Adaptation to scientific and technical progress of Annex II to Directive 2000/53/EC (ELV) and of the Annex to Directive 2002/95/EC (RoHS)

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Final report

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Although evidence and information supplied during the last Annex II Revision on engine bearings was substantial, this was – and still isn't – the case for transmission and air conditioning compressor bearings.

4.4.5 Final recommendation

Despite this, it is clear that many applications have already gone lead-free and that the remainder is expected to become lead-free by 1 July 2011.

Taking the stakeholders' unanimous request into account, it is therefore recommended not to change the wording of exemption 4b and keep the current expiry date.

4.4.6 References

ACEA et al. 2009	ACEA/JAMA/KAMA/CLEPA/EAA/OEA et al. joint response document "20090804_Global AI_exe 4b.pdf", 2009
Federal Mogul 2009	Federal Mogul independent response document, 30 July 2009.
Mazda 2007	Mazda response document, October 2007.
Stakeholder workshop 2007	Stakeholder workshop response document, 10 October 2007.

4.5 Exemption no. 5

"Lead in Batteries"

The evaluation of exemption 5 under the current contract was based on results of former evaluations. Initial answers have been received from stakeholders[19] in the context of the second stakeholder consultation. Further questions have been sent to stakeholders who have sent input. Answers have since been received and a conference call has been held.

The outcome of this information gathering exercise and of the exchange with the above mentioned stakeholders is reflected in the following.

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[19] Stakeholders include Eurobat/ACEA/JAMA/KAMA/CLEPA/ILA and BDI. Within this chapter "stakeholders" is used as generic term referring to all mentioned organisation if not otherwise specified.

4.5.2 Description of exemption

All of the more than 1 billion vehicles worldwide with a combustion engine contain at least one SLI (starting, lighting, and ignition) automotive battery based on the lead / acid / lead-oxide electrochemical system (EUROBAT 2009a).

The common type of an SLI battery consists of the following components:

- A multitude of lead alloy grids, which keep the active mass in place and conduct the current to the terminals;
- the active mass, a mixture of sponge lead (negative plate) and lead oxide (positive plate) with additives;
- an electrolyte of sulphuric acid, in which all plates are immersed;
- separators made of insulating polyethylene material;
- electrical connections including the terminals;
- the case, normally a heavy duty polypropylene box.

According to stakeholders, the average weight of a European SLI battery is 15–16 kg, with a lead content of about 9–9,5 kg. The average lifetime is 5 to 7 years.

17 177 466 vehicles concerned by the ELV Directive were newly registered in the EU in 2007. The annual amount of lead used in lead-acid batteries for new cars in the EU27 thus is around 160 000 t per year[20]. Considering that the average car uses between 2 and 3 batteries throughout its fifteen year lifetime, the annual use of lead in SLI batteries is about 320 000–480 000 t.

Stakeholder input states that a lead containing SLI battery is environmentally safe during its life cycle, since production is regulated by specific EU legislation such as the Directive on Integrated Pollution Prevention and Control (IPPC). Furthermore, lead acid SLI batteries plants need special environmental permits and lead smelters employ Best Available Techniques (BAT) as defined in IPPC and are well controlled by environmental authorities. Therefore the environmental impact of lead emissions from the production of the batteries is considered to be very small. Also, there are no lead emissions into the environment associated with the lead SLI battery during its use (Global Automotive Industry 2009, EUROBAT et al. 2009, ACEA 2010).

Concerning the end-of-life treatment, stakeholders further state that the collection rate of leaded batteries in ELVs is nearly 100%. Stakeholders explained that all of the lead in batteries is recyclable, with an efficiency of 99,5%. During recycling, much more than 99% of lead particulates emissions are captured and reintroduced into the recycling process. Plant emission standards are strict, not exceeding 1,0 mg/m^3 of flue gases. Produced slag contains

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[20] 2 significant digits.

less than 10% lead in “fairly inert” form, although some processes can reach concentrations of less than 1%.

Stakeholders make clear that secondary lead requires only one third of the energy required to produce primary lead.

