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Applying Energy Storage Codes and Standards to Zinc Batteries

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NAATBatt Zinc Battery Workshop 2

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Why you are promoting Zinc-based batteries

Nail penetration test of Li-ion pack

Common Zinc applications and standards

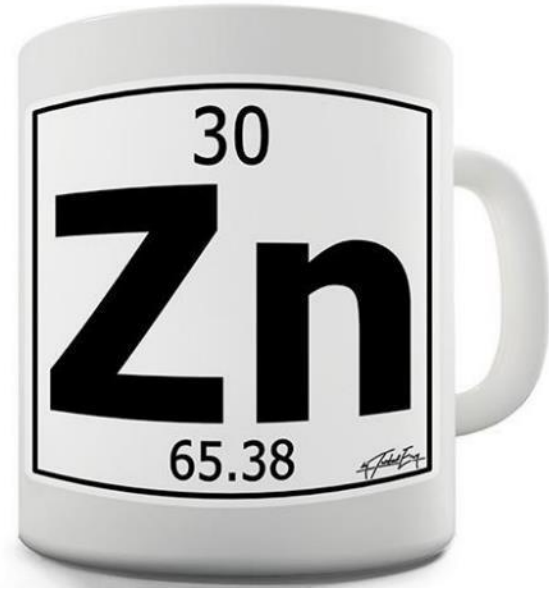
- Zinc batteries are in widespread use in many different applications and chemistries
- Some chemistries are specifically referenced in existing standards, but not all
  - UL 1989, Standby Batteries, for certain lead acid replacement applications, typically nickel-zinc
  - UL 2054, Household and Commercial Batteries, covers a range of applications, typically carbon-zinc
  - Flow batteries in ES standards
- Additional performance standards are driven by the end application
  - Hearing aid batteries and AA, AAA type cells, ANSI C18 series and IEC 60086 series

Old 3V zinc–carbon battery, ca. 1960, with cardboard casing

*Image sources: https://en.wikipedia.org/wiki/Zinc%E2%80%93carbon_battery ; https://en.wikipedia.org/wiki/Nickel%E2%80%93zinc_battery ; https://www.thelundreport.org/content/insurers-pressure-state-regulators-deny-expanded-access-hearing-aids ;

Applying Energy Storage (ES) standards to zinc batteries

- Zinc-based options are gaining momentum in stationary ES applications
  - Flow batteries such as zinc-bromine
  - Rechargeable nickel-zinc, zinc-manganese, and zinc-air
- ES codes & standards which may impact your application:
  - UL 1989 for some vented chemistries used for UPS, ES applications
  - UL 1973, Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
    - Sections referencing flow batteries, especially Appendix C
    - Single cell failure design tolerance – section 39 and Appendix F
  - UL 9540, Energy Storage Systems and Equipment
  - UL 9540A, Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
  - NFPA 855, Standard for the Installation of Stationary Energy Storage Systems
  - IEC Standards – no specific zinc standards
    - IEC 61427 series and IEC 62933 series, related to ES applications
    - Flow batteries in IEC 62932 series



Be as involved and aware as possible in battery and end product standard development that may effect your growth

