Establishing harmonised methods to determine the capacity of all portable and automotive batteries and rules for the use of a label indicating the capacity of these batteries – Final Report – Executive Summary

Context and Approach

In relation to Article 21 of the Battery Directive[1], the study proposes to establish harmonised methods to determine the capacity of all portable and automotive batteries, and rules for the use of a label indicating their capacity. The approach followed for this study consisted of two main tasks which are further described below.

Task 1 performed a background literature survey and a thorough technical evaluation of existing capacity determination methods, in light of existing international standards and of the commonly practiced approaches by the industry. The objectives were to identify the product categories included in the scope of the study, to understand the technical meaning of capacity, to list and analyse the existing methods for battery capacity measurement, and to develop harmonised methods.

Task 2 of the report presented several labelling options (based on the harmonised methods developed in Task 1) that not only convey the essential information but are also easily understandable by consumers.

The interim results were discussed with stakeholders during a meeting held in Brussels on March 25th 2008. Meetings and teleconferences with experts on batteries (e.g. IEC TC 35 committee, members of Recharge, EUROBAT[2], EPBA[3]) were also organised several times in order to complement the study.

Task 1: Definition of harmonised methods

- Product categories

Portable batteries include primary batteries (non-rechargeable) and secondary batteries (rechargeable) which rely on a variety of technologies based on different chemistries (alkaline manganese, zinc carbon, lithium, zinc air, silver oxide, nickel oxihydroxide and lithium iron disulfide for primary batteries; nickel cadmium, nickel metal hydride, lithium ion, lithium polymer and lead-acid for secondary batteries) and different designs (design with a steel nail inserted into the battery can as in alkaline batteries, spiral wound design as in most portable secondary batteries). Automotive batteries consist of lead-acid batteries used as a power source in vehicles for starting the internal combustion of the engine.

- Meaning of capacity and parameters influencing the capacity

The technical meaning of the capacity of a battery is a measure of the energy contained within a battery under set conditions expressed in ampere hours (Ah). This "technical capacity" is not the only information used by battery manufacturers to communicate on the capability of their products. For portable secondary batteries, the technical definition is taken as a reference to rate the capacity of the batteries (i.e. in mAh). For portable primary batteries the information is usually provided in terms of "performance" expressed in service-hours, which refers to the

[1] Directive 2006/66/EC
[2] European association of manufacturers of storage batteries
[3] European Portable Battery Association

duration of the discharge ("lifetime of a battery" which is linked to the capacity[4]) or a number of pulses (i.e. a number of flashes a battery can deliver when used in a camera). For automotive batteries, the capacity of the battery is provided following the technical definition (Ah) and complemented by an indication of the ability of the battery to start an engine in cold climate, i.e. the "Cold Cranking Amperes" (CCA).

The actual delivered capacity of a battery is highly dependent on the operating temperature, on the voltage below which the end-use application will not operate properly (end-point voltage), on the frequency and duration of use by the consumer (e.g. intermittent against continuous[5]) and on battery age[6]. For portable secondary batteries, the frequency of use is not so much influencing for the capacity. For both portable secondary batteries and for automotive batteries (which are designed to service one type of application: e.g. cars) the capacity is not greatly dependent on the device. However, for portable primary batteries, the capacity and thus the performance are highly dependent on the drain rate (load) of a device[7] and on how frequently a consumer uses a device. As such, for primary batteries, there is no single battery capacity marking that would be appropriate or representative of all electrical devices (e.g. torch lamp, alarm clock, radio, etc.).

- Existing test methods and proposed harmonised methods for capacity measurement

The standards developed by the International Electrotechnical Committee (IEC), which are all transposed in European standards (EN), were identified as being the most common methods used to measure the capacity and performance of batteries.

For portable secondary batteries[8], the IEC/EN standards[9] are set on a discharge test of 5 or 20 hours at constant current determining a single value of the capacity in ampere-hours and providing a good basis for the rating of the battery capacity. For automotive batteries, the IEC/EN standard[10] defines methods to measure both their capacity (Ah) and their CCA which allows an objective rating of their capability. Here, there was no need to develop harmonised methods as the IEC/EN standards already provide a reasonable framework.

