UN/SCETDG/27/INF.5

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-seventh session
Geneva, 4-8 July 2005
Item 6 of the provisional agenda

LISTING, CLASSIFICATION AND PACKING

Use of Watt-hours as a Size Criterion for Lithium ion Batteries

Transmitted by the Portable Rechargeable Battery Association (PRBA)

Introduction

1. In document ST/SG/AC.10/C.3/2005/13 PRBA recommends that Watt-hours (Wh) be used in place of Equivalent Lithium Content as a measure of cell or battery size. PRBA provides the following additional information to further support its proposal to use Wh.

Background

2. In regulating lithium primary batteries, transport regulations have historically used lithium content as the criterion for determining the degree of regulation that should be applied to varying sizes of cells and batteries. This was particularly appropriate in quantifying the degree of risk for lithium primary batteries in that the anodes of new lithium primary batteries and cells consist of metallic lithium and lithium metal is a Division 4.3 regulated material.

3. Unlike primary lithium batteries, lithium in a lithium ion cell or battery is only present in an ionic state. Lithium ions pose no significant danger warranting regulation, including when they are in the electrolyte of a battery. When a lithium ion battery is charged, the lithium ions migrate to the anode where they are held in a carbonaceous crystalline structure. Lithium ion rechargeable battery technology was in part chosen over a technology employing lithium metal due to its relative safety.

4. When lithium ion batteries were introduced into the regulations, the concept of equivalent lithium content or lithium-equivalent content (ELC) was developed to provide a surrogate for lithium content for use as a criterion for assigning different levels of regulation to this new kind of battery. Equivalent lithium content is used even though there are only minute (if any) byproduct quantities of lithium metal present in lithium ion batteries.

5. ELC in grams is calculated by multiplying the rated capacity in ampere-hours of a cell by 0.3. The ELC of a battery equals the sum of the grams of ELC contained in the component cells of the battery.

What are the deficiencies with using ELC?

6. ELC is a term unique to the UN Model Regulations. This causes confusion and delay when questions arise about a battery's size while it is transportation.

7. ELC is difficult to determine thus making regulations hard to comply with and enforce, potentially frustrating some shipments needlessly while other shipments in violation of the regulations move without detection.

8. While calculating ELC using the Ah provided on a single cell battery such as a cell phone battery is straight forward, ELC is more difficult to calculate in a multi-cell battery pack. Whereas the battery pack's ELC should be calculated on the basis of the sum of the grams of ELC contained in the component cells of the battery, the ampere-hour figure commonly quoted on the battery packs of portable electronic equipment such as DVD players and laptop computers is the rating for the battery. Whether it is appropriate to use the Ah rating of the battery for the calculation of ELC depends on how the cells are configured (i.e.; the series/parallel arrangement of cells in the pack). If all batteries in the battery are connected in parallel with one another the battery Ah rating may be used to calculate the ELC of the battery. If any cells are connected in series with one another, the battery Ah rating should not be used. Since the cell configuration is not typically identified on batteries, it is not possible to determine whether use of the battery's Ah is appropriate for calculating ELC.

9. The attached spread sheet illustrates the above point. It shows for some possible cell configurations the ELC that might be erroneously calculated based on the Ah printed on the battery and the ELC correctly calculated using sum of the ELCs of each individual cell in the battery. Note that in the case of a number of the 12 cell batteries the ELC value calculated using the battery Ah would lead to the conclusion that they are subject to the less stringent requirements in Special Provision 188 whereas in actuality they should be fully regulated under the current requirements.

10. In conclusion, the actual configuration of the cells in the battery and the number and size cells present must be known in order to arrive at the correct ELC. Using the rated Ah marked on the battery could lead to erroneous conclusions on the degree of regulation applicable to the battery.

11. **Due to the complexity of communicating and calculating ELC, PRBA believes another criterion that is independent of the cell configuration should be used to rank lithium ion batteries for purposes of applying varying levels of regulation.**

Why is Wh a better measure?

12. Watt-hours is a common term like voltage and amperage and is widely recognized. Watt hours is simply the product of a cell or battery's rated voltage and Ah. As such a battery's Wh can be more easily communicated should a question arise in transportation.

13. A battery's Wh rating is more easily determined and as illustrated in the attached spreadsheet is independent of how the cells are configured in the battery.

14. **On this basis PRBA recommends that Wh be used as a measure of indicating the level of regulation to which lithium ion batteries should be subject.**

Battery Pack Equivalent Lithium Content (ELC) and Watt Hours

Cell Capacity, Ah	2.2	2.2	2.4	2.4	2.4	2.4	3.0	3.0
Cell Voltage, V	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
ELC per cell, grams	0.66	0.66	0.72	0.72	0.72	0.72	0.9	0.9
Cells in series	4	3	3	4	6	1	3	4
Cells in parallel	3	4	4	3	2	12	4	2
Number of cells	12	12	12	12	12	12	12	8
Total ELC, grams	7.92	7.92	8.64	8.64	8.64	8.64	10.8	7.2
Battery capacity, Ah	6.6	8.8	9.6	7.2	4.8	28.8	12	6
Battery voltage, V	14.8	11.1	11.1	14.8	22.2	3.7	11.1	14.8
Battery Watt-hours	97.68	97.68	106.56	106.56	106.56	106.56	133.2	88.8
Erroneous Battery ELC	1.98	2.64	2.88	2.16	1.44	8.64	3.6	1.8