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# Battery Transportation and Waste Regulations

Lessons for the Fuel Cell Industry

**George A. Kerchner**

*Regulatory Analyst*

202.719.4109

[gkerchner@wrf.com](mailto:gkerchner@wrf.com)

**Saskia Mooney**

*Regulatory Analyst*

202.719.4107

[smooney@wrf.com](mailto:smooney@wrf.com)



# U.S. DOT Lithium Battery Interim Final Rule

- Dec. 15, 2004 rule prohibits primary lithium cells and batteries as cargo on passenger aircraft
- Rule initially was going to include rechargeable lithium ion cells and batteries
- Rule also amends 9 sections of the hazardous materials regulations (HMR)
- Rule adds 5 new special provisions to HMR applicable to lithium and lithium ion batteries (and batteries packed with or contained in equipment)



# U.S. DOT Lithium Battery Interim Final Rule

- Creates complex regulatory scheme for shippers of lithium and lithium ion batteries
- DOT public meeting in January 2005 brought to light problems with implementing rule, inconsistency with international regulations
- Pilots association and carrier association still feel additional work is needed
- Final rule expected within 6 months may contain “exception” for packages containing small quantities of primary lithium batteries (< 6?)



# FAA Primary Lithium Battery Report (June 2004)

## *Flammability Assessment of Bulk-Packed, Nonrechargeable Lithium Primary Batteries in Transport Category Aircraft*

- Relatively small fire can start primary lithium battery fire
- Once the lithium in single battery begins to burn, it releases enough energy to ignite adjacent batteries
- Battery releases “burning electrolyte and molten lithium spray”
- Cargo liner material may be vulnerable to perforation by molten lithium
- Halon 1301 (fire suppression agent in aircraft) is ineffective in suppressing or extinguishing primary lithium battery fire

