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ExTAG meeting

Dubai, UAE – 2019-09-23

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Battery testing

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Introduction

Definition - cell

3.7.3

cell

basic functional unit, consisting of an assembly of electrodes, electrolyte, case, terminals and usually separators, that is a source of electric energy obtained by direct conversion of chemical energy

- Note 1 to entry: See primary cell and secondary cell.

Definition – primary cell or battery

3.7.9

primary cell or battery

cell or battery which is not designed to be electrically recharged

Definition - battery

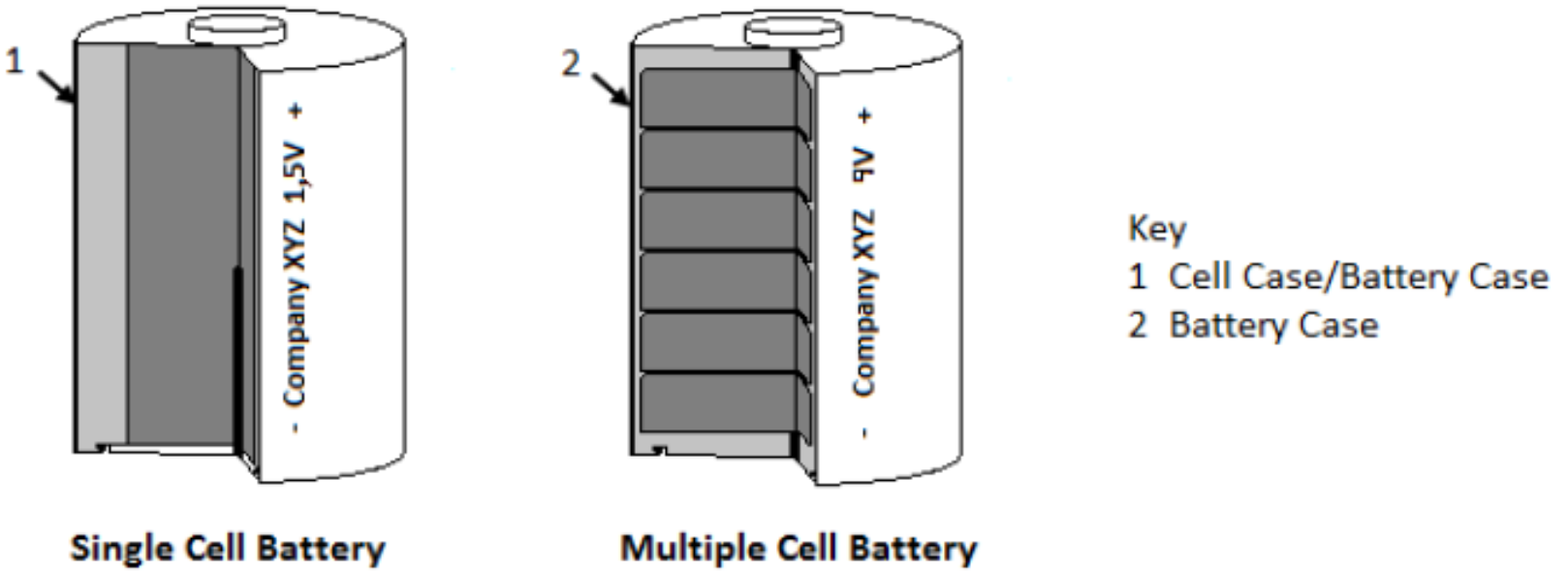
3.7.1

battery

one or more cells fitted with devices necessary for use, for example, terminals, marking and protective devices

Note 1 to entry: See Figure 1 for examples of typical battery constructions.

Definition - battery



Key
1 Cell Case/Battery Case
2 Battery Case

Figure 1 – Typical battery examples

Definition – battery compartment

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3.7.14

battery compartment

compartment of the equipment that accommodates one or more cells and batteries

Note 1 to entry: The battery compartment is an integral part of the equipment.

