

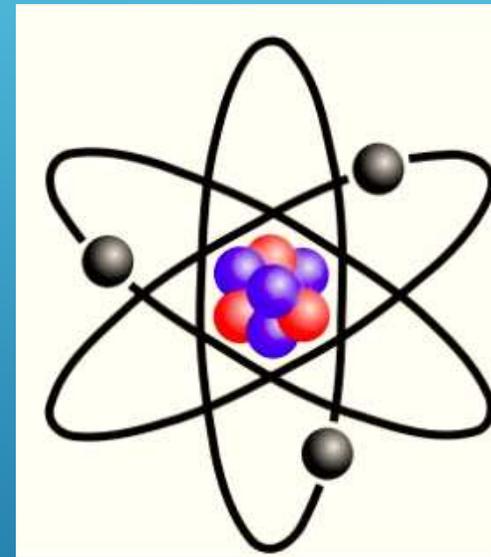
## 3rd INTERSESSIONAL WORKING GROUP MEETING - UN TESTING REQUIREMENTS ON LARGE LITHIUM BATTERIES

Hosted by RECHARGE, COSTHA and PRBA  
September 29 – October 2, 2014

Wiley Rein LLP  
Washington, DC

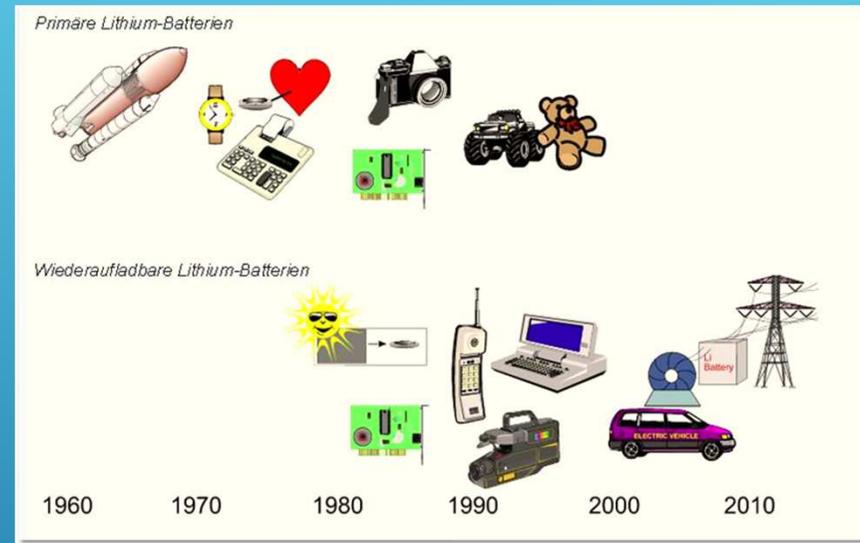
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Lithiumbatteries- Primary (non el. rechargeable function) and Secondary:

- next steps in global society?
- Li-Metal Innovation, (primary + secondary)
- High-V System, 5V...
- Li-ion, etall, new design new materials (2014)
- Li-S (SN?), strategic,in 5 years?
- ...
- Application: Decentral Energy solutions...others



**LITHIUMBATTERIES ARE BOOMING FAST AND CREATE INNOVATIONS – A CHALLENGE FOR THE WG.**

Scientifically battery (+ -)cells are referred to as electrochemical or galvanic cells, due to the fact that they store electrical energy in the form of chemical energy and because the electrochemical reactions that take place are also termed galvanic. Galvanic reactions are thermodynamically favorable (the free energy difference,  $\Delta G$ , is negative) and occur spontaneously when two materials of different positive standard reduction potentials are connected by an electronic load (meaning that a voltage is derived). The material with the lower positive standard reduction potential undergoes an oxidation reaction providing electrons by the external circuit to the material with the higher positive standard reduction potential, which in turn undergoes a reduction reaction.

High Energy Density Lithium Batteries. Edited by Katerina E. Aifantis, Stephen A. Hackney, and R. Vasant Kumar  
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**BATTERIES VS. BATTERY CELLS, NOT ONLY CELLS ?**

