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COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the Transport of Dangerous Goods

Twenty-sixth session, 29 November-3 December 2004
Item 3 (c) of the provisional agenda

OUTSTANDING ISSUES OR PROPOSALS OF AMENDMENTS TO THE RECOMMENDATIONS ON THE TRANSPORT OF DANGEROUS GOODS

Miscellaneous proposals

Changes to Special Provision 188 for Lithium Batteries and UN Manual of Tests and Criteria

Transmitted by the Portable Rechargeable Battery Association (PRBA)

Introduction

1. Special Provision 188 (SP 188) in the 1998 UN Recommendations provided an exemption from regulation for lithium ion cells and batteries with an aggregate equivalent lithium content of not more than 1.5 g and 8 g, respectively. The 1998 UN Recommendations also provided an exemption for lithium ion cells containing between 1.5 g and 5 g and batteries containing between 8 g and 25 g of equivalent lithium content if the cells and batteries passed the required tests in the UN Manual of Tests and Criteria. The 2000 UN Recommendations, however, removed the exemption for these larger cells and batteries (1.5 g – 5 g and 8 g – 25 g), therefore requiring these cells and batteries to be shipped as Class 9 dangerous goods.

2. Lithium ion cells and batteries were first introduced in the marketplace in 1995. In light of the limited experience with the technology, the restrictions described in paragraph 1 necessarily were conservative. In more recent years, additional testing of lithium ion batteries has been undertaken that allows more accurate determination of conditions that may present concern in transportation. In addition, billions of lithium ion cells and batteries have safely been shipped by ground, air, and sea since 1995. According to recent industry data, more than 1.5 billion lithium ion cells are now shipped annually.

3. PRBA and several competent authorities have conducted tests on lithium ion cells and batteries over the past several years to determine what risks, if any, are associated with these products in transport. The results of these tests are contained in reports issued by the U.S. Department of Transportation (DOT) (*Safety Testing of Li-ion Cells*), the United Kingdom Civil Aviation Authority (CAA) (*Dealing With In-Flight Lithium Battery Fires In Portable Electronic Devices*, and PRBA (*Effect of Cell State of Charge on Outcome of Internal Cell Faults*).

- The U.S. Department of Transportation nail and drill penetration tests conducted in 2001 on lithium ion cells at various states of charge (SOC) show very few significant reactions, especially when tested at lower SOC (< 50%).

- The U.S. Department of Transportation results are consistent with those found from tests on lithium ion cells conducted in 2004 by Exponent Failure Analysis for PRBA. Exponent's tests show that cells at lower SOC (< 50%) are far less likely to have severe or moderate outcomes when subject to severe abuse conditions.

- The U.S. Department of Transportation also recently issued a report on lithium *primary* batteries entitled, *Flammability Assessment of Bulk-Packed, Nonrechargeable Lithium Primary Batteries in Transport Category Aircraft*, that also includes a reference to testing on lithium ion rechargeable batteries. The two fire pan tests conducted on the lithium ion batteries did not show any significant adverse results.

- The United Kingdom CAA tests were conducted to determine whether on-board charging of batteries raises the possibility of an in-flight fire. The tests, though not related to the transport of batteries, do show that the probability of such a fire in-flight is considered to be extremely low because of the multiple built in safety devices contained in lithium ion batteries. Fire extinguishers also were found to be effective on battery fires that were deliberately initiated.

- A report published in 2000 on the accelerating rate calorimetry (ARC) for lithium ion cells at 100% and 50% SOC shows the differences between lithium ion cells at different SOC.[1] For example, the self-heating temperature begins at approximately 80°C when cells are at 100% SOC and approximately 100°C when cells are at 50% SOC. This indicates that the self-heating beginning temperature is lower for cells at 100% SOC. (The self-heating beginning temperature becomes lower when the SOC % value becomes higher from 0% to 100%.) The evolution of the self-heating beginning temperature and the self-heating speed are shown in the table below.

SOC (%)	Self-heating beginning temperature (˚C)	Self-heating rate (˚C /min)		
		100˚C	120˚C	140˚C
100	Approx. 80	Approx. 0.15	Approx. 0.24	Approx. 0.40
50	Approx. 100	Approx. 0.04	Approx. 0.06	Approx. 0.13
0	Approx. 130	_	_	Approx. 0.03

1 *E. Peter Roth, Electrochemical Society Proceedings Volume 99-25, (2000) 766.*

4. Since 2000, the aggregate equivalent lithium content of lithium ion cells and batteries used in today's laptops and other portable consumer products has increased significantly in order to meet the rising power consumption demand.[2] The proposal on fuels cells submitted by the Experts from Japan and the United States of America at the July Sub-Committee meeting (*See* ST/SG/AC.10/C.3/2004/49) correctly points out that that the average power consumption of today's laptops is now 20 Watts. This sharp increase in power consumption was not anticipated in 1999 when SP 188 was developed and the 1.5 g and 8 g exemption limits for lithium ion cells and batteries were established. To meet the power demand, lithium ion cells and batteries have seen a marked increase in energy density (ampere-hours) and, consequently, equivalent lithium content. In order to continue to meet this rising power demand, eliminate unnecessary transportation restrictions, and promote technical progress on laptops and batteries PRBA proposes that the Sub-committee raise the 1.5 g and 8 g exemption limits on lithium ion cells and batteries.

5. Under the current UN Recommendations, an 8 g lithium ion battery pack at 100% SOC is equal to a 2 g undischarged lithium metal battery pack. Based on these values and that at 50% SOC, a lithium ion cell and battery pack contain half the energy and thus half of the equivalent lithium content than a cell and battery at 100% SOC, a lithium ion cell containing between 1.5 g and 3 g and lithium ion battery containing between 8 and 16 grams and shipped at 50% SOC (or less) should be eligible for the exemptions contained in SP 188.

6. The SOC of cells and batteries shipped in transportation can be verified by documentation provided by the shipper. Therefore, PRBA also proposes to amend SP 188 by requiring shippers to include documentation that reflects a cell or battery's current SOC, when applicable.

7. PRBA recognizes that the term "state of charge" is not defined in the UN Recommendations and thus also proposes to add an appropriate definition in *UN Manual of Tests and Criteria, Part III, sub-section 38.3.*

Proposal

SP 188 Amend to read as follows:

In 188 (a), add:

"and not more than 3 g when the state of charge is not more than 50% of the design rated capacity" just before the last ";".

In 188 (b), add:

"and not more than 16 g when the state of charge is not more than 50% of the design rated capacity" just before the last ";".

In 188(e)(iv), add the following paragraph immediately following 188 (e)(iv):

"(f) Each shipment containing lithium ion cells or batteries requiring a reduced state of charge of not more than 50% of the design rated capacity shall be accompanied with a document stating the existing state of charge."

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[2] *1 PC World, News & Trends,* Top 15 Notebook PCs *(October, 2003).*

UN Manual of Tests and Criteria, Part III, sub-section 38.3, amend to read as follows:

In 38.3.2.2, immediately following the definition of *Small cell*, add:

"*State of charge* means the available capacity in a cell or battery, after a charge or discharge operation, usually expressed as a percentage of the cell or battery's rated capacity."