Note 2 to entry: A battery compartment may be a battery container

Definition - battery container

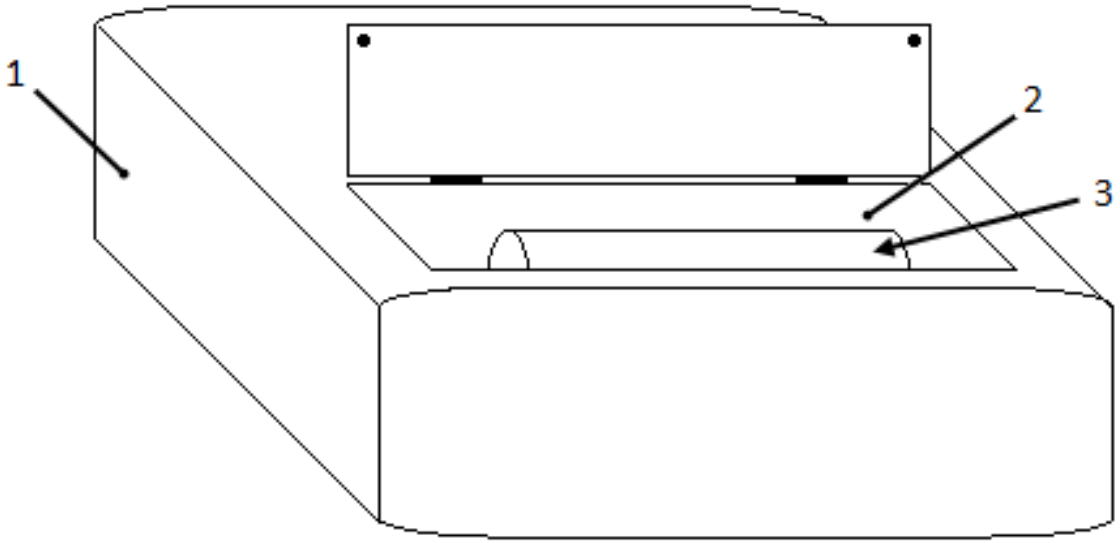
3.7.15

battery container

enclosure to contain one or more cells or batteries

Note 1 to entry: See Figure 2 for examples of typical battery constructions.

Definition - battery container



Key
1 Equipment
2 Battery Compartment
3 Cell/Battery/Replaceable Battery Pack

- **Figure 2 – Typical battery compartment**

Definition - replaceable battery pack

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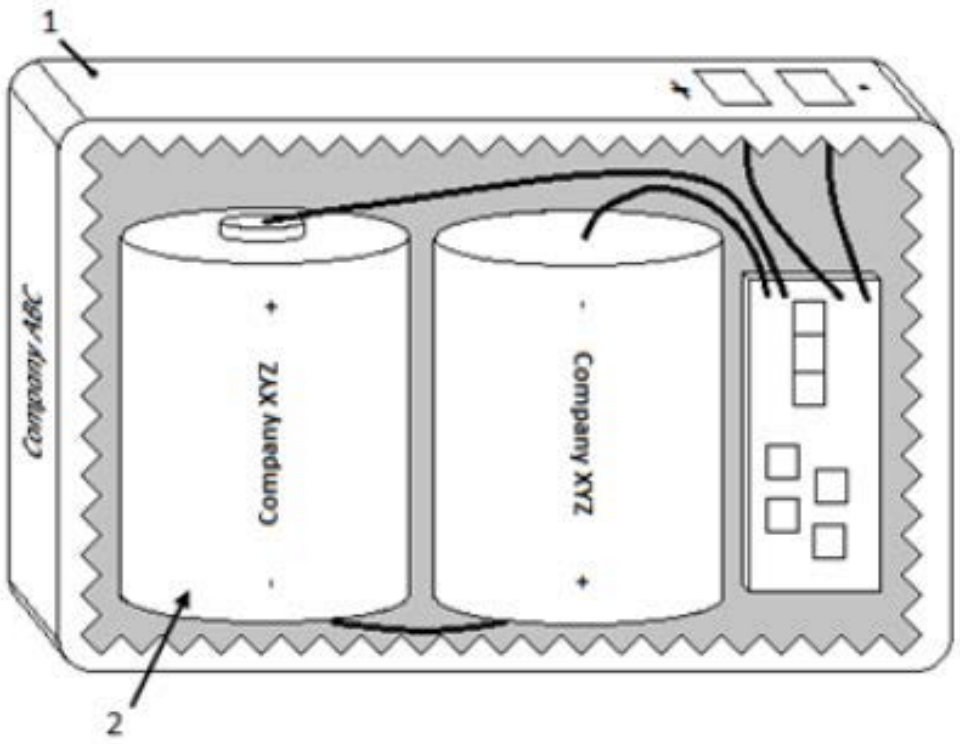
replaceable battery pack

assembly consisting of one or more interconnected cells, along with any integrated protective components, which form a complete replaceable battery

Note 1 to entry: See Figure 3 for examples of typical replaceable battery pack construction.