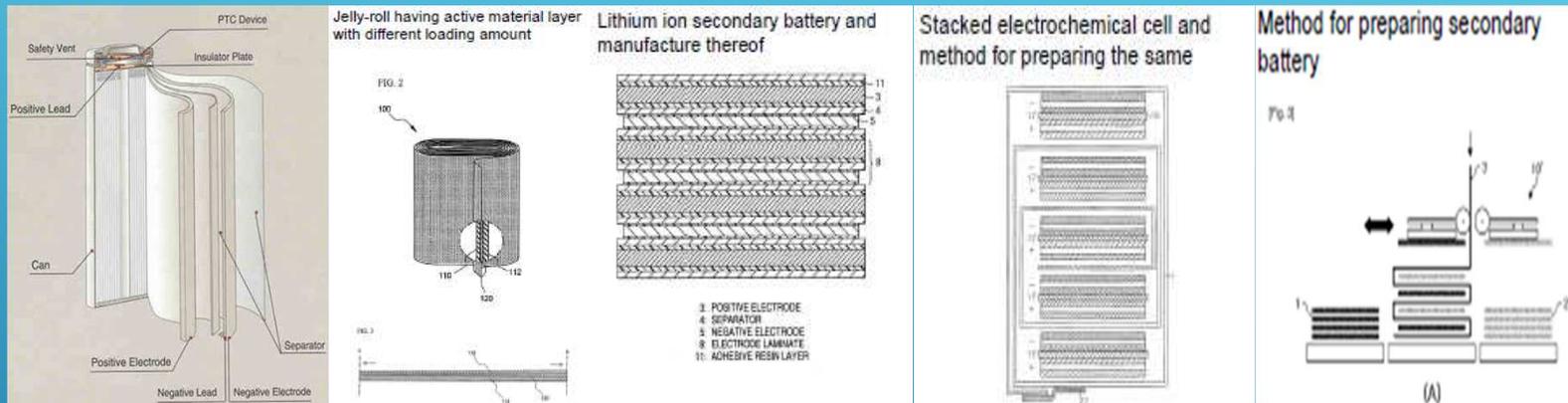
- ▶ Li-Battery Cell and Definition: Primary & Secondary
- ▶ Single Cell Battery, is a Battery - is not ?
- ▶ Discussion / Information Paper

**CONTENT DEFINITIONS.. CLARIFICATION.. CELL AS BATTERY  
CELL, 1S BATTERY, BATTERY .**

- IEC 61960 Ed2 “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”.
- IEC 62660 “secondary single cell whose electrical energy is derived from the insertion/extraction reactions of lithium ions between the anode and the cathode.”
- IEC 60086 / IEC 62281 „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”.

## BATTERY CELL DEFINITIONS IN IEC

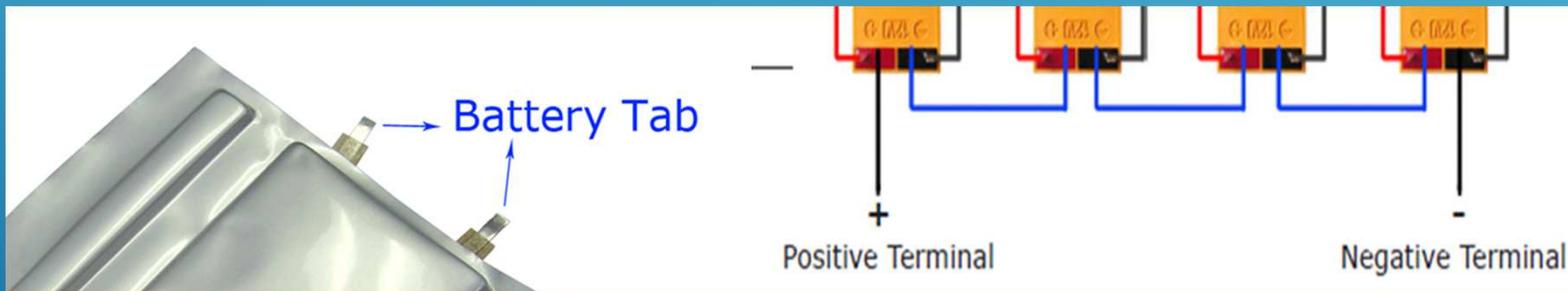
- ▶ **Battery Cells** are made of different design, especially with more than one electrode assembly or cell inside (winding, stacking, e.c.). The amendment proposal shall being the base for more clarity and sustained understanding.



- ▶ **“Cell means a (single) encased electrochemical unit (one positive and one negative electrode) which exhibits a voltage differential across its two terminals, and may contain its protection devices.”**

**CELL = BATTERY CELL**

- ▶ Proposal for Definition “Cell” new: „at least one positive and one negative electrode“:
- ▶ “Battery Cell means a single encased electrochemical unit (at least one positive and one negative electrode) which exhibits a voltage differential across its terminals, and may contain its protection devices.”



TERMINAL OR TABS OR TERMINALS ?

