LOG OF MEETING
DIRECTORATE FOR ENGINEERING SCIENCES

SUBJECT: Meeting with representatives from Portable Rechargeable Battery Association (PRBA) to discuss ongoing investigation into counterfeit batteries.

DATE OF MEETING: February 19, 2004

PLACE OF MEETING: Bethesda Towers, 410A

LOG ENTRY SOURCE: Doug Lee, ESEE *DL*

DATE OF LOG ENTRY: March 1, 2004

COMMISSION ATTENDEES: Doug Lee, ESEE
Richard Stern, EXC

NON-COMMISSION ATTENDEES:
Norm England- Portable Rechargeable Battery Association (PRBA), President and CEO
David Weinberg- Howry Simon Arnold & White, General Counsel for PRBA
George Kerchner- CapAnalysis, Consultant for PRBA
Sean Oberle- Product Safety Letter

SUMMARY OF MEETING:

Mr. Kerchner said that they had heard about the press release involving the recall of some Kyocera phone batteries and the CPSC investigation into other batteries that may rupture or overheat. The PRBA set up this meeting to introduce their organization to the CPSC staff. Mr. Kerchner discussed some of the new (Jan 2003) UN tests required for lithium and lithium-ion cells.

Mr. England and Mr. Weinberg stated that the PRBA represents about 85% of the portable rechargeable battery manufacturers. They provide support and represent its members on legislative, regulatory and standards issues at the state, federal and international level. Key issues include recycling and transportation of batteries. They were established in 1991 as a nonprofit trade association initially representing five major manufacturers; Energizer, Panasonic, Saft, Sanyo, and Varta.

Mr. England and Mr. Weinberg offered the assistance of PRBA with any research or investigation work the CPSC staff may need. Attached are some informational sheets provided by PRBA on lithium-ion safety and new testing requirements.

BATTERY POWER PRODUCTS & TECHNOLOGY
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New Testing Requirements for Lithium and Lithium Ion Cells and Batteries

New Transportation Regulations Remove Long Time Exception for Small Cells and Batteries

George A. Kerchner
CapAnalysis Group

International dangerous goods transportation regulations pertaining to lithium and lithium ion (and polymer) cells and batteries have undergone significant changes over the past five years. These changes are a result of the inconsistent application of international transportation regulations pertaining to lithium ion batteries, increasing concern by transportation regulatory officials regarding shipments of high-energy density batteries, and the proliferation of lithium ion battery technologies. The confluence of these factors has resulted in the elimination of the long-time exception from testing requirements for small, consumer-size lithium and lithium ion cells and batteries under the US and international dangerous goods transportation regulations. Thus, all lithium and lithium ion cells and batteries manufactured after January 1, 2003 must be tested in accordance with eight new UN Tests specified in the UN Manual of Tests and Criteria prior to being shipped. New packaging, shipping documentation and marking also will be required.

US Hazardous Materials Regulations

For purposes of transportation, lithium and lithium ion cells and batteries are regulated in the US pursuant to Part 49 of the Code of Federal Regulations, Section 173.185 (49 CFR Section 173.185) of the US hazardous materials regulations (HMR). The Office of Hazardous Materials Safety, which is within the US Department of Transportation's Research and Special Programs Administration (RSPA), is responsible for coordinating the transportation of hazardous materials (also known as dangerous goods) by air, rail, highway and water and drafting the regulations that govern such materials.

Prior to June 21, 2001, the HMR and RSPA's letters of interpretation were ambiguous with respect to how lithium ion cells and batteries were regulated in the United States. In addition, the HMR were inconsistent with the international transportation regulations (e.g., UN Recommendations on the Transport of Dangerous Goods Model Regulations, International Civil Aviation Organization (ICAO) Technical Instructions, and International Maritime Dangerous Good (IMDG) Code), which were revised in 1998/1999 to address lithium ion batteries that do not utilize lithium metal or lithium alloy. The problem was that the HMR did not have a provision for determining the amount of lithium metal or lithium alloy that would be contained in lithium ion cells and batteries. Thus, lithium ion batteries were widely understood to be considered dry batteries and excepted from regulation under the HMR.

On June 21, 2001 RSPA issued a final rule to harmonize the HMR with the 1998 UN Model Regulations, ICAO Technical Instruction, and IMDG Code thereby regulating lithium ion batteries as lithium batteries subject to a lithium equivalency calculation. Equivalent lithium content is calculated in grams on a per cell basis to be 0.3 times the rated capacity in ampere hours. Thus, the equivalent lithium content for a battery/battery pack is the rated capacity in ampere hours for a single cell multiplied by 0.3 and then multiplied by the number of cells in the battery/battery pack.

Also included in RSPA's June 21 rule was a new exception that allowed lithium ion cells containing less than 1.5 grams of equivalent lithium content and lithium ion batteries containing less than 8 grams of equivalent lithium content to be shipped without undergoing certain UN Tests and other requirements required of larger lithium and lithium ion cells and batteries.