Definition - battery pack



Key
1 Battery Container
2 Cell/Battery

IEC

Figure 3 – Typical replaceable battery pack

IEC 60079-0 Ed 7

IEC Hazardous Area standards

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- IEC 60079-1 – Flameproof “d" – Annex E
- IEC 60079-2 – Pressurization "p" – Annexes G & H
- IEC 60079-5 – Powder filling – "q" – Sub-Clause 4.6
- IEC 60079-7 – Increased safety "e" – Sub-Clause 5.6
- IEC 60079-15 – Type of protection "n" – Sub-Clause 10.2.2
- IEC 60079-18 – Encapsulation "m" – Sub-Clause 7.8
- IEC 60079-31 – Protection by enclosure "t" – Sub-Clause 4.3.5.1
- IEC 60079-35-1 – Caplights for mines – Clause 7

Current Requirements for Intrinsic Safety

- **Standards used for IECEx CoCs;**
  - **IEC 60079-0 Ed 6 (2011)**
  - **IEC 60079-0 Ed 7 (2017)**
  - **IEC 60079-11 Ed 5 (2006)**
  - **IEC 60079-11 Ed 6 (2011)**

What are we looking for?

- Open circuit voltage
- Short circuit current
- Maximum surface temperature on short circuit
- Electrolyte leakage on short circuit
- Venting

Other considerations

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- Off-gassing of cells
- Faults – internal safety devices not meeting requirements
- Battery supply remaining connected when main power disconnected
- Control of charging
- Definition of cells and batteries used

IEC 60079-11

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- **No major changes for requirements between Ed. 5 and Ed. 6.**
- **Verifications and tests were modified;**
  - **Sub-Clause 10.5 introduced the relaxations for Level of Protection "ic"**
  - **Sub-Clause 10.5.3 b) introduced the requirement to test cells at any temperature between laboratory ambient and the maximum rated ambient of the equipment.**
  - **Sub-Clause 10.5.3 b) introduced the permission to maintain the internal current limiting for Level of Protection "ib" for the short-circuit temperature rise test.**

Items under consideration

- Supercapacitors are not addressed
- Spark-ignition testing using cells
- Surface temperature testing
- Stability of cell technology
- Permitted inductance in circuits
- Lithium-ion cells
  - Safety concerns with testing
  - Increase in short-circuit current

Work in progress

- What is SC31G MT 60079-11 doing to address these items?
  - An interpretation sheet has been developed.
  - The 7th edition of IEC 60079-11 is preparation.

Interpretation sheets

- Interpretation sheet for Ed 6 ISH6
- Interpretation sheet for Ed 5 ISH1
- Drafted and circulated to NCs for comment in April
- Due to be circulated as Draft Interpretation Sheet 2019-10
- Published 2019-12?

IEC 60079-11 ED 7

- Started 2017
- Major re-organisation and rewrite
- Trying to address inconsistent application
- Planned publication was originally 2020.

Some changes proposed for 7th edition

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- **Supercapacitors e.g. EDLC**

Surface temperature testing

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- Defining temperature at which the cells are tested
  - Low temperature
  - Ambient temperature
  - High temperature

Ignition testing

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- Spark ignition testing of cells
  - How to achieve safety factor
  - How to overcome cell decay during the test
  - Limitation of spark test apparatus (5 A max assuming 1.5 Safety Factored gas mixture)

Stability of design

- Stability of cell technology
  - Tested at initial certification
  - Not subject to re-test
  - What happens to existing equipment if cells are retested
  - Safety concerns if required to be routine tested

New cell chemistry

- **New cell chemistries not listed in IEC 60079-0**

Technological improvements

4,5 V cell relaxation

- **Should this relaxation remain?**
- **Based on the inability to have a non-inductive spark at less than 8,5 V.**

High short circuit current

- Permitted inductance in circuits
  - No current limiting then an increase in short-circuit current reduces permitted circuit inductance
  - What about the internal cell impedance?

