PUBLIC VERSION

Consultation Questionnaire
Exemption 5(b) of ELV Annex II

Lead in batteries for battery applications not included in entry 5(a) [1]

1 Exemption 5(a): Lead in batteries in high-voltage systems (> 75 V DC) that are used only for propulsion in M1 and N1 vehicles; the exemption expired in January 2019

2 It is implemented through the specific contract 070201/2020/832829/ENV.B.3 under the Framework contract ENV.B.3/FRA/2019/0017

3 Gensch et al. (2016 a): 8th Adaptation to scientific and technical progress of exemptions 2(c), 3 and 5 of Annex II to Directive 2000/53/EC (ELV). Final Report for the European Commission DG Environment under Framework Contract No ENV.C.2/FRA/2011/0020. ELV III.5. https://elv.exemptions.oeko.info/fileadmin/user_upload/Consultation_2014_1/20160216_ELV_Final_Gen_Ex_2c__Ex_3_Ex_5.pdf.

4 Directive 2000/53/EC of the European Parliament and of the Council of 18 September 2000 on end-of life vehicles, ELV Directive, European Union (21 October 2000), accessed December 5, 2013

1. Acronyms and Definitions

DoD Depth of discharge
ELV End-of-life vehicles
LAB Lead-acid battery
LIB Lithium-ion battery
NiMH Nickel metal hydride battery
OEM Original equipment manufacturer

2. Background

Bio Innovation Service, UNITAR and Fraunhofer IZM have been appointed[2] to assist the European Commission in the evaluation for the review of three exemptions currently listed in Annex II of the ELV Directive 2000/53/EC.

The above-mentioned exemption has become due for review. It was reviewed[3] last time in 2015/2016 under the ELV Directive[4], and the consultants concluded that the use of lead was still unavoidable. The Commission therefore granted the exemption in line with the requirements of ELV Art. 4(2)(b)(ii). The exemption is due for review in 2021 in order to adapt it to the state of scientific and technological progress.

This questionnaire has been prepared for the stakeholder consultation held as part of the evaluation. The objective of this consultation and the review process is to collect and to evaluate information and evidence according to the criteria listed in Art. (4)(2)(b)(ii) of Directive 2000/53/EC (ELV Directive), which you can download from here:
http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0053

Additional background information can be found on the exemption review page accessible through the following link: www.elv.biois.eu

If you would like to contribute to the stakeholder consultation, please answer the following questions:

3. Questions

1. The last adaptation report[5] on exemption 5 concluded with the following statement: "It is also presumed that in cases where a dual battery system is in use, the use of a LAB [lead-acid battery] as an auxiliary battery would not be avoidable even where starter functionality is not needed. This is based on the understanding that there is a lack of experience with batteries other than LAB for this function, though this could change over the next few years, as Li-Ion batteries [LIB] are understood to provide a suitable candidate for such cases. Three to five years are envisioned to be needed in this case to allow reaching parity of cold cranking performance. As replacement with Li-Ion batteries is not yet implemented in vehicles on the market, it can be followed that more time would be needed to finalise testing and type approval processes, once parity was established."

a. Has parity been reached in terms of cold cranking performance of LIB (lithium iron phosphate-based batteries in particular) and LAB as expected? What is the status of testing and the type approval process? Please describe the progress that has been made since the last revision.

- The parity of LIB versus LAB in regards to cold cranking performance has been reached

b. What is the typical temperature range for the operation of 12 V LAB and the viable alternatives?

- LAB: -30°C … +85°C (temporarily up to 3hrs, laboratory test conditions up to 75°C, safety limit up to 105°C).
- LIB: Higher temperature dependency of power capability of LIB compared to LAB:
  At extreme temperature of -30°C danger of plating at LIB, charging of LIB difficult at extreme temperatures. Low performance of LIB at extremely low temperatures of under -20°C, high performance at temperatures above -20°C. At very high temperatures risk of degassing.

c. For which temperature range do such 12 V batteries need to be tested and validated for the different vehicle classes (ICE, hybrid, fully electric)?

- LAB: Typical engine compartment temperatures up to 105°C may happen and be requested by OEMs but would damage the battery. Laboratory test limit lays at 75°C.
- LIB: validation testing over full temperature range

d. What is the cold cranking ability of current 12 V batteries according to common testing standards?

- 60Ah LIB: 480A@ -30°C; 800A @ -18°C, therefore approximately parity to LAB has been reached

2. Drop-in alternatives for 12 V LAB are available on the market (commonly but not limited to lithium iron phosphate). Several vehicle models from different OEMs have been reported to use 12 V LIB in 2014, in addition to a range of other alternative technologies (e.g. supercapacitors). It was further reported that in 2014 an estimated 900.000 vehicles were in service with a 12 V LIB on board.

Please provide reasoning as to why such (drop-in) alternatives are commercially available and are already widely in use, but are currently not the default battery system employed in new vehicles.

- The LIB batteries available on the market in 2014 had only QM regarding safe supply. With the introduction of safe powernets and ISO26262 the market requirements have changed (see Question #1).
- The 900k vehicles with LIB in 2014 seem to be very high number from Bosch market perspective and cannot be confirmed, we see it still as a niche market or in combination with lead-acid battery in dual battery systems.
- The cost of lithium-ion batteries is still higher compared to lead-acid batteries even in combination with electronic battery sensors. The main reasons are higher cell prices and an additional switch needed for protecting the lithium-ion chemistry.

