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Portable Rechargeable Battery Association And US Department of Transportation Remain Focused on Lithium Ion Batteries in Transport

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During the past 18 months, the US Department of Transportation (DOT) has initiated flammability tests on lithium ion cells and batteries, released an economic impact analysis on how a 2002 proposed lithium battery rule may impact small businesses, issued an emergency (interim) rule on lithium primary batteries, and published a report on flammability tests conducted on lithium primary batteries. The US DOT has remained focused on lithium and lithium ion batteries in order to more fully understand the "hazards" associated with these different battery chemistries in transport and harmonize the US hazardous materials regulations (HMR) with the international dangerous goods regulations.

During this same period, the Portable Rechargeable Battery Association (PRBA) has drafted extensive comments on US DOT rules and notices, sponsored extensive failure analysis testing on lithium ion cells and batteries, and represented the industry at meetings with officials from DOT, the White House Office of Management and Budget (OMB), the Air Lines Pilot Association, (ALPA) and the United Nations Subcommittee of Experts on the Transport of Dangerous Goods in Geneva, Switzerland.

The result of all these activities may be a complete overhaul of the regulations that govern the transport of lithium ion cells and batteries and portable electronic equipment containing them.

Batteries in Transport - US DOT Activities

The proliferation of lithium ion batteries in the marketplace and a lithium primary battery incident that occurred at the LAX airport in 1999 set in motion regulatory activity by the US DOT that has impacted shippers of lithium primary batteries, lithium ion secondary batteries and equipment containing these batteries. This regulatory activity has included:

1. On June 21, 2001 US DOT issued a final rule that for the first time regulated lithium ion batteries as Class 9 Miscellaneous hazardous materials. It also introduced the concept of "equivalent lithium content" as a way to characterize the size of lithium ion batteries for purposes of the HMR.

2. On April 2, 2002, the US DOT issued a proposed rule to remove from its regulations a number of "exceptions" for larger lithium and lithium ion cells and batteries, and to require testing of all cells and batteries. This rule was intended to harmonize the US HMR with the international dangerous goods transportation regulations. However, the US DOT has yet to issue a final rule.

3. In June 2004, the Federal Aviation Administration (FAA) published a report entitled “Flammability Assessment of Bulk-Packed, Nonrechargeable Lithium Primary Batteries in Transport Category Aircraft”. It detailed the results of a series of flammability tests conducted on lithium primary batteries. The tests were designed to determine the conditions necessary to ignite a lithium primary battery, the characteristics of a lithium primary battery fire, the potential hazard to an aircraft as a result of a lithium primary battery fire and the effectiveness of Halon 1301 fire suppression systems used on passenger aircraft in extinguishing a lithium primary battery fire.

4. On December 15, 2004, the US DOT issued an Interim final rule that banned lithium primary batteries as cargo on passenger aircraft and mandated a new marking for packagings containing these batteries. This rule was issued in response to FAA flammability tests on lithium primary batteries that showed, among other things, Halon 1301 fire suppression systems were not effective in suppressing a lithium primary battery fire.

5. In May 2005, the FAA began conducting flammability tests on lithium ion cells similar to those it had conducted on lithium primary batteries.

6. On June 15, 2005, the US DOT issued an initial regulatory flexibility analysis (IRFA) that provided a detailed economic analysis on the potential small business impacts of the April 2, 2002 proposed lithium battery rule.

As a result of this activity, shippers in the US of lithium and lithium ion batteries and equipment containing them currently find themselves facing an inconsistent set of domestic and international hazardous materials transportation regulations. Fortunately, the US DOT has done an excellent job in issuing numerous interpretation letters that clarify the US and international lithium battery regulations. These letters address a variety of topics. They include UN lithium battery thermal testing requirements, weight limitations on batteries contained in equipment, shipping batteries for "testing," shipping batteries for disposal, DOT's Interim Final Rule and use of the cargo aircraft only label, and UN testing requirements for batteries of similar design. PRBA has compiled these interpretation letters for its members, and they can be found on PRBA's website at www.prba.org/dot_letters.html.

Even so, the current landscape has led to confusion among shippers, carriers and agencies responsible for enforcing the lithium battery regulations. The regulations are expected to evolve even further over the next 12 months as the US DOT works towards harmonizing its regulations with the international regulations and publishing a Final Rule for its December 2004 Interim Final Rule.

There is no assurance that this evolution will clarify shippers' obligations, however. To achieve this result, in the coming months PRBA will be responding to regulatory proposals and, perhaps more important, actively pursuing reasonable revisions to the international regulations that govern the transport of lithium ion cells and batteries.