Based on the current EC Battery Directive 91/157/EEC and its successor Directive 2006/66/EC, separate collection of spent lead acid batteries is mandatory all over the EU. According to the ELV Directive, the dismantling of lead acid batteries from ELV is also mandatory.

Stakeholders argue that shredding companies operate under strict conditions to ensure that lead and sulphuric acid do not contaminate either the environment or the shredder products. Spent lead acid batteries also have a monetary value, and this acts as an incentive for recycling.

Stakeholders also note that conventional pyrometallurgical recycling is efficient and well-understood and doesn’t have a significant environmental impact. Alternative recycling technologies have been investigated at research level. For example, the CLEANLED project evaluated hydrometallurgical lead recycling as a potentially more environmentally friendly technology. However, as stated by stakeholders, this technology has never been used at larger industrial scale and a full comparison can thus not be made.

Stakeholders request an unlimited extension of exemption 5 with its current wording.

4.5.3 Justification for exemption

Stakeholders provided information (Global Automotive Industry 2009) on the need for the current exemption. Information provided during the previous consultation, although no explicit reference was made to it, was still relevant.

As with all lead-related exemptions, the goal is to, if possible, eliminate lead through the use of alternative technologies or reduce the amount used per application. Another possibility is increasing the lifetime of batteries, resulting in reduced fleet battery renewal and thus less lead use.

Reduction of lead content

In its contribution, stakeholders explained that efforts had been made to increase the lead use efficiency in lead SLI batteries. 10% reduction of battery weight was achieved through developing more efficient structure material and controlled processes. No detailed data was provided to support this claim or illustrate the success rate.

However, with the increasing amount of electric components in the car and additional functions, battery needs to cover more energy demand (more electrical components, Start&Stop

technology). Hence these effects on efficiency gain have not resulted in a reduced battery weight and has even led to an increase in lead use overall. No statistics were provided to support this.

Apart from ongoing lead-use efficiency research, stakeholders states that no reduction of lead-use can occur without affecting the performance of the battery. Therefore, significant lead reduction is not foreseeable or possible according to the stakeholder.

Extended battery life

According to stakeholders, no technology exists to increase the lifespan of batteries. The lifetime of batteries is affected by corrosion of the positive electrode carrier materials, i.e. the grid. Electrodes use a lead-based additive paste used to increase performance. However, every charge cycle affects the adhesion of these pastes which progressively shed. Once shedding of the pastes becomes significant, the battery becomes unusable because its performance is significantly reduced.

Stakeholders claim that only battery design can affect this problem, no chemical additive known can positively influence the shedding process. The stakeholder underlines that the addition of chemicals into batteries is not regulated and can therefore be very harmful to both the battery and the environment.

In short, efforts to increase battery lifespan through better design are ongoing and no chemical additive or other technology is known to positively affect battery life. Nevertheless, it has been observed that lifetime of lead-acid battery has been increased by about 25% over time (based on standardized European test sequences) but no detailed explanation was delivered as regards technical reasons for this effect (EUROBAT et al. 2009). Only, alternator voltage management was mentioned to have further increased the average lifetime of batteries. Moreover, Absorbent Glass Mat (AGM) batteries are lead-based technology used in so-called micro hybrid vehicles which use Start&Stop technology to optimise fuel consumption. AGM were quoted as having twice the cycle lifetime of regular lead-acid batteries (Pers. communication by stakeholders 2009).

Environmental impact

Stakeholders state that along battery life cycle, the environmental impact is kept low by regulations and is strictly monitored by national and environmental health authorities. Moreover, the dismantling of lead acid batteries from ELV is also mandatory.

Stakeholders provided key summary (EUROBAT et al. 2009) from a lead industry study on voluntary risk assessment for lead (VRAL) which included an investigation of industrial emissions from the secondary lead industry. The study was completed in 2007. The risk assessment did not reveal evidence of any significant environmental impacts associated with battery recycling by EU secondary lead producers. The VRAL was subjected to formal EU review and submitted to the European Chemicals Agency in 2008 (Global Automotive Industry 2009).

