Lithium Ion Batteries – Past, Present and Future
What is IATA?

- Trade Association of the world’s airlines.
- Founded in 1945 by 30 airlines in Havana, Cuba.
- Incorporated in Canada by a special Act of Parliament.
- Approximately 260 member airlines worldwide which carry 98% of air cargo.
IATA’s Dangerous Goods Activities

- Work with governments, international organizations and trade groups to develop Regulations.
- Regulations must be practical, economically sound and advance safety.
- Optimum balance between safety and economic considerations.
- A change in this balance causes an overall decrease in safety.
International Regulatory Structure

- United Nations (UN) Subcommittee of Experts on the Transport of Dangerous Goods:
  - UN Recommendations on the Transport of Dangerous Goods (Model Regulations); and
  - UN Manual of Tests and Criteria

- International Civil Aviation Organization (ICAO) Dangerous Goods Panel:
  - Technical Instructions for the Safe Transport of Dangerous Goods by Air

- IATA Dangerous Goods Board:
  - Dangerous Goods Regulations
Regulatory History

  - Assigned to Class 4, Flammable solid
  - Limited to cargo aircraft, 35 kg G
  - To, from, within the US, only under Special Permit.
Regulatory History (cont.)

- 1984 – ID 8025, Lithium batteries
  - Assigned to Div. 4.3, dang. when wet
  - Specific tests applicable: thermal stability, short circuit
  - Limited to cargo aircraft, 35 kg G
  - Exception for cells with ≤ 0.5 g lithium and batteries with ≤ 1 g lithium
  - To, from, within the US only under Special Permit.
Regulatory History (cont.)

- 1991 – UN 3090, Lithium batteries, UN 3091, Lithium batteries, contained in equipment
  - UN assigns to Class 9
  - Still differentiation between liquid cathode and solid cathode

- 1993 – Lithium batteries packed with equipment added to UN 3091
Regulatory History (cont.)

- 2003 – Special provision 188 (A45) is revised:
  - Specific packing requirements;
  - Marking on packages, except for those contained in equipment and packages containing < 24 cells or < 12 batteries;
  - Drop test;
  - 30 kg G limit.
Regulatory History (cont.)

- 2009 – UN 3090 / 3091 become lithium metal batteries. Addition of UN 3480 / 3481, lithium ion batteries
  - Wh introduced for UN 3480 / 3481
  - ICAO creates new packing instructions with lower limits for SP 188 cells and batteries
  - New lithium battery handling label
Regulatory History (cont.)

- 2011 – Revisions to 38.3 of the UN Manual of Tests and Criteria:
  - Address lithium metal vs. lithium ion
  - Differentiate between small and large cells and batteries

- Introduction of quality management system for manufacturers of lithium cells and batteries
Lithium Ion Cell Production

The worldwide rechargeable battery market, Million cells, 1995-2015

Which cell are we talking about?

Front Edge Technology, Inc

GS Yuasa International / Lithium Energy Japan

2015: estimation data
Market Penetration

- **Cellular Phones sold per Year (Million)**
  - Li-ion
  - NiMH
  - Million Units/year
  - 2000 vs 2014

- **Portable PC sold per Year (Million)**
  - Li-ion
  - 250 M Tablets
  - 195 M Portable PCs
  - Million Units/Year
  - 2000 vs 2014

- **Tons of Li-ion Cathode per year**
  - Tons of cathode/year
  - 2000 vs 2014

- **Li-ion 18650 cell price ($/Wh)**
  - $/Wh
  - 2000 vs 2014

*Source: AVICENNE ENERGY Analyses 2015*
Safety Issues

- Drive to increase energy density and reduce weight has placed pressure on manufacturing tolerances and QMS
- Use of flammable liquid electrolyte adds to safety risk
- Lack of coordinated, universally applied, global standards
- Lack of government oversight
Concerns with Lithium Ion Batteries

- UPS B747F accident in Dubai (Sept 2010)
  - Rapid production of very large volumes of smoke
  - Uncontrolled fire leading to loss of control and total destruction of the aircraft and death of the crew

- Testing by the FAA:
  - Cell-to-cell propagation in the event of a fire
  - Generation of significant volumes of flammable gases from cells when exposed to heat from a fire
  - Limited ability of aircraft fire suppression system to manage a lithium battery fire event
Air Transport Restrictions

- Effective 1 January 2015 ICAO prohibits carriage of lithium metal cells and batteries (UN 3090) as cargo on passenger aircraft

- Effective 1 April 2016 ICAO prohibits carriage of lithium ion cells and batteries (UN 3480) as cargo on passenger aircraft
Mitigation Strategies

- Improved coordination of test standards: UL, IEC, UN 38.3
- State of charge
- Performance standards
- Potential for the use of enhanced packaging
Opportunities – Way Forward

- Safety is not a transport issue to solve
- Need for a coordinated approach to lithium battery safety
  - Manufacturing standards
  - Review of electrolytes, cathode and anode material to reduce risk of thermal runaway
- UN Subcommittee is undertaking a full review of classification of lithium batteries
- Improved safety will lead to less regulatory change
Thank you

David BRENNAN
Asst. Director Cargo Safety & Standards
Tel: + 41 (0) 22 770 2947
Email: brennand@iata.org
Email: dangood@iata.org