Lithium Battery Incident at Los Angeles International Airport

While RSPA was preparing its June 21, 2001 rule, an incident occurred at the Los Angeles International Airport involving a shipment of two pallets of small, consumer-size primary lithium batteries that raised serious concerns at RSPA and the National Transportation Safety Board regarding the exception then applicable to lithium and lithium ion batteries. The pallets, containing 120,000 primary lithium batteries, caught fire and burned after being mishandled and damaged by cargo handling personnel. At the time, these batteries were excepted from regulation under the HMR and ICAO Technical Instructions.

As a result of this incident, RSPA staff undertook an exhaustive analysis on lithium and lithium ion cells and batteries to better understand both battery chemistries and their respective risks. This analysis included nail and drill penetration and fire submersion experiments. RSPA officials also suggested to the battery industry that it was considering removing the regulatory exception for small lithium and lithium ion cells and batteries and requiring a Class 9 hazardous material designation for all shipments.

While RSPA conducted its analysis and experiments, the Portable Rechargeable Battery Association (PRBA) and several other battery trade associations implemented a voluntary air transportation communications program (VATCP). Under this program, members of the trade associations upgraded their packaging and began using new markings and shipping documentation for their shipments of lithium and lithium ion cells and batteries that were transported by air. Once RSPA completed its analysis, a new regulatory scheme for shipping and testing lithium and lithium ion batteries was developed for inclusion in the UN Recommendations on the Transport of Dangerous Goods Model Regulations and UN Manual of Tests and Criteria.

New Testing and Transportation Requirements

The new UN regulatory scheme includes many of the same provisions first developed in the VATCP. It also requires that all lithium and lithium ion cells and batteries manufactured after January 1, 2003 pass the following UN Tests prior to being transported:

Test 1: Altitude Simulation - This test simulates air transport under low-pressure conditions.

Test 2: Thermal Test - This test assesses cell and battery seal integrity and internal electrical connections. The test is conducted using rapid and extreme temperature changes.

Test 3: Vibration - This test simulates vibration during transport.

Test 4: Shock - This test simulates possible impacts during transport.

Test 5: External Short Circuit - This test simulates an external short circuit.

Test 6: Impact - This test simulates an impact.

Test 7: Overcharge - This test evaluates the ability of a rechargeable battery to withstand an overcharge condition.

Test 8: Forced Discharge - This test evaluates the ability of a primary or a rechargeable cell to withstand a forced discharge condition.

A complete description of the UN Tests is available at www.unece.org/trans/main/dgdb/ dgcomm/ac10rep/ac1027a2e.pdf.

RSPA issued a notice of proposed rulemaking on April 2, 2002 to adopt the new UN testing requirements and remove the long-held exception from testing for small, consumer-size lithium and lithium ion cells and batteries. RSPA's proposed rule does provide a grandfather clause that allows batteries that were manufactured prior to January 1, 2003 to be shipped until December 31, 2004 without being tested. This provides the battery industry a two year period to exhaust its supply of cells and batteries "in the pipeline" (i.e., batteries in the chain of commerce). There also is a proposed exception for cells and batteries shipped for testing (when shipped by ground).

The other important regulatory change that goes into effect on January 1, 2003 pertains to the Class 9 designation required of larger lithium and lithium ion batteries. The following cells and batteries must pass the new UN Tests and be shipped as a Class 9 hazardous material:

- A lithium metal or lithium alloy cell with a lithium content of more than 1.0 gram;
- A lithium ion cell with an equivalent lithium content of more than 1.5 grams;
- A lithium metal or lithium alloy battery with an aggregate lithium content of more than 2.0 grams; and
- A lithium ion battery with an aggregate equivalent lithium content of more than 8 grams

RSPA's proposed rule also contains new packaging, marking and shipping documentation requirements for shipments of lithium and lithium ion cells and batteries. Effective January 1, 2003, packages containing more than 24 lithium or lithium ion cells or 12 lithium or lithium ion batteries must:

- Be marked to indicate that it contains lithium or lithium ion cells or batteries and that special procedures should be followed in the event that the package is damaged;
- Be accompanied by a document indicating that the package contains lithium batteries and that special procedures should be followed in the event that the package is damaged;
- Be capable of withstanding a 1.2 meter drop test in any orientation without damage to cells or batteries contained in the package, without shifting of the contents that would allow short circuiting and without release of package contents; and
- Not exceed 30 kg gross mass.

Note: There is a discrepancy between RSPA's proposed rule and the UN Model Regulations and ICAO Technical Instructions regarding the exception from testing requirements for cells and batteries shipped for testing, and how the new packaging and marking requirements apply to batteries packed with or contained in equipment. PRBA currently is working with RSPA to resolve that discrepancy.

Conclusion

The new regulatory scheme for transporting lithium and lithium ion cells and batteries developed by the US Department of Transportation and international regulatory organizations is a reasonable approach for insuring the safe transport of these products. There are, however, several challenges now facing the battery industry. First and foremost, lithium and lithium ion battery manufacturers must identify competent battery testing facilities that are equipped to run the eight UN Tests in order to comply with the January 1, 2003 deadline. With a shortage of such testing facilities in North America, a last minute rush by the battery industry to comply with the new testing requirements may result in a backlog at these facilities. Second, it appears that lithium ion batteries exceeding 8 grams of equivalent lithium content will become more common to meet the power demand of new portable consumer electronic equipment. Thus, unless the regulations are changed (i.e., increasing the 8 gram exception to 12 grams, or granting a limited quantity exception for lithium ion batteries containing less than 20 grams of equivalent lithium content) a significant number of lithium ion batteries used in consumer applications may soon require a Class 9 hazardous material designation for purposes of transportation.