Regarding the collection and recycling issues, stakeholders claim that the recycling of lead-acid batteries in the EU is already close to a closed loop system, that means, best be estimated as close to 100% (Global Automotive Industry 2009).

Alternative technologies

Alternative technologies include different lead-free battery chemistries such as Ni-Cd (nickel cadmium), Ni-MH (nickel metal hydride) and Li-Ion (lithium ion) batteries. Ni-Cd batteries have been completely banned by the ELV Directive since the 31 December 2008.

Stakeholders firstly point out that onboard automotive electrical systems are designed for an optimal use with lead-acid batteries. Therefore, any significant change in the battery technology may require the redesigning of many components in order to ensure optimal use of the battery. The stakeholder explained that onboard automotive electronics are designed to be able to sustain up to 15 V. A Li-Ion cell has an initial voltage of 3,6 V and a charge voltage of 4,2 V. Therefore, a switch to Li-Ion batteries will cause either an increase of onboard voltage from 12 V to 14,4 V (4 cells), or a decrease from 12 V to 10,8 V (3 cells). So far, the maximum voltage has not been surpassed. However, charging a 14,4 V Li-Ion battery requires 16,8 V, leading to the burn out of the onboard fuses. The 3 cell alternative was said to provide voltage too small to start the engine. A switch to alternative battery systems was therefore claimed to entail very significant redesign costs of onboard electronics. No evidence was provided to support this last claim.

According to stakeholders, the performance of car batteries is measured by their energy density, their power output and their cold cranking ability. The energy density characterises the battery's ability to store energy, while its power output characterises the battery's ability to supply large amounts of energy quickly. The latter is important in order to start the combustion engine. Finally, the cold cranking ability of a battery is its ability to supply high power at low temperatures, typically at or below -30^{o}C. Alternative technologies have higher energy density, higher power output and longer lifespans. However, this is only the case at normal operating temperatures. In cold weather, lead-acid batteries outperform competing technologies. Stakeholders explains that the cold cranking characteristic is the most important from the car maker's perspective since it strongly characterises the reliability of vehicles in cold weather. Because the cold cranking ability of alternative batteries is much smaller than that of lead-acid batteries, the possibility of using alternative battery technologies is ruled out altogether. Data on this was provided during the last consultation as presented in Table 8. Although mention was made of problems with the discharge rate of Ni-MH batteries in the last consultation, this was not repeated during the current consultation.

Table 8 Main characteristics of lead-acid batteries (EUROBAT 2009b)

Parameter	**Lead-acid battery**
Typical weight	15-16 kg
Power density	500 W/kg
	1500 W/l
Energy density	30–35 Wh/kg
	100-110 Wh/l
Self-discharge rate	Low (~3% per month)
Temperature range	-30 to +75°C
Cold cranking	yes
Operational lifetime	5-7 years
Cost	50-150€/kWh 8-10€/kW
Application	Used in combustion engine or hybrid vehicles.

Additionally, stakeholders explain that lead-acid batteries do not require extra electronics to control cell voltages or other aspects of battery operation, to the contrary of alternatives such as Ni-MH or Li-Ion batteries. According to stakeholders, these control systems greatly increase the cost of alternatives. No data was provided to support this.

Absorbent Glass Mat (AGM) batteries are crucial for the technology which permits a reduction in fuel consumption and CO_2 emissions by at least 10% according to stakeholders. Further research in this field may allow even further emission reductions and environmental benefits. The product is still under development and may offer even future chances for improving the environmental compatibility of batteries and vehicles (Global Automotive Industry 2009).

Finally, stakeholders indicate that work is being done on a technology based on lead-acid batteries and materials such as carbon to compete with Ni-MH hybrid vehicle solutions. No further details or data were provided on the topic, especially with respect to the timeline of research & development activities.

Mention is also made of starter systems involving the use of capacitors. The main advantage of this technology is the high power output it provides and its insensibility to cold temperatures. However, the capacitor must be charged before starting the vehicle. Consequently, a capacitor alone cannot be considered as an alternative battery system (EUROBAT 2009b). No data was provided on this technology.