Because of the nature of primary batteries, delivered capacity and rated capacity vary significantly across applications. As a result, no single capacity measurement is meaningful when a battery has a host of end-uses. In particular, general purpose primary batteries typically have several applications and associated discharge tests. For portable general purpose primary batteries[11], the IEC/EN testing methods are set[12] on a specific list of loads, end-point voltages, and duty cycles representing most commonly used devices[13] (up to 7 devices for one battery model e.g. a radio-test, a torch lamp-test). Results obtained are in terms of performance for each application-test, and no single measure of the rated capacity can be determined as this is highly dependent on the test conditions . By contrast, some less common batteries, specialty batteries

[4] Simply put, the lifetime of a battery is the ratio of its capacity over the intensity of the current during its discharge
[5] Results will differ for devices used two hours per day versus one hour per month
[6] Batteries vary in their ability to deliver service at different ages
[7] The drain rate refers to how fast energy is taken from the battery - the higher the demand the lower the capacity and performance
[8] Including secondary portable custom-made battery packs for use in e.g. laptops, digital cameras, mp3 players, etc.
[9] IEC/EN 60622; IEC/EN 61951; IEC/EN 61960; IEC/EN 61056
[10] IEC/EN 60095
[11] i.e. batteries designed to fit in a wide range of end-use applications
[12] IEC/EN 60086
[13] The IEC applications tests defined for a specific battery capture the **upper 80 % of the market** in terms of battery-operated applications using this type of battery i.e. the application tests defined for a battery represent 80% of the most common applications of this battery

and watch batteries have a very narrow range of uses[14] so that it is usually possible to rate their performance or capacity with a single value (measured via a single "service output test"), or through the use of one single test ("service output test") sometimes complemented by 2-3 application tests.

Consequently, the harmonisation of capacity measurement methods within primary batteries was performed considering two approaches:

For watch and specialty batteries, for which the tests specified within existing standards are convenient, there was no need to harmonise the tests. Method A in IEC/EN 60086-3 was selected for watch batteries, and the service output tests which provide a meaningful data on performance of the battery were selected for specialty batteries.

For general purpose batteries of geometries which are tested with a multitude of application tests, the study suggested to harmonise the tests for in order to enable clear and concise labelling based on a maximum of 4 performance data (instead of up to 7, 4 being less misleading than having 7 performance data but still being representative), provided that the information remains meaningful and representative of the battery's performance, and most importantly provides a tool for performance comparison between products. A selection of the up to four most representative application tests was made[15] for each battery geometry (independently on its chemistry). This selection was undertaken in the light of discussions with international battery experts in May 2008 at the IEC/TC 35 committee[16] meeting where BIO Intelligence Service was invited. The results of such harmonisation process are presented in the summary table (please refer to the "Summary Table" attached).

Some portable primary batteries not covered by the IEC/EN 60086-2 were identified: these batteries are based on new technologies (e.g. Lithium Iron Disulfide) but present common geometries (e.g. R6, R03 formats) and voltage. For these batteries, it was recommended that they should be tested as the other batteries of the corresponding geometry which are covered by the IEC/EN 60086-2 standard.

- Compliance requirements

Specific compliance requirements that a type of product should meet in order to be able to display certain information on its performance or capacity were also defined in terms of sample size (for the tested product), timing of the measurement, choice of the displayed capacity/performance data, etc. These requirements were based, as much as possible, on the specifications from the IEC/EN standards as well.

Task 2: Capacity label design and application

The unit in which the capacity/performance information will be conveyed on the label was defined for each type of battery (e.g. ampere hours for portable secondary batteries and automotive batteries, service hours or pulses for primary general purpose batteries). A level of accuracy of the displayed data was also suggested in the study. Also for primary portable batteries, it was suggested to display the performance of the battery after 1 year and not the "fresh" or initial performance, as most of the batteries found in stores are already 1 year old.

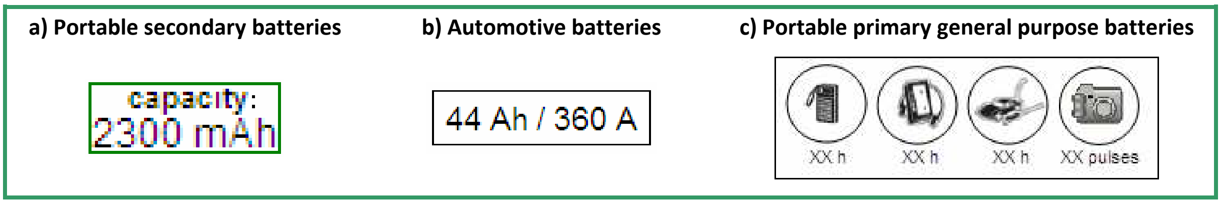
[14] i.e. watch batteries or specialty batteries designed for specific applications such as small calculators, hearing aids, electrical fence remote controls, etc.