Physical contraints

- Creepage and clearance of cells;
  - Failure between anode/cathode of cells

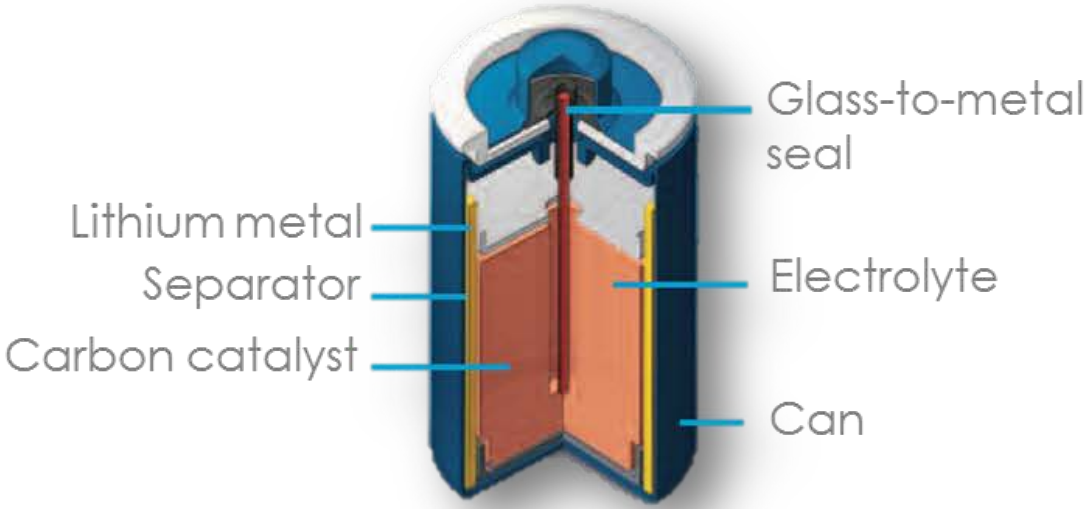
    E.g. Failure of PP3 style cell

PP3 style construnction

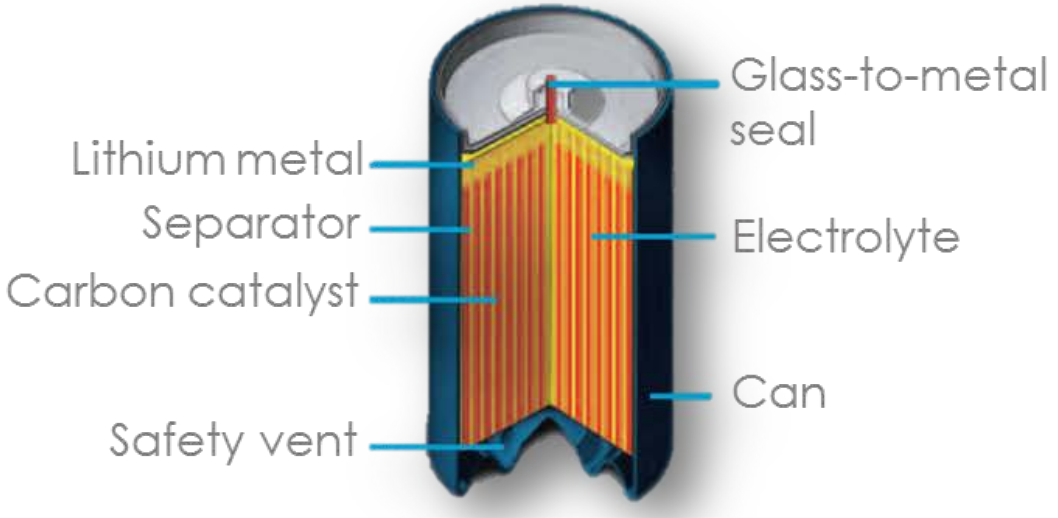
Li-ion cells

- **Lithium-ion cells and availability of cells without protection for test purposes.**
- **Safety concerns with testing.**

Construction Examples



Bobbin construction (High energy cells)



Spiral construction (High power cells)