In short, stakeholders believe that no lead-free battery technology is foreseeable at this time. It is currently not known if and when the lead battery can be surely and reliably replaced in vehicles. A roadmap of battery evolution was not possible to provide, but stakeholders said that most efforts were invested in increasing the cycle lifetime of the batteries. Moreover, stakeholders also clarified that a rapid reduction in fuel consumption and in greenhouse gases are key targets of the automotive industry that have priority over lead substitution or reduction in batteries. The lead acid battery industry has developed and invested affordable advanced lead-acid innovations for micro-hybrid vehicles. Such cars are equipped with start/stop systems and recuperation to win back the breaking energy and with intelligently managed alternators (Global Automotive Industry 2009, BDI 2010). Long-term reliable lead battery technology still has a huge development potential (BDI 2010).

Review date

Battery industry stakeholders request a prolongation of the exemption without any kind of review or expiry date. They claim that setting such a date would create (investment) uncertainty into battery technology development which could have adverse economic, technological and environmental impacts. The comments received by battery industry are listed below (Pers. communication by stakeholders 2010):

- Fear of political damage to lead acid battery technology since review date is interpreted by industry as the beginning of a full phase-out or complete ban of lead acid batteries. This has already been experienced in the context of the Battery Directive where Nickel-Cadmium batteries have experienced serious drawbacks starting from the set review date.
- Furthermore, battery industry is reluctant about a review date, because US companies – which are important players in the battery market – could be restrictive with future investments leading to possible negative socio-economic drawbacks on battery technology.
- Technological coexistence of all battery technologies is needed since there is so much technological development ongoing in the field of battery systems that there is currently a transition period / paradigm change which needs to be awaited before shifting to new energy storage technologies.

Stakeholders from car industry agreed to setting a review date but request it to be 8 years in order to cover a full vehicle development cycle that would be needed to redesign and type approve a vehicle with a new lead reduced or lead free battery technology (Pers. communication by stakeholders 2010):

- Today industry doesn’t know into which direction technological battery development is going and some time is welcomed to get a clearer picture. However, the proposed 5 years are considered not long enough since it is considered that 8 years are requested at least to be able to make a fully clear statement on where development is going with regard to battery technology.

4.5.4 Critical review of data and information

Provided information will be analysed in order of presentation.

Reduction of lead content

Although no data was provided to support claims made on lead reduction potential, it is well known that significant reductions in lead content will directly affect the performance and the reliability of batteries. Only more efficient lead use can reduce lead content without affecting performance, but the potential of this option seems rather limited. AGM batteries are an example of more efficient lead use although they are mainly used in micro hybrid vehicles. Furthermore, the introduction of TEGs in vehicles to improve fuel consumption actively may also help reduce the battery size (cf. section “req. 2”).

Extended battery life

Once again, lead-acid technology is several decades old and its inherent problems are well known. Therefore, although large efforts have already been made and the battery’s life has been extended a lot, further extending battery life at this stage is difficult.

Confidential information provided during the last consultation also revealed that AGM batteries had a longer cycle life. However, because they are used in micro hybrid vehicles where they are exposed to much more cycling, it is unclear what the overall effect is.

Environmental impact

Under the strict legal framework and long-term industry application, the environmental impact associated with life cycle of lead-acid batteries can be considered as very low. A study conducted by Fraunhofer Institut on Chemical Technology (ICT) also revealed that collection and recycling systems of lead-containing products in the EU function well. Germany has 96% recycling rate of lead-acid SLI battery, while the EU has about 95% in 2004 (Hirth et al. 2007). It was also concluded that Improvement in the end-of-life phase of lead-acid battery is not necessary. Nevertheless, there are some recommendations given with regard to the lead battery production, e.g. optimising the corrosion of electrode carrier materials (Hirth et al. 2007).

Alternative technologies

To avoid misunderstandings, it must be clarified that the substitution of lead in lead-acid batteries is not possible. The avoidance of lead would result in an alternative battery system.