[15] Among the wide variety of existing geometries for general purpose battery (13 types) only 4 geometries (R03, R6, R14, and R20) present over 4 application tests in the IEC 60086.

[16] Technical committee in charge of developing the IEC standards for primary portable batteries

Labelling options for each category of batteries were proposed based on the harmonised methods identified in Task 1. Either based on the display of a single rated capacity (e.g. for portable secondary batteries), either based on the display of up to four performance data related to a specific application (for primary portable general purpose batteries).

Figure 1 - a) b) c): Examples of labelling options for three categories of batteries



The "Summary Table" (attached) provides an overview of the recommended labelling options. The study proposed a two step approach for the label: first step is the development of "basic" labelling options, and a second step presented more elaborate labelling options which might necessitate further research before it is possible to implement them. These options (inspired by the European Energy Label) were presented as an outlook of how the "basic" labelling presented in the first step could evolve in the future.

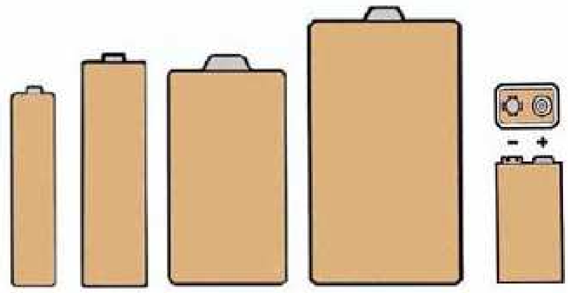
Finally, some labelling exemptions were proposed for batteries which do not seem to represent a significant impact on the environment or a great share of the market, and also for batteries which are not accessible to the end-user (i.e. batteries which are embedded in equipment, e.g. back-up batteries in laptop computers) and for which the consumer does not have to make buying decision.

For primary batteries, it was suggested to exempt portable primary batteries sold without packaging and with equipment from labelling as the consumer is not faced with a buying decision when purchasing these batteries. Moreover, it was suggested to restrict the labelling to these batteries which represent up to 90% of the market, and 95-99 % of the waste stream for portable primary (see Figure 2):

- batteries of R6 geometry,
- batteries of the R03 geometry
- batteries of the R14 geometry
- batteries of the R20 geometry
- batteries of the F22 geometry (6F22 and 6LR61)

(i.e. Exemption of watch batteries, specialty batteries, and of other type of portable primary general purpose batteries)

Figure 2: Designation of portable primary batteries according to they shape



Zinc Carbon IEC	R03	R6	R14	R20	6F22
Alkaline IEC	LR03	LR6	LR14	LR20	6LR61
Nickel oxyhydroxide IEC	(Z03)	(Z6)	–	–	–
Lithium Iron disulfide IEC		(F6)	–	–	–
Dim. mm (ca)	44x10	50x14	50x26	61x34	42x26x17

For portable secondary batteries, an exemption is suggested for rechargeable button cells and memory back-up batteries and batteries packs which are supplied embedded (i.e. not intended for replacement by the end-user) in equipment. In particular this exemption would apply to embedded batteries with a longer life than the equipment. In Europe it can be estimated that 100,000,000 of batteries embedded in mobile phones and other applications such as computers would only represent by weight 50 Tonnes per year (Calculation basis (0.1 g / unit x 100 millions + 1.0 g / unit x 40 million = 50 Tonnes). Therefore, these batteries represent by weight less than one percent at the most of the batteries placed yearly on the market. By comparison, the total European Portable Battery market is in the range of 160 to 200'000 Tonnes.

Conclusions

The study identified harmonised methods to determine the capacity/performance of all portable and automotive batteries and rules for the use of a label indicating the capacity of these batteries in order to allow end-users to take informed buying decisions. The recommendations of the study are summarised in the "Summary Table" attached.