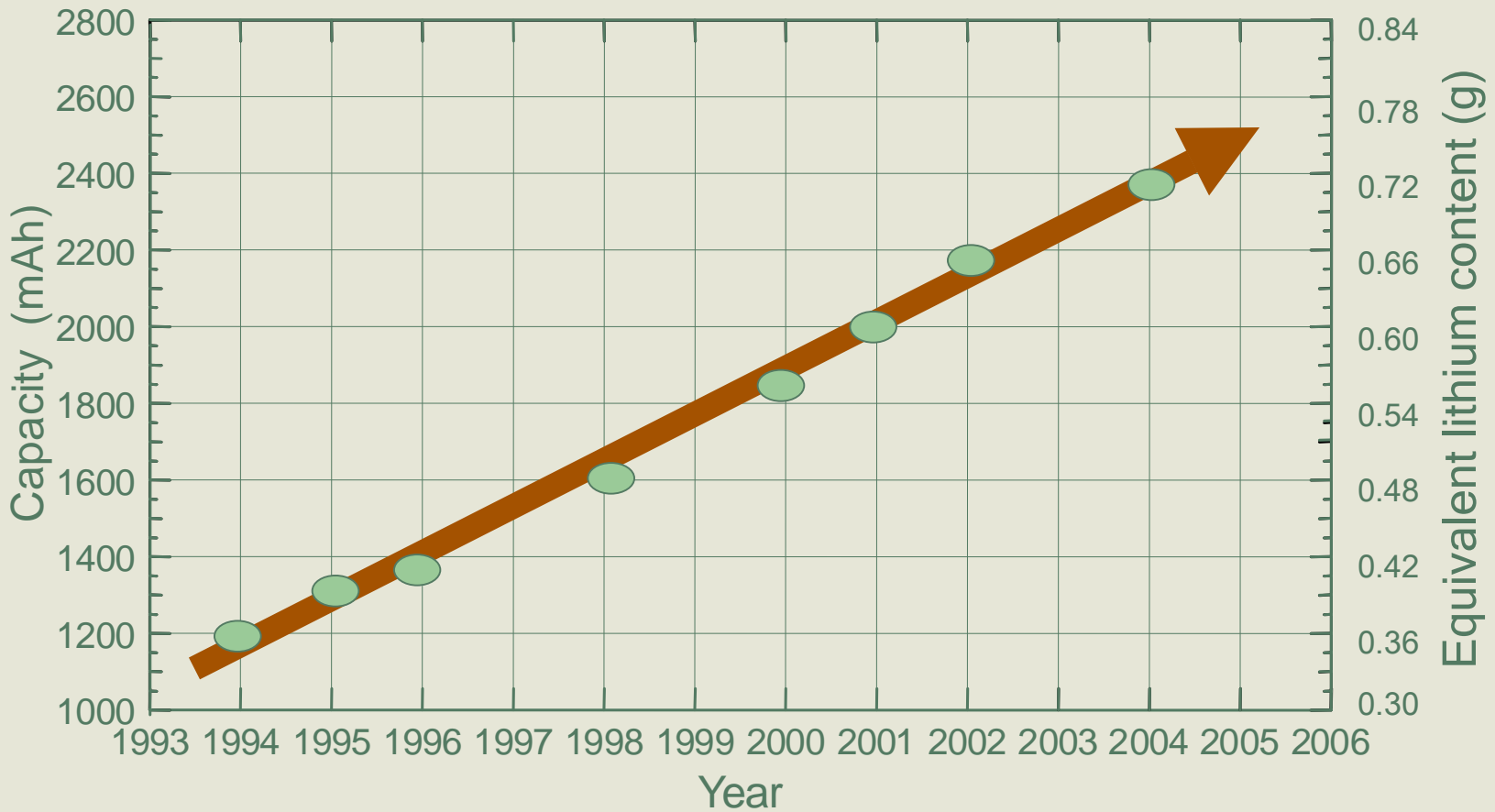


# Implications for Lithium ion Batteries?

- Higher capacity lithium ion cells may draw additional scrutiny from US DOT
- FAA-type flammability tests on lithium ion cells?
- Prohibition as cargo on passenger aircraft??