The stakeholders provided evidence supporting their main technical arguments on the advantages of lead-acid batteries, mainly their reliability in cold weather, over their main alternatives: Ni-MH and Li-Ion batteries. However, when considering potential systems using alternative batteries, stakeholders explained that a 30% battery capacity increase would be necessary to overcome their reduced CCA. This seems to indicate that it is possible to overcome this limiting factor, although other technical issues may prevent a switch and these alternatives are likely to remain less reliable than lead-acid batteries.

A brief mention was made by stakeholders of capacitor use in starting systems. This option was quickly discarded given that it cannot function independently from a battery. However, it seems that this technology has more potential than the stakeholder originally acknowledged.

The stakeholder was actually making reference to supercapacitors, also known as electric double-layer capacitors. These capacitors have far superior power density than electrochemical batteries, even in cold operating conditions. The only apparent disadvantage of such supercapacitors is their high self-discharge rate (20 times higher than a typical battery, i.e. about 5% per day) and low energy density, making them unsuitable to entirely replace a usual battery system, as stated by stakeholders.

Coupled to a lead-free battery or smaller lead-acid battery however, this device could be a suitable alternative to current lead SLI batteries. Such a system is currently increasingly being used by the Denver Regional Transportation District (RTD) in its buses.

According to a quick investigation (Ha 2009) conducted by the contractor with the Denver RTD, a supercapacitor is simply connected in parallel to the battery in the starter circuitry. Once it is fully recharged by a regular alternator it is disconnected from the circuit until the next engine start. Previously, batteries were estimated to need about an hour to recharge, while supercapacitors require 30–60 seconds. Simultaneously, RTD has switched from regular lead-acid batteries to maintenance-free batteries.

Initial results from their five-year experience reveal that battery lifespan has doubled, battery use is reported to be two thirds lower and starting-related breakdowns are one fifth as frequent as those in buses not equipped with supercapacitors, making the system very reliable. Furthermore, the system has proven to be very low maintenance, no replacements or repairs of supercapacitors having taken place since the first devices were installed. During starting, the supercapacitor provides two to three times more current than regular batteries. No problems with the discharge rate have been reported, although buses are at most out of service for three consecutive days.

RTD Denver also confirmed that it seemed reasonable to believe that a supercapacitor coupled with a lead-free battery running near 12 V could replace the traditional lead-acid battery used. At the very least, a down-sized battery could be used, although they have not tried this approach yet.

The US National Renewable Energy Laboratory (NREL) also confirms that this type of system can extend battery life and result in the use of a downsized lead-acid battery.

When confronted with this, stakeholders indicated that this solution remained unsuitable due to packaging, safety and volume restrictions. Further investigation on the contractor's behalf into supercapacitors used by RTD Denver from supplier KBi has confirmed packaging constraints, but no safety or volume restrictions. Operational temperatures of KBi products are the cause of the packaging constraints, being between -50°C and 50°C, while storage temperatures are between -60°C and 70°C. The operational upper limit is incompatible with motor block temperatures. According to industry stakeholders, the device would thus have to be installed elsewhere in the vehicle.

As far as safety is concerned, stakeholders claimed that the solvent used posed safety hazards. KBi uses a potassium hydroxide solution that is considered non-flammable and low hazardous (Ha 2009).

RTD Denver uses a 35 kW system running at 24 V, storing up to 120 kJ in the bus. This unit weighs 26 kg and has a volume of 17 L (35x20x25 cm), i.e. about twice the size of a typical car battery, assuming a volume of 9,0 L. A smaller device from KBi offers 8,8 kW at 12 V, storing up to 30 kJ in about 4,8 kg and 2,7 L (27x6,3x16 cm). During a single car start, a typical lead-acid SLI battery will never supply more than 850 A at 12 V (voltage typically drops during engine start, the specified minimum is 7,2 V) for up to 10 seconds (difficult start due to cold weather for example or poor engine condition). It therefore has a maximum power rating of 10 kW and stores up to 300 kJ, allowing for up to three ten-second starts. The previously mentioned small supercapacitor sold by KBi would therefore – at least according to the contractor’s theoretical analysis – be able to start an average engine during a typical three-second start (Table 9). Its 2,7 L and 4,8 kg would not impose large weight or volume burdens, although the indicated volume does not include packaging or other possibly necessary devices. A doubling of the volume, a likely worse case scenario, reaching 5,4 L, remains smaller than a car battery.

