Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

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Electric storage systems: transport provisions

Lithium-ion batteries special provision SP188 update

Transmitted by RECHARGE the Advanced Rechargeable & Lithium Batteries Association and PRBA – The Rechargeable Battery Association

Introduction

1. The lithium batteries regulation has always considered that the hazards attached to small batteries are reduced when compared to large batteries. For that reason, the special provision SP188 is enabling to transport small batteries under specific transport conditions.

2. The initial definition of the scope for SP188 and the maximum size of the batteries was related to the weight of lithium contained in the cells or batteries, selected as a representative indicator of the batteries hazard, to determine a maximum threshold. Indeed, it is recognized that the hazards of the lithium batteries are mainly related to the amount of contained reactive substances, including lithium and other active material, as well as electrolyte (see appendix for supporting data). The weight of lithium contained in the lithium-ion batteries (UN 3480) was considered as a non-practical indication, and it has been replaced by the indication of the equivalent energy content in watt-hours (Wh). The lithium metal batteries (UN 3090), on the contrary, have still maintained the limit unit in weigh of lithium metal contained, in grams.

3. The global approach for the definition of the thresholds values was based on the market and applications at the time. Particularly, it was recognized that the “small batteries” used in laptops, cell phones and power tools could be considered as “small batteries” and benefit of specific transport conditions. A common characteristic of these batteries was that they all were all of a limited size, and respecting the criteria proposed: 20 Wh for the cells, 100 Wh for the batteries.

4. Since that time, the technology evolution has been very important, enable to define batteries providing more energy with the same amount of active material contained in the batteries. This is demonstrated by the values published for the specific energy of the lithium batteries, expressed in Wh/kg. Some tables and graphs based on current scientific literature are presented in the appendix to this document. These graphs indicate an increase over the period of at least + 50 %. This result has been obtained thanks to a better usage of the active material, with more stable electrolytes and higher voltage of the lithium-ion cells. In addition, this progress is expected to continue in the coming years.

5. As result of the technical change, the limit defined is now not anymore suitable for the considered applications: Thanks to the technical progress, some cell phone contains now a single cell battery of slightly more than 20 Wh. In a similar way, some power tools contain a battery above 100 Wh. This design improvements generate a very impractical condition for the shipment of this equipment, as some can no longer be shipped under SP188.

6. As a technical result of the threshold for SP188 being expressed in Wh, the corresponding limit in weight of the batteries is progressively decreasing: a cell with an energy of 20 Wh today is typically weighting 50 % less than a cell of the same energy when the regulation was decided! This is creating an issue for the continuity of the transport conditions for the small cells and batteries transported according to SP188. Due to the technical progress, cells and batteries proposing a better service, and exceeding 20 Wh/cell or 100 Wh/battery, cannot be transported in the same condition as less performing batteries, despite their content in reactive materials, as indicated by the weight, is not exceeding the initially defined threshold.

7. The proposal is to update the threshold expressed in Wh to follow the technical progress and keep the weigh constant. Based on the data presented in the appendix to this document, the new thresholds proposed should be 30 Wh/cell and 150 Wh/battery. It could be noted that this threshold is still below the value proposed in some countries for road transport (e.g. 300 Wh per battery in the USA).

Proposal

8. Amend in special provision SP188 paragraphs (a) and (b) as follows (new text is underlined, deleted text is marked as strikethrough):

"(a) For a lithium metal or lithium alloy cell, the lithium content is not more than 1 g and for a lithium-ion cell, the Watt-hour rating is not more than ~~20~~ 30 Wh;

(b) For a lithium metal or lithium alloy battery the aggregate lithium content is not more than 2 g, and for a lithium-ion battery, the Watt-hour rating is not more than ~~100~~ 150 Wh. Lithium-ion batteries subject to this provision shall be marked with the Watt-hour rating on the outside case, except those manufactured before 1 January 2009;"

