Compliance Testing of Lithium & Lithium Ion Batteries
Overview

- Applicable Regulations
- UN “T” Tests
- Pass Fail Criteria
Compliance Testing

- International Air Transport Association (IATA) 2004 Dangerous Goods Regulations, 45th Edition

- HMR, 49 CFR parts 171-180 (49 CFR 173.185)

- UN Manual of Tests and Criteria, Part III, Sub-Section 38.3 Lithium Batteries
Definitions

- **Cell**: Single encased electrochemical unit which exhibits voltage differential across two terminals.

- **Battery**: One or more cells electrically connected by permanent means.

- **Grams of Lithium Content**:
  
  - **Grams of Equivalent Lithium Content**
  
  - **Aggregate Lithium Content**

- **Aggregate Lithium Content**
Definitions

- Small Battery > 500g  ALC < Large Battery
- Small Cell >12g ALC < Large Cell
UN Manual of Tests and Criteria
Part III, Sub-Section 38.3

- Cells vs. Battery Packs
- Size
  - T1: Altitude
  - T2: Thermal Cycle
  - T3: Vibration
  - T4: Shock
  - T5: Short Circuit
  - T6: Impact (cells only)
  - T7: Overcharge
  - T8: Forced Discharge (cells only)

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<th>4 New Charged</th>
<th>4 New Discharged</th>
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<td>4 Cycled Charged</td>
<td>4 Cycled Discharged</td>
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Test 1 - Altitude

- Simulates air transportation under low pressure conditions.
- 6 hours at 11.6kPa (50,000ft)
Mass Loss and OCV

Mass Loss:  
\[ M < 1 \text{g} \quad 0.5\% \]
\[ 1 \text{g} < M < 5 \text{g} \quad 0.2\% \]
\[ M > 5 \text{g} \quad 0.1\% \]

OCV: 90% of value at start of test
Test 2 - Thermal Test

- Evaluate seal integrity and internal electrical connections.
- Rapid temperature change
- Six hours at +75°C
- Six hours at -40°C
- 30 minute transition
- 10 cycles.
- Large batteries 12 hours each extreme
Test 3 - Vibration

- Sine Sweep 7Hz-200Hz-7Hz in 15 minutes
- 12 passes (3 hours)
- Each of 3 axes.
Test 4- Shock

- Small Cells
- Half Sine Pulse
- 150gs-6msec
- 3+, 3- in each of 3 axes (18 total)

- Large Cells
- 50gs-11msec
Test 5 - External Short Circuit

- Stabilize at +55C
- Apply short (0.1 ohms)
- Maintain at +55C for one hour
- Observe for 6 hours
- Criteria: < +170C
Thermal Test

Measure Part Temperature for Pass/Fail Criteria
Test 7- Overcharge

- Charge Current 2x mfg recommended maximum continuous charge
- Charge Voltage
  - <18V, 2x battery voltage or 22V
  - >18V, 1.2x max charge voltage.
- Test for 24 hours
- Criteria: No disassembly or fire within 7 days.
Cell Only Tests

- Test 6- Impact
  - 15.8 mm diameter bar
  - 9.1kg mass dropped from 61 cm
  - Criteria: < +170°C, no disassembly or fire within 6 hours of testing.

- Test 8- Forced Discharge
  - Apply PS and load
  - Criteria: no fire within 7 days of test.
When to Retest

- Lithium Cells or Batteries which differ from tested type by
- Change of 0.1g or 20% by mass
- Change that would materially affect results
Other Considerations

- Charging/Discharging Systems
- Battery cycling
- Documentation Reports & Certs
Summary & Questions

- T Tests
- Costs & Time
- Other Considerations