# Capacity Changes of 18650 Cell



\*Courtesy of Battery Association of Japan

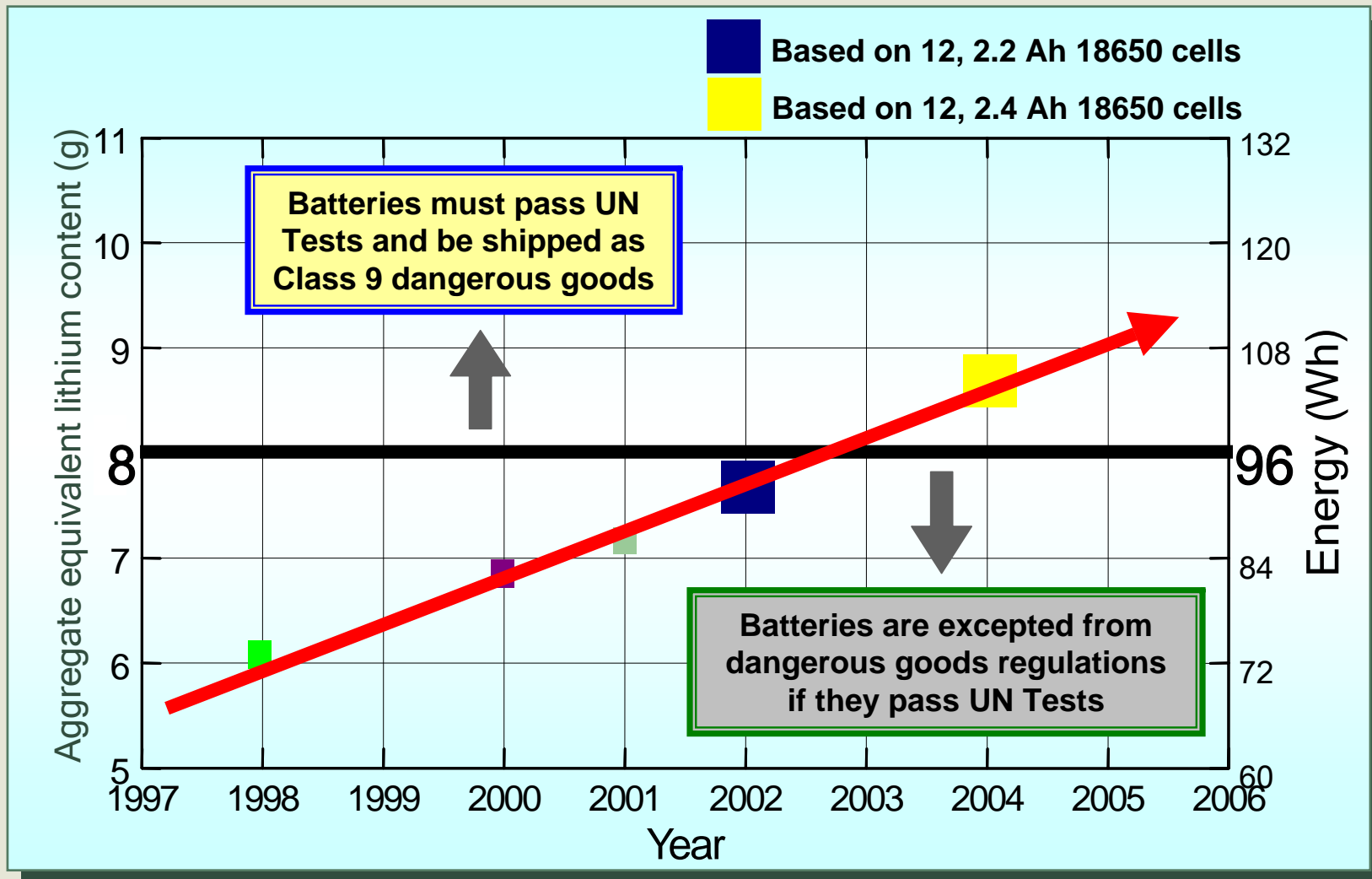


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# Aggregate Equivalent Lithium Content and Energy of Battery Pack



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\*Courtesy of Battery Association of Japan

# Changes for Lithium ion Battery Regulations???

- PRBA proposed that US DOT create a separate section in HMR for lithium ion cells and batteries, new UN number, and new entry in haz mat table
  - Proposed section would replace equivalent lithium content exception limits with watt hours
  - 25 Wh for cells, 200 Wh for batteries
  - PROPOSED THAT ALL LITHIUM ION CELLS AND BATTERIES BE SHIPPED AT <50% SOC
- New section would make it easier for carriers to distinguish between lithium and lithium ion batteries



# Status of US DOT April 2002 Proposed Lithium Battery Rule

- DOT is expected to publish in 2005 results of study conducted on economic impact of rule
- Study focused primarily on costs of UN tests now required for all lithium and lithium ion cells and batteries and shipping Class 9 haz mat
- When DOT will issue final rule is uncertain
- Changes in U.S. regulations will significantly affect shipments of new and spent batteries
- Have you UN tested your battery lately?



# U.S. DOT List of Battery Incidents in Transport

- U.S. DOT recently presented paper to International Civil Aviation Organization (ICAO) regarding air transport incidents involving batteries or batteries contained in equipment
- Incidents resulted in the production of smoke, fire or the generation of “dangerous quantity” of heat
- Incidents involved lead (20), Ni-Cd and Ni-MH (4), lithium primary (5), lithium ion (1), and dry cell (8) batteries



# FAA Inspector General Report

- Office of Inspector General, Secretary of Transportation report on “New Approaches in Managing FAA Haz Mat Program” (Nov. 2004)
  - Report was prepared to assess FAA execution of its haz mat program to insure compliance with regulations
  - FAA priorities in 2004
    - Non-spillable lead acid batteries
    - Lithium batteries
    - Packaging standards
    - Flammable aerosols in luggage
    - Diagnostic specimens



# New Battery Rule from US DOT?

- Due to ongoing concerns over battery incidents, US DOT may issue a general battery rule within 12 months
- Rule may remove exception for nonspillable batteries
- Rule may require markings and shipping papers for all battery shipments



# PRBA Activities on Battery Transport Issues

- Implemented Voluntary Air Transportation Communications Program in 2001
- “Observer” at United Nations Subcommittee of Experts on the Transport of Dangerous Goods
- Submitted proposals in December 2004 to amend special provisions in UN Model Regulations
- Developed shipping brochures on batteries



# Portable Fuels Cells – The Final Frontier?

- Battery incidents in transport can be lesson for fuel cell industry
- Preferred current technology for fuel cells is methanol based, a Class 3 hazardous material (flammable liquid) under DOT and international transportation regulations
- US Fuel Cell Council did outstanding job of securing changes to UN Model Regulations for portable fuel cells with methanol
- Challenge - Ensure shippers (“value added distributors”?) understand hazards associated with product



# Subtitle C Regulation of Batteries

- Waste identification and counting
- EPA I.D. numbers
- Accumulation and storage time limits
- Uniform hazardous waste manifest
- Recordkeeping and reporting
  - Biennial reports (LQGs only)
  - Exception reports
  - Record retention