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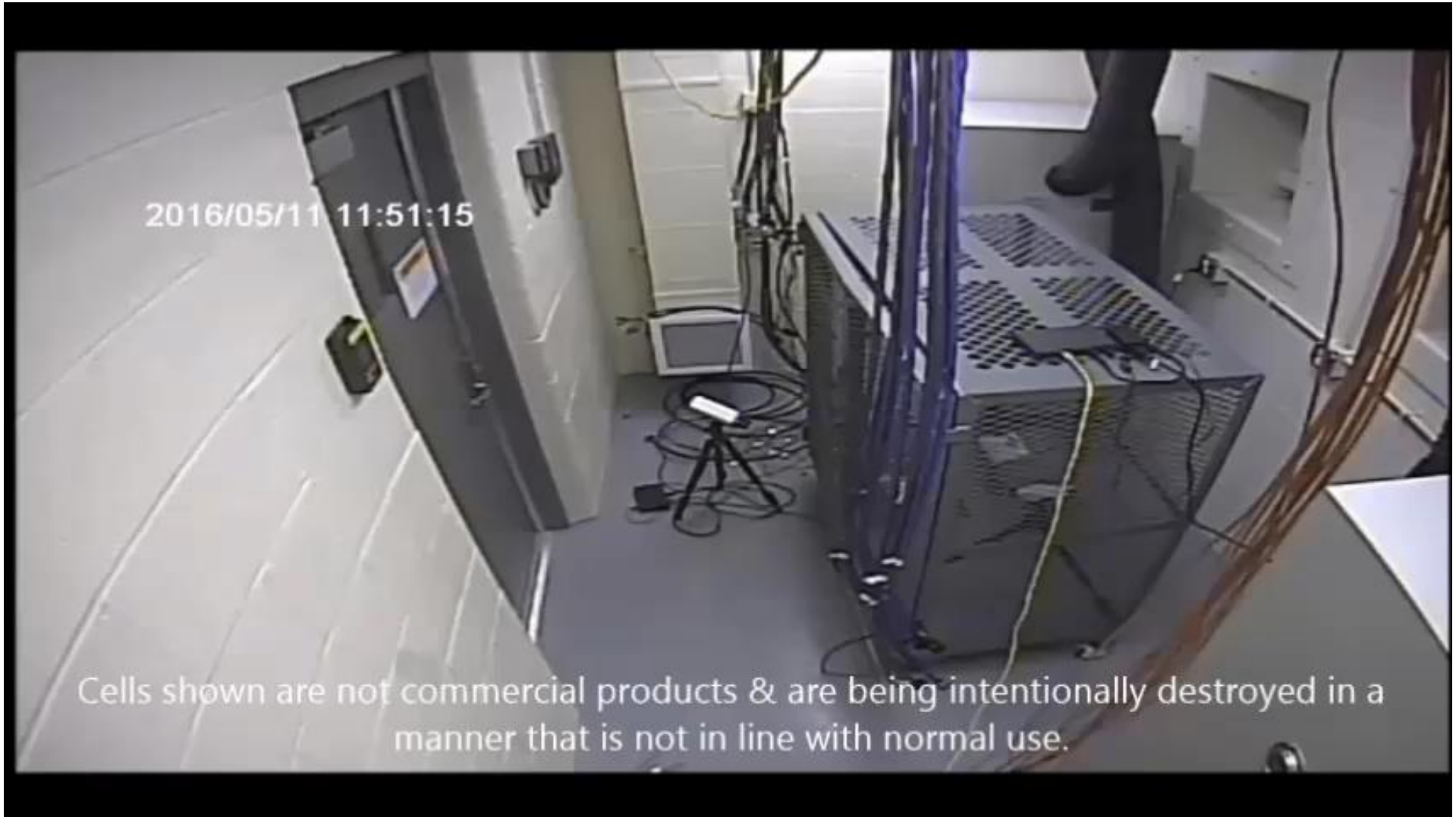
*Image source:; https://inkrocks.com/collections/geeky/products/periodic-table-of-elements-zn-zinc-novelty-mug

Why you *really* are promoting Zinc-based batteries!



Thermal runaway on overcharge test

UL 1973 single cell failure design tolerance

- UL 1973 does not specifically mention zinc chemistries with the exception of flow batteries but Section 39 is required
- Appendix F provides suggestions for possible failure modes:
  - Introduce internal cell failures in cells during assembly via internal contamination, separator defect, or internal heaters
  - Apply external stress such as heating, indentation, nail penetration, short circuit, or overcharge
- The test lab has to find a way to drive the cell into failure under the current standard – whether or not thermal runaway may result – UL 9540A has similar requirements
  - Extended periods of overcharge may be the most likely method

Review abusive test requirements carefully – some may require additional protection (e.g. BMS) that might not seem required

UL 1973 Section 39.3.1 Language:

"Other technologies such as lithium metal, sodium sulfur, sodium nickel chloride, and lead acid where there may not be enough field data regarding their tolerance to single cell failure events, are to be subjected to a single cell failure test method similar to 39.2, except as modified as noted below. ***The failure mechanism for these technologies may be different than that of lithium ion and thermal runaway may or may not result from the cell failure.*** *Similar to lithium ion, when choosing a cell failure technique, it should be representative of what can occur in the field for the particular technology. The failure mechanism chosen shall consider failures due to potential cell manufacturing defects for that technology and/or cell and battery design deficiencies that could lead to latent failures of the cell, and that would not be evident under the individual cell safety testing."*

[emphasis added]

Conclusion

- **Generally speaking, there are few zinc-specific standards**
  - Look for the most applicable standard that can give you coverage at the “cell” level as applicable to your technology
  - Focus on end product standards for the applications you are targeting
- **Get involved in the Standards process!**
  - Currently no zinc battery technology companies represented on the UL 1973 Standards Technical Panel (STP) as written in the most recent version
- **Involve your preferred test and certification provider early to create the compliance plan that works for you**

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Thank you.

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