unit, consisting of an assembly of electrodes, electrolyte, container, terminals and usually separators, that is a source of electric energy obtained by direct conversion of chemical energy
Note – See primary cell and secondary cell.

Is in purpose 1

[IEV ref 114-03-01]
electrochemical cell
composite system in which the supplied electric energy mainly produces chemical reactions or, conversely, in which the energy released by chemical reactions is mainly delivered by the system as electric energy
Note 1 to entry: This entry was numbered 111-15-10 in IEC 60050-111:1996. It has been modified.

Purpose 3: battery (not cell)

- **Existing definitions**

[UN 38.3 definitions]
Battery means two or more cells which are electrically connected together and fitted with devices necessary for use, for example, case, terminals, marking and protective devices. A single cell battery is considered a cell and shall be tested according to the testing requirements for "cells" for the purposes of the Model Regulations and this Manual (see also the definition for "cell").

NOTE: Units that are commonly referred to as "battery packs", "modules" or "battery assemblies“ having the primary function of providing a source of power to another piece of equipment are for the purposes of the Model Regulations and this Manual treated as batteries.

[IEV ref 482-01-04]
Battery
one or more cells fitted with devices necessary for use, for example case, terminals, marking and protective devices

Cells assembly description

Purpose 4: battery size = button cells

- **Existing definitions: button cells are supposed to describe small cells, but no information about size.**

UN 38.3 Definitions:

Button cell or battery means a round small cell or battery when the overall height is less than the diameter.

IEV ref 482-02-40

button cell
coin cell

cell with a cylindrical shape in which the overall height is less than the diameter e.g. in the shape of a button or a coin

Note – In practice, the term coin is used exclusively for non-aqueous lithium cells.

Purpose 4: small and large cells /batteries

- **Existing definitions:**

in UN Model, the limit in size is expressed in Li content or in Wh, not in weight.

UN 38.3 Definitions:
Small battery means a lithium metal battery or lithium ion battery with a gross mass of not more than 12 kg.
Small cell means a cell with a gross mass of not more than 500 g.

Purpose 5: battery chemistry identification

- **Existing definitions: IEC Li cells include Lithium metal and Lithium sulfur chemistries, but no definition UN 38.3?**

No « Lithium metal » battery definition in UN 38.3 or IEC

[UN 38.3 definitions]

Lithium ion cell or battery means a rechargeable electrochemical cell or battery in which the positive and negative electrodes are both intercalation compounds (intercalated lithium exists in an ionic or quasi-atomic form with the lattice of the electrode material) constructed with no metallic lithium in either electrode. A lithium polymer cell or battery that uses lithium ion chemistries, as described herein, is regulated as a lithium ion cell or battery.

[IEV ref 482-01-06]
lithium cell
cell containing a non-aqueous electrolyte and a negative electrode of lithium or containing lithium
Note – Depending on the design features chosen, a lithium cell may be primary or secondary

IEV ref 482-05-07
lithium ion battery (NOT CELL?)
secondary battery with an organic solvent electrolyte and positive and negative electrodes which utilize an intercalation compound in which lithium is stored
Note – A lithium ion battery does not contain lithium metal.

Purpose 5: UN Numbers for batteries chemistry

Identified needs: Battery chemistry => UN numbers corresponding name and description

- UN 3090, UN 3091 class 9 — Lithium metal batteries, and Lithium metal in/packed with equipment
- UN 3480, UN 3481 Class 9 — Li ion batteries (and Li ion polymer), and Li-ion in/packed with equipment
- UN 2794 class 8 — Batteries, Wet, filled with acid, electric storage
- UN 2795 class 8 — Batteries, Wet, filled with alkali, electric storage
- UN 2800 class 8 — Batteries, Wet, non spillable
- UN 3028 class 8 — Batteries, dry containing KOH solid
- UN 3292 Class 4.3 — Batteries or cells containing sodium
- UN 3496 Class 9 — Batteries Ni Metal hydride
- UN3499 Class 9 — Capacitors
- UN3508 Class 9 — Asymmetric capacitors
- **Li-S? Li-metal polymer?**

Is it a need to have a definition for new chemistries?

Definitions purpose: capacitors

- **Existing definitions: only in IEC, no definition of assymetric capacitor ?**

[IEV ref 114-03-03]
electrochemical capacitor
supercapacitor
device that stores electrical energy using a double layer in an electrochemical cell
Note 1 to entry: The electrochemical capacitor is not to be confused with electrolytic capacitors (114-03-04).

[IEV ref 114-03-04]
electrolytic capacitor
capacitor consisting of a metallic plate as first conductor, a very thin oxide film formed on the metal as the dielectric and an electrolyte as second conductor
Note 1 to entry: Electrolytic capacitors typically have large capacitance because the dielectric is very thin.
Note 2 to entry: The electrolytic capacitor is not to be confused with electrochemical capacitors
(114-03-03).
Note 3 to entry: Definition 436-03-05 in IEC 60050-436:1990 doesn't mention electrolyte.