3. Please describe the mission profiles of 12 V batteries in the different vehicle classes. According to information available to the consultant, ICE vehicles require a high power draw for cold cranking, but otherwise only require relatively low power for other functions powered by the 12 V system, leading to overall shallow depth of discharge (DoD) and low cycle frequency requirements. Battery electric vehicles do not require such high power for cold cranking, but draw comparatively more power that ICE both in “on” or “off” mode to supply the board computer, battery management system, and “comfort features”, therefore requiring a battery that can withstand higher DoD and provide a higher cycle life. It has been described in the last adaptation report5 that some hybrid vehicles use the 12 V battery for engine cranking, while others do not.

Please provide specific data for the technical requirements mentioned above regarding the 12 V battery for each vehicle class and provide reasoning regarding the substitutability of LAB with alternative technologies (including LIB) for each vehicle class.

- ICE: The parity of LIB versus LAB in regards to cold cranking performance has been reached
- Many electrified vehicles (HV and 48V) use the higher voltage level to crank the vehicle. In those cases, the 12V battery needs to fulfill the following main functions:
    - Providing power during parking
    - Providing power in case of malfunctioning of the main power source (failure of DC/DC).
- Both battery types fulfill the requirements for higher cycle life and their application of EVs

4. The last adaptation report[5] cited data from 2014 illustrating the considerable difference in cost between LAB, NiMH, and LIB for automotive 12 V application. Please provide information regarding the development of the cost per kWh / kW as well as per market-available unit (12 V battery) since then. Please also refer to the expected price development in the next few years.

- LIB price is still higher than LAB price; further reduction on LIB price expected

5. The recycling rate for LAB has been reported to be very high. Please provide any information regarding the current and expected recycling rate for alternative technologies including LIB, for mass percentage of the battery as well as individual elements (e.g. metals such as lead, cobalt, nickel, manganese, lithium, as well as electrolytes and other elements of the batteries). Please also refer to the economic feasibility of recycling now and in the future.

- LAB recycling efficiency in EU is 98-99%. LAB Recycling rate (-> efficiency) used to be 99% in 2017, has decreased to about 97% in 2020, mainly due to new EU countries where the registration process of battery return is not perfect.1% approximately of all EU cars end their life in other countries like in Africa, there the battery return also cannot be recorded, that's why it never had been 100%.
- LIB recycling efficiency in EU: No evident actual recycling rate data and regulation available. There are ongoing discussions about a New Battery Regulation, which shall be released end of 2022, which foresees that in 2023 the recycling rate of LIB has to be 50% in relation to the weight of the overall battery system (incl. housing, cooling system etc.)

6. More generally, please explain whether the use of lead in the application(s) addressed under the above exemption is still unavoidable so that Art. 4 (2) (b) (ii) of the ELV Directive would justify the continuation of the exemption. Please be specific with your answer, for example clarify, if applicable, what types of vehicles your answer refers to, i.e., conventional vehicles and various types of hybrid and electric vehicles, and which functionalities and applications the exemption still needs to cover.

The lithium-ion battery price is currently higher than comparable lead acid batteries (including battery sensor) and there is still need for research on certain technical topics:

- With current state-of-the art concepts, supply via LIB cannot be guaranteed in all operation points, e.g. post-crash or overvoltage situations
- Dual battery systems with high safety requirements depend on diverse redundancy, therefore combined systems of LIB and LAB currently seem to be beneficial

7. Please explain the efforts your organisation has undertaken to find and implement the use of lead-free alternatives for automotive uses. Please refer to alternatives, which at least reduce the amount of lead applied or eliminate its necessity altogether.

Bosch has accumulated extensive knowledge on lithium-ion batteries in a wide range of applications (48V batteries, PHEVs, EVs, powertools, e-bikes, 12V motorcycle starter batteries, etc.).

8. Please provide a roadmap specifying the necessary steps/achievements in research and development including a time scale for the substitution or elimination of lead in this exemption.

For a broad market introduction of LIB, there is the need for further research on certain technical topics; therefore recommendation for a prolongation of the lead-ban exemption until 2025

9. What is the amount of lead that would be contained in vehicles

a. placed on the EU market

b. worldwide

in case the exemption is continued? Please provide at least a rough calculation or substantiated estimate clarifying how you arrive at the final result.

An overall market picture could probably be available at e.g. Eurobat.

10. Overall, please let us know whether you agree with the necessity to continue the exemption and sum up your arguments for or against the continuation.

- ⇨ Bosch sees that Lithium-ion batteries will replace the Lead-acid battery technology in the mid-term.
- ⇨ Bosch has broad experience in Lithium-ion battery applications for several market segments.
- ⇨ Bosch recommends a limited transition phase for the market change from Lead-acid batteries to Lithium-ion batteries.
- ⇨ **Bosch recommends continuing the exemption for Lead-acid batteries in new vehicle applications until end of 2025 with a transition-phase of 2-3 years until end of 2027/2028. This means that latest beginning 2029 no newly homologated vehicle shall be launched with a lead-acid battery anymore. Already homologated vehicles with lead-acid battery before 2029 shall be excluded**.

11. Is there any other information which you deem important in the context of the review and which you would like to provide?
n.a.

Please note that answers to these questions can be published in the stakeholder consultation, which is part of the evaluation of this request.
If your answers contain confidential information, please provide a version that can be made public along with a confidential version, in which proprietary information is clearly marked.

Please do not forget to provide your contact details (Name, Organisation, e-mail and phone number) so that the project team can contact you in case there are questions concerning your contribution.