Mr. Kerchner is regulatory analyst with CapAnalysis Group, an affiliate of the law firm of Howrey Simon Arnold & White, LLP. He has extensive experience assisting the battery industry on a wide range of domestic and international regulatory and policy issues such as transportation, collection and recycling, product labeling and hazardous waste management.

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Lithium-ion Battery Safety

Since its introduction in 1990, lithium-ion battery technology has proven itself in the field with an enviable safety record for a new technology with over 300 million cells sold world-wide to date. The technology is produced with intercalating carbon, resulting in a significant increase in stability and cycle life.

Thermal stability is a critical issue in any battery's safety. High cell temperatures can be generated by internal shorts leading to localized hot spots, external short circuit condition leading to very current discharges, exposure to high external temperatures, i.e. furnaces or flames, or overcharge. Lithium-ion batteries have extremely high energy density which must be released in a controlled manner. Basic cell engineering has resulted in safe cell designs using:

1. Thermal shutdown separators which melt at elevated temperatures and restrict current;
2. Positive Thermal Coefficient (PTC) devices which limit the current flow in an external short circuit condition (which is resetable);
3. Pressure or thermally actuated current interrupts inside individual cells to prevent overcharge; and
4. Rupture vents in the cell hardware which open to release cell pressure in a controlled manner.

A number of additional issues arise when cells are connected together in a battery pack such as thermal management, individual cell voltage control and electrical interaction with the charger and application. Multiple redundant protections have been incorporated into today's battery packs to protect against overcharge, over current, mechanical and climatic abuse, including:

1. Electronic current interrupts triggered by high individual cell voltage as monitored by pack protection IC;
2. Electronic current interrupts triggered by high current flow as monitored by pack protection IC;
3. Tightly regulated charge control either within the battery pack or in a dedicated charger; and
4. Resetable and non-resetable thermal fuses.

Industry, government and international lithium battery testing programs exist for the qualification of new cell and battery designs. Underwriters Laboratories has a UL 1642 Lithium Battery Safety Standard and the United Nations has a set of Test Methods for Lithium Cells and Batteries for air transport. The International Electrotechnical Commission has now completed a Draft Standard for Secondary Lithium Cells and is now preparing the analogous Secondary Lithium (multi-cell) Battery Standard. These comprehensive testing programs are being used by lithium-ion cell and battery manufacturers as a benchmark to qualify new product designs.

Source: Marc Juzkow, Polystor Corporation

Definitions:

Limiting resistors & Blocking diodes:
Many early laptops contained "two terminal" battery packs using a diode with a parallel resistor as the safety device. The battery was charged through the current limiting resistor and discharged through the diode.

Thermal breakers:
These devices are placed in close contact with the cells, and open up the battery circuit at a specified temperature, typically 50°C. Many battery packs are designed as three wire packs that use a 50°C thermal breaker in a separate charge circuit and a 70°C "fail safe" thermal breaker in the overall pack.

Temperature sensors:
These are typically three terminal IC's that are placed in close contact with the cells, and tells the charging circuit that if the battery pack has heated up the charge current must be reduced. The most common units provided an output voltage that was proportional to it's surface temperature, either in millivolts per °F, °C.

PTC devices:
The PTC (positive temperature coefficient) device is typically used to replace a nickel jumper strip between two cells on the end of the pack. These devices, which are rated in "hold" and "trip" current normally have a very low resistance, in the milli-ohm range, at normal currents; but at or near "trip" current the internal resistance rises into the kilo-ohm range, which essentially opens up the circuit. These devices can reset themselves.

Temperature fuses:
The temperature fuse is a one-time fail safe device. They typically will carry 15 amps and open up if the battery pack overheats to the design temperature of the fuse. Once the fuse opens the pack is dead and the fuse is not user replaceable.

Thermistors:
NTC (negative temperature thermistors) operate similar to the temperature sensors and are typically rated at 10k ohms at 25°C. They are placed in close contact to the cells and as the temperature of the cells rise, the resistance of the thermistor is reduced, thus shutting down the charge circuit.

Smart circuits:

Many recently designed notebook computers use the "SM Bus" smart battery management system and provide the notebook with data such as the charge status of the battery, the name and date of the manufacturer of the battery, the number of times it has been charged, the last time it has been charged, etc., etc. These are also often referred to as fuel gages.

Thermal runaway

A condition whereby a cell on charge or discharge will destroy itself through internal heat generation caused by high overcharge or overdischarge current or other abusive condition. Thermal runaway conditions arise over a relatively short period of time following the failure of a cell or group of cells. Under such condition the float current on the remaining cells would rise above specified norms leading to a rise in temperature producing consequential failure