# Lead Batteries and RCRA

- 40 CFR § 266.80 conditionally exempts lead-acid batteries being reclaimed from Subtitle C regulation (1985)
  - There was no equivalent exemption for Ni-Cds, however, so industry petitioned EPA



# Ni-Cd Batteries and RCRA

- In 1995 the Universal Waste Rule (40 CFR Part 273) was promulgated to provide streamlined requirements for Ni-Cds and other hazardous waste batteries
  - Option remains to manage lead-acid batteries under 40 CFR § 266.80
- The Universal Waste Rule:
  - Extends the time to accumulate batteries on site
  - Allows shipment using a common carrier
  - Eliminates the hazardous waste manifest requirement



# Direct Methanol Fuel Cells

- DMFCs
  - Portable Market
    - Mobile phones
    - Notebook computers
    - Cameras
    - MP3s and PDAs
  - DMFCs will require replacement fuel cartridges
  - DMFC cartridge design is evolving, so regulatory analysis is an imperfect projection



# DMFC Fuel Cartridges

- Today there is no end-of-life (EOL) strategy for DMFCs
- E<sup>3</sup> Impact Analysis:
  - Rochester Institute of Technology (RIT) evaluating life cycle environmental and economic impacts
    - Funded by US EPA
    - Cooperation from US Fuel Cell Council
    - Goal at end of the day is to develop EOL strategy options for industry



# DMFC Fuel Cartridges

- E<sup>3</sup> Impact Analysis cont...
  - Analysis to include investigation of waste generation impacts
  - A study cited by the US Fuel Cell Council projects that “...almost 22% of all hand-held electronic devices with rechargeable power packs could be powered by methanol fuel cells by 2011.”
  - Costs for infrastructure development are high due to uncertainty of product EOL strategy



# RCRA and DMFC Cartridges

- If the methanol fuel is “ignitable” under 40 CFR § 261.21, used cartridges may be hazardous waste
- Options for management might include:
  - Utilize existing exclusions/exemptions
  - Petition EPA for streamlined regulation (e.g., Universal Waste Rule or 40 Part 266.80)
  - Handle as fully regulated hazardous waste



# Possible Available Exclusions/Exemptions

- Household Hazardous Waste (HHW)
- Conditionally Exempt Small Quantity Generator Waste (CESQG)
- Scrap Metal Being Recycled (assumes metal container)
- “RCRA Empty” Containers



# HHW and CESQG

- HHW – strictly from households (i.e., not mixed with non-household waste); no quantity limit
- CESQG – generates less than 100 kg (220 pounds) of hazardous waste per month, or less than 1kg of acutely hazardous waste per month



# Scrap Metal Being Recycled

- If cartridges are metal (i.e., stainless steel) and recycled:
  - May qualify for solid waste exemption if “processed scrap metal” (i.e., sorted by metal type and recycled) (§ 261.4(a)(13))
  - May qualify for hazardous waste exemption if “scrap metal being recycled” (§ 261.6(a)(3)(ii))



# RCRA Containers

- DMFC cartridges meet the “container” definition under RCRA
  - A container is any portable device in which a material is stored, transported, treated, disposed of, or otherwise handled (§ 266.10)
  - EPA examples include:
    - 55-gallon drums
    - Tanker trucks
    - Buckets
    - Test tubes



# “RCRA Empty” Containers

- A container is empty and unregulated if:
  - (i) All wastes have been removed that can be removed using the practices commonly employed to remove materials from that type of container, *e.g.*, pouring, pumping, and aspirating, *and*
  - (ii) No more than 2.5 centimeters (one inch) of residue remain on the bottom of the container or inner liner, *or*
  - (iii)
    - (A) No more than 3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is less than or equal to 110 gallons in size, *or*
    - (B) No more than 0.3 percent by weight of the total capacity of the container remains in the container or inner liner if the container is greater than 110 gallons in size. (§ 261.7)



# Other Options Under RCRA

- Universal Waste Rule (petition for rule amendment)
  - For widely generated hazardous wastes (i.e., batteries, thermostats, lamps, and certain pesticides)
- Exemption similar to 40 CFR § 266.80 for lead-acid batteries (petition for rulemaking)
- Other?



# Take Home Message

- If your spent fuel cell cartridge (or fuel cell) is possible hazardous waste:
  - Understand the RCRA requirements and exemptions and plan/design accordingly
  - We can only surmise about the future RCRA status and management options for DMFC cartridges, because the design is evolving
  - But expect these issues to be contemplated as part of the E<sup>3</sup> Impact Analysis