Batteries in Transport - PRBA Activities

PRBA has long been recognized as the world's leading portable rechargeable battery trade association. For the past 14 years, PRBA has represented the industry before State, Federal and international governmental agencies and non-governmental organizations on battery collection, recycling, labeling and transport issues.

For example, PRBA was actively involved in developing the Universal Waste Rule (40 C.F.R. Part 273), which was finalized in April 1995. The rule reduced regulatory barriers to the collection of rechargeable batteries on a nationwide basis. In addition, PRBA represented the rechargeable battery industry in encouraging the enactment of the 1996 Federal Battery Bill, also know as the Mercury-Containing and Rechargeable Battery Management Act. The Federal legislation removes barriers to nickel cadmium battery recycling programs resulting from individual State laws and regulatory restrictions governing the collection, recycling and transportation of these batteries.

More recently, in July 2004, PRBA was granted Observer Status at the UN Sub-Committee of Experts on the Transport of Dangerous Goods. This provides the portable battery and electronics industries a voice at these important international transport meetings. PRBA may pursue a similar role with the International Civil Aviation Organization (ICAO) Dangerous Goods Panel. PRBA also secured for its members the required "Competent Authority Approval" from the US DOT that authorizes shipments by air of prototype and low production lithium and lithium ion cells and batteries.

PRBA recently submitted several proposals with the UN Subcommittee of Experts that would significantly change the regulations that govern the transport of lithium ion cells and batteries and equipment that contain them. These proposals are available on PRBA's website. They include the following:

(a) A change to regulating lithium ion cells and batteries based on watt hours (Wh) rather than equivalent lithium content (ELC);

(b) Providing a 25 Wh exemption for "small" lithium ion cells and a 200 Wh exemption for "small" lithium ion batteries;

(c) A requirement that all lithium ion cells and batteries, except those packed with or contained in equipment, be offered for transport at no more than 50 percent state of charge; and

(d) Establishing a new UN number specifically for shipments of lithium ion cells

and batteries.

PRBA is requesting these changes for several reasons. First and foremost, it is obvious that to meet the necessary power consumption demands in today's portable consumer applications, especially notebook computers and cordless power tools, the capacity of lithium ion rechargeable cells and batteries has increased significantly over the past five years. This sharp increase in power consumption demand and subsequent capacity was not anticipated when the current lithium ion battery transportation regulations were developed in 1999.

Consequently, if the regulations are not revised as PRBA has proposed, many lithium ion batteries and consumer electronic devices containing these batteries will need to be shipped as fully regulated hazardous materials. This would significantly increase transport costs and would affect portions of the transport industry not accustomed to dealing with hazardous materials. Additional costs would stem from compliance with employee training, packaging, marking and labeling and shipping paper requirements as well as surcharges carriers commonly impose for transporting hazardous materials.

Moreover, consumers as well as manufacturers and distributors also have occasion to offer for transport portable electronic equipment by commercial carriers (e.g., to return a device back to the manufacturer). If the regulations are not revised, it is entirely possible that within a few years consumers may have to deal with all the packaging, labeling, marking and shipping paper requirements of the hazardous materials transportation regulations. The impracticality of such a scenario is apparent.

To confirm that the regulatory scheme it advocates is appropriate, PRBA sponsored several tests conducted by Exponent Failure Analysis. The first test evaluated the severity of impact of a potential internal short circuit if cells or batteries were at varying states of charge (SOC).

Exponent conducted this test on cells from three manufacturers, and at various states of charge. The cells were intentionally crushed to create worst case short circuit conditions (i.e., an internal short without breaching the cell case so that confinement is maximized). The results revealed that the consequences of short circuiting at 50 percent SOC are minor. Most cases were unaffected; the one case that ruptured at 50 percent SOC had only a minor crack.

The tests also revealed that temperatures resulting from short circuits were well within controllable ranges. For example, the maximum temperature measured on the outside of cases of 50 percent SOC cells never exceeded 120°C.

In short, the testing supports the conclusion that shipping cells and batteries at no more than 50 percent SOC provides an additional level of safety. PRBA hence has proposed inclusion of this requirement for lithium ion cells and batteries in transport.

PRBA also contracted with Exponent Failure Analysis Associates to conduct flammability tests on lithium ion cells and batteries analogous to those the FAA had done on lithium primary batteries. These tests showed that:

1. Halon 1301 is very effective in controlling burning lithium ion cells;

2. Direct flame impingement on small, unpackaged quantities of bare cells and battery packs can lead to internal thermal runaway of individual cells and venting of gases and in a few cases cells will rupture and eject their contents, but have minimal effects on bulk packaged lithium ion cells at 50 percent or less state of charge; and

3. Aircraft cargo liner material is capable of withstanding the tested flame impingement from burning gases vented by lithium ion cells subjected to external heating.