Appendix

A. European Technology and Innovation Partnership for Batteries: Batteries Strategic Road map (2020)

BATTERIES EUROPE
EUROPEAN **TECHNOLOGY** AND **INNOVATION** PLATFORM

TABLE 10: ROAD TRANSPORT: LIGHT DUTY BEV*TYPICAL BATTERY SIZE

Road transport: Light duty BEV*Typical Battery Size : 20-100 kWh (today), 40-120 kWh (in the future)					
KPI	Operating conditions	System/Pack/ Cell level	Unit	2020	2030
Cell/pack weight ratio		Pack	%	70	80
Cell/pack volume ratio		Pack	%	60	75
Operating lifetime expectation	Minimum guaranteed lifetime (equivalent 80% DOD)	Pack	km	~150,000 (~Vehicle lifetime)	
Gravimetric Power density **	180s, SoC 100%-10%, 25°C	Cell	W/kg	750	1,000
Gravimetric Energy density	C/3 charge and discharge, 25°C, charging with CC and CV step	Cell	Wh/kg	~250	~450
Volumetric energy density	C/3 charge and discharge, 25°C, charging with CC and CV step	Cell	Wh/L	~500	1,000
Volumetric power density**	180s, SoC 100%-10%, 25°C	Cell	W/L	1,500	2,200
Cycle life	80% DOD, 25°C	Cell	cycles	1,000	2,000
Hazard level		Cell	-	<=4	<=4
COST					
Cost		Pack	€/kWh	200	85
Cost		Cell	€/kWh	125	70
MARKET					
Market size	Source: Avicenne Energy, 2019; IEA Global EV Outlook 2020		GWh/year	~40	~1,000-2,500

*The following specifications do not consider new use cases such as vehicle-to-grid

** Here it is not specified if the pulse is in charge or discharge mode. The operating conditions give 10%-100% as a SoC range in which the 180s power pulse can be applied; obviously for low SoC starting values the pulse should be applied in charge mode, whereas for high SoC starting values the pulse should be applied in discharge mode.

B. Batteries SET-plan (2017)

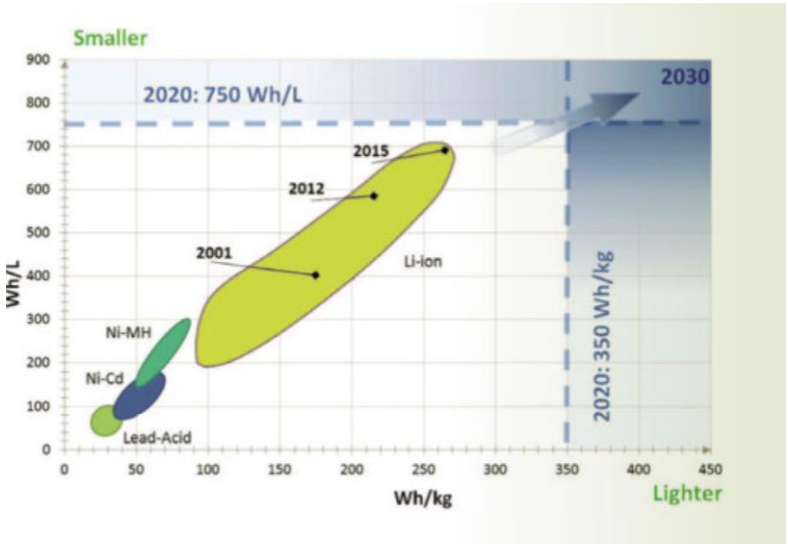

Figure 19: The energy density of Li-ion batteries has been increasing steadily over recent years.
Source: Joint Research Centre, European Commission.

EMIRI
Bridging the Innovation Gap

3. R&I targets on performance, cost, manufacturing

- **Basis:** as set to the Implementation Plan of Key Action n°7 of the SET Plan

Table a

		Current (2014/ 2015)	2020	*2030
Performance targets for automotive applications unless otherwise indicated				
1	Gravimetric energy density [Wh/kg]			
	pack level	85-135	235	> 250
	cell level	90-235	350	> 400
2	Volumetric energy density [Wh/l]			
	pack level	95-220	500	> 500
	cell level	200-630	750	> 750
3	Gravimetric power density [W/kg]			
	pack level	330-400	470	> 470
	cell level		700	> 700
4	Volumetric power density [W/l]			
	pack level	350-550	1.000	> 1.000
	**cell level		1.500	> 1.500
5	Fast recharge time [min] (70-80% ΔSOC)	30	22	12
6	Battery life time (at normal ambient temperature)			
	Cycle life for BEV*** to 80% DOD [cycles]		1.000	2000
	Cycle life for Stationary to 80% DOD [cycles]	1000-3000	3000-5000	10000
	Calendar life [years]	8-10	15	20

*: Post-Lithium ion technologies are assumed relevant in this time frame
**: May also be relevant to stationary applications
***: Cycle life for PHEV must be bigger

Table b

	TARGETS	Current (2014/ 2015)	2022	2030
Cost target				
1	Battery pack cost for automotive applications [€/kWh]	180-285	90	75
2	Cost for stationary applications requiring deep discharge cycle [€/kWh/cycle]		0,1	0,05

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(https://www.isi.fraunhofer.de/content/dam/isi/dokumente/cct/lib/TRM-ESEM-2030_en.pdf)

Targets of leading countries worldwide to reach energy densities (Wh/kg) of large-scale LIB cells of the third battery generation (application in BEV/PHEV)