Pictures courtesy of SAFT

Construction Examples

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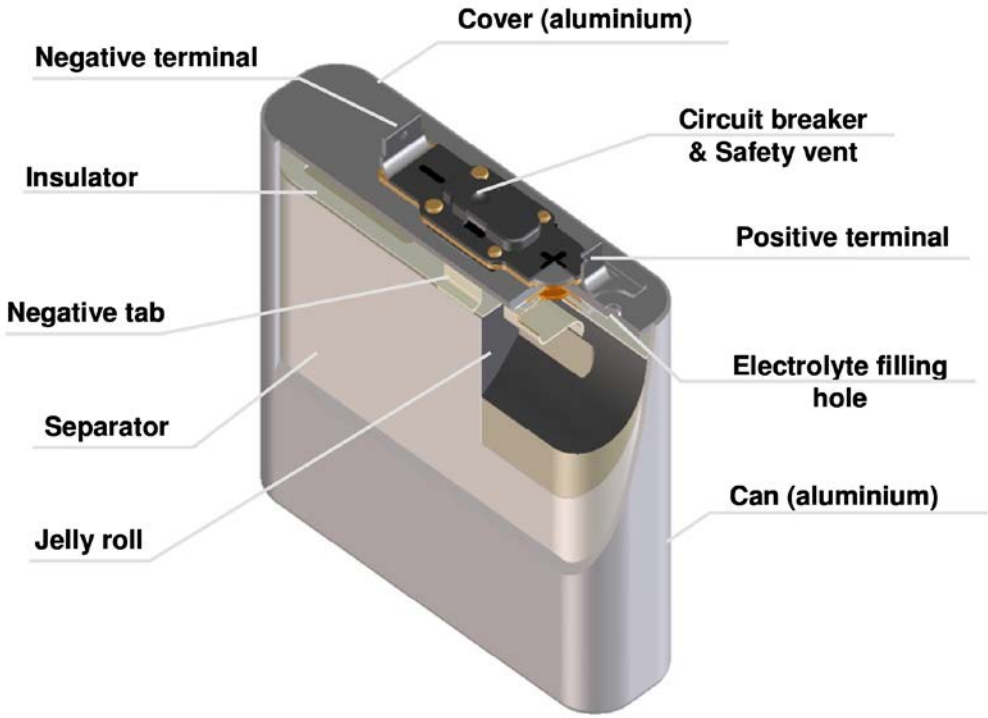
Prismatic form factor

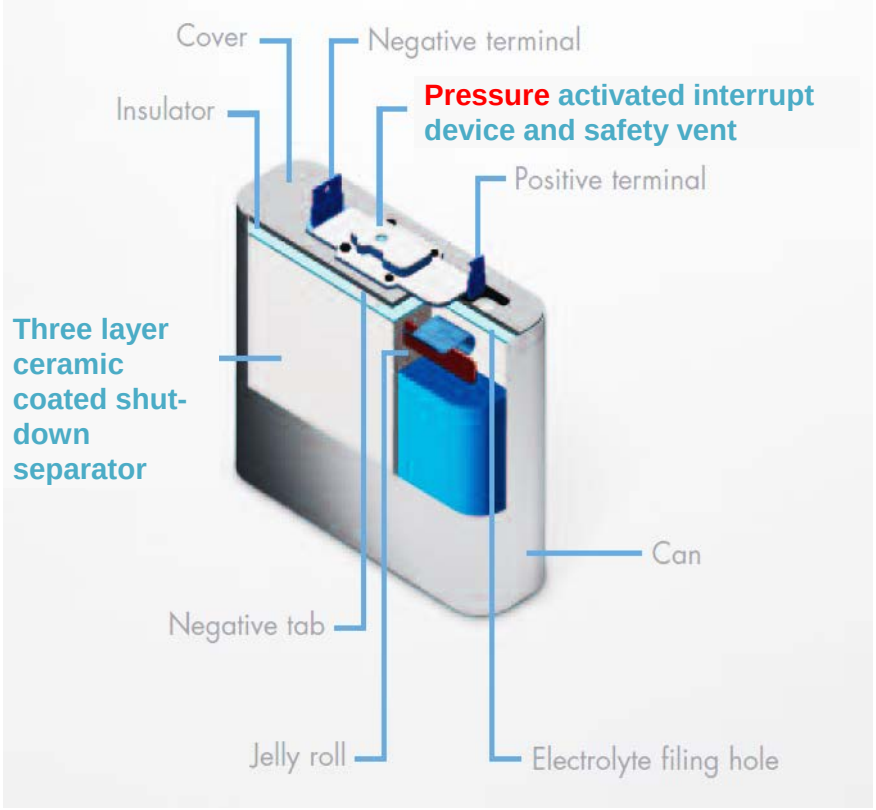
- Main materials
  - Aluminium
  - Copper
  - Metal oxides
  - Inorganic electrolyte



Courtesy of SAFT

Construction Examples

1. • Pressure activated circuit breaker
   • Operates at 6 bar internal cell pressure
2. • Shutdown separator
   • Operates at 123°C
3. • Safety vent
   • Operates at 12 bar internal cell pressure



Pictures courtesy of SAFT

Solutions

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