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Do not connect the positive (+) and negative (-) terminals with a metal object

Battery terminals are the electrical contacts used to connect a load or charger to a battery cell, single cell or multiple-cell battery, a battery assembly. These terminals have a wide variety of designs, sizes, and features that often not well documented.

Tabs are Battery Cell terminals in regard of this Manual.



Some Battery Cells offer only1 real terminal or more, sometimes 5 terminals...

**TERMINAL OR TABS OR TERMINALS ?**



## Voltage

- ▶ The theoretical standard cell voltage,  $E^0$  (cell) can be determined using the electrochemical series and is given by the difference between the standard electrode potential at the cathode,  $E^0$  (cathode), and the standard electrode potential at the anode,  $E^0$  (anode) [2] as

$$E^0 \text{ (cathode)} - E^0 \text{ (anode)} = E^0 \text{ (cell)}$$

**A BATTERY CELL NOT ACTIVATED IN TRANSPORTATION ?**

- ▶ “Cell means a single encased electrochemical unit (one positive and one negative electrode) which exhibits a voltage differential across its two terminals, and may contain its protection devices.”
- ▶ “**Battery** Cell means a (single) encased electrochemical unit (at least one positive and one negative electrode) which exhibits a voltage differential across its (two ??) terminals, and may contain its protection devices or other features.”

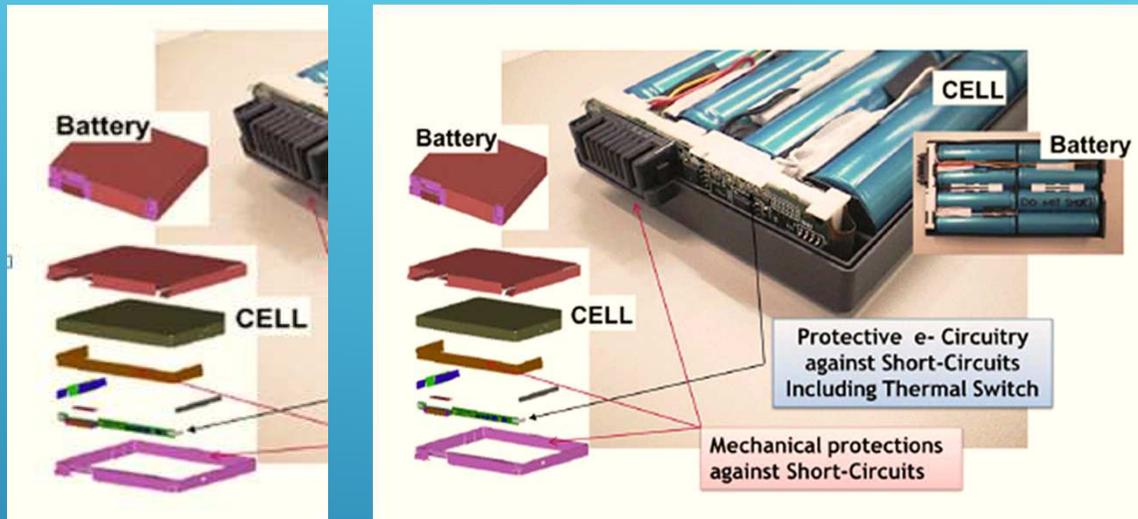
BATTERY CELL ...ONE UNIT, TWO ORE MORE CELLS?



Type	T. Tests
Cells - primary	T.1-T.6, T.8
Cells- secondary	T.1-T.6, T.8
Component cell (not transp. separately from battery)	T.6 and T.8
Single cell battery (1s) primary	T.1 - T.6 and T.8,
Single cell battery (1s) secondary (with OCP)	T.1-T.5, T7
Batteries	T.1-T.5 (battery-level) , (T.7 if rechargeable))
	<b>Section. 38 .3 (5<sup>th</sup> amended)</b>

*A component cell not equipped with battery element is a cell, is not?*

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In the EU and Germany a Battery: one or more Cells...

## SINGLE CELL BATTERY (SCB) AND BATTERIES MADE UP OF SCB

- ▶ SCB primary/ secondary now T.1-T.6, T.8 (as Cells)
- ▶ With view on batteries the difference is T.6 (no); **T.7 (sec.)** and T.8 (yes)
- ▶ ? SCB secondary **T.1- T.8**, (ocp ?)
- ▶ Batteries (modules, assemblies) made of SCB Battery: T.1- T.5, (T.7 secondary), resp. assembly entries

**THE SCB IS NORMALLY A BATTERY T. TEST OBJECT (INTEGRITY, OCP FUNCTION EC.**

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