Data from these tests have been submitted to the US DOT. In its transmittal comments, PRBA emphasized that by sponsoring testing using the FAA protocols PRBA was not endorsing the appropriateness of those tests or the conclusions reached by DOT. In fact, PRBA noted that it has significant concerns for the manner in which the FAA tests on primary lithium batteries were carried out, the conclusions reached, and the regulatory steps taken. However, even within the constraints of that approach, the testing confirms the wisdom of the regulatory proposals PRBA has advanced.

More recently, this has been confirmed by additional testing conducted by the FAA. Preliminary results from this testing were posted by the FAA on November 7, 2005. They were fully consistent with Exponent's findings. That is, Halon 1301 is effective in controlling burning lithium ion batteries, and aircraft cargo liner material is not compromised as a result of burning electrolyte.

Battery Type and Number of Incidents	Incident Type and Number
Alkaline (5)	Short circuit/fire (2) Burning smell (1) Flashlight explosion - 9 minor injuries(1) Sparking (1)
Lead-Acid including Nonspillable (20)	Short circuit and fire/burning (14) Heat and/or smoke (3) Sparking (2) Short circuit (1)
Lithium (5)	Short circuit/fire (1) Smoke/fumes (3) Mishandling/fire (1)
Lithium ion(1)	Fire (large prototype) (1)
Nickel - Cadmium (4)	Short circuit and fire (3) Battery hot (1)
Unknown (7)	Laptop battery - hot to touch (1) Burning smell/charring (3) Power supply units exploded (1) Smoldering in camcorder (1) Unknown (1)

Table 1.

Additional US DOT Concerns with Batteries in Transport

In addition to the US DOT's work on lithium and lithium ion batteries, the agency also is generally concerned about the risk other batteries pose in transport. In July 2004, the US DOT sent a letter to Norm England, president and CEO of PRBA, that noted the agency's ongoing concerns regarding "fires caused by batteries and battery powered equipment." The letter outlined steps they would like to see the industry take to eliminate these problems.

A few months later, in October 2004, the US DOT provided the International Civil Aviation Organization (ICAO) Dangerous Goods Panel a list of 42 battery "incidents" in transport that have occurred over the past 12 years. A brief summary of these incidents is provided in Table 1.

In response to the US DOT's letter and ICAO paper, PRBA alerted all of its members to the agency's concerns and drafted a guidance document for use by PRBA members and their customers that summarizes the regulatory requirements for shipping portable rechargeable batteries and battery powered equipment. This document is available on PRBA's website.

Two other important battery transport issues the US DOT may address within the next two years merit note. These are shipping and testing requirements for lithium ion batteries used in large format applications, and the exceptions provided for shipments of vehicles or engines containing large lithium ion batteries found in 49 CFR 173.220 of the US HMR. While these will not have a direct impact on manufacturers and distributors of portable batteries and electronic products, the work done in developing them is certain to influence US DOT's perception of smaller units.

Conclusion

When one considers that approximately 1.6 billion lithium ion cells were manufactured in 2005 and billions of other types of cells and batteries are manufactured and shipped each year, the concerns expressed by the US DOT and other transportation authorities regarding batteries in transport are understandable. Nonetheless, it must be recognized that the number of incidents involving batteries in transport is incredibly small compared to the billions of cells, batteries and products packed with or containing them that are safely shipped each year.

The applications for lithium ion batteries will continue to expand over the next several years. For example, the portable power tool industry is moving towards using lithium ion batteries instead of the long-preferred nickel cadmium batteries. Therefore, there are several challenges facing the portable rechargeable battery industry and companies that ship batteries or products that use these batteries:

1. Regulations governing the transport of lithium ion batteries and products powered by them have not kept pace with changes in lithium ion technology and the proliferation of applications for lithium ion batteries. In order to address these changes in the marketplace, eliminate unnecessary transportation restrictions on these products, and promote technical progress on lithium ion batteries, the regulations that govern the transport of lithium ion batteries must be amended;

2. Employers must ensure that their employees have the appropriate training to properly package batteries or products packed with or containing batteries to prevent short-circuits and movement which could lead to short-circuits. This is especially important in light of the fact that these products frequently are shipped on passenger aircraft; and

3. Cell and battery manufacturers, battery assemblers, and battery distributors should provide their customers with information on the hazards associated with batteries in transport and instructions on the proper packaging procedures for these products to eliminate the risk of batteries short-circuiting or generating a dangerous quantity of heat in transport.

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