Table 9 Overview on the maximum power and maximum starting time

Two battery systems	Maximum power	Maximum starting time
Lead-acid battery	10 kW	10 seconds
Supercapacitor (KBi Part Number 700000 as reference)	8,8 kW	3,4 seconds

However, as mentioned before, the energy density of a supercapacitor is very low thus being the main hindrance from the technical point of view. The technical properties together with other possible alternatives are summarised in Table 10. It shows that the supercapacitor alone has very low energy storing capability: it cannot store enough energy to operate the normal electrical bordnet. Nevertheless, a supercapacitor coupled with a battery system could solve this problem. To get a rough feeling about the possible combination, a hypothetical calculation is carried out. In order to reach the same energy density equivalent to a lead-acid battery, option 1 (supercapacitor coupled with 4 kg Li-Ion) and option 2 (supercapacitor coupled with 10 kg Lead-acid) are possible. It should be pointed out that the calculation is theoretical and with the only consideration of energy storing capability.

To avoid misunderstandings, the example here does not declare that a supercapacitor coupled with a battery system can substitute the lead-acid battery used in a passenger car. It is clear that buses and cars do not have equivalent operating conditions and that their battery systems can thus not be compared. Nevertheless, the example shows on a fact-base that at least the supercapacitor technology can function under cold condition and overwhelm the CCA problem which was mentioned as the most important factor from the car maker's perspective. However, until now no evidence showed that this technology either functions or does not function in cars. From reviewers' point of view, it is nonetheless at least a hint on a possibility worth to be investigated.

Table 10 Comparison of alternative battery technologies

	Lead-Acid	**NiMH**	**Li-Ion**	**Supercapacitor (reference KBi Nr 700000)**	**Supercapacitor (reference KBi Nr 700000) + battery**
Typical weight	15-16 kg	8-9,8 kg	4,9-6,9 kg	4,8 kg	Option 1: Supercaps+Li-Ion: 4,8 kg+4 kg Option 2: Supercaps+LdA: 4,8 kg+10 kg
Power density	500 W/kg	1000 W/kg	1500-2000 W/kg	1833 W/kg	
	1500 W/l	2600 W/l	1500-2000 W/l	3239 W/l	
Energy density	45-50 Wh/kg	60 Wh/kg	100-120 Wh/kg	1,7 Wh/kg	In order to reach the energy density equivalence of LdA, an extra battery providing 479 Wh is required. It might be 4kg Li-ion or 10kg Lead-acid
	100-110 Wh/l	170 Wh/l	120-150 Wh/l	3,1 Wh/l	

Stakeholders also made a quick mention of batteries based on lead-acid technology and added carbon to compete with Ni-MH batteries but provided no further details on the subject. A personal investigation (Dickinson 2009) revealed that a new battery produced by Axion Battery Products called the PbC® battery[21], although not exactly what the industry stakeholders implies, is a promising technology. This hybrid lead-acid battery integrates a supercapacitor into the battery used instead of the traditional lead-containing negative electrode. Axion claims the system reduces lead content by 65%, battery weight by 20% as well as recharging time, while increasing power output and the lifespan of the battery. A reduced energy density however is to be noted (the energy density is lowered to about half that of a traditional lead-acid battery). Additionally, these batteries can be easily produced in existing plants and can also be recycled in existing facilities.

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[21] A similar product is called UltraBattery™ and developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO)

These batteries are currently aimed at the micro hybrid market where AGM batteries currently used experience increased recharging times when repeatedly charged and discharged in a congested traffic situation. The PbC® battery does not experience this issue. The battery is expected to be marketed very soon but some aspects are still being developed. It can therefore not be considered as an immediate substitute to traditional lead-acid batteries.

Stakeholders' response was that the reduced energy density outweighed the reduced lead content. As of yet, this remains to be proven, as even with half the energy density, a PbC® battery with unchanged energy storage would still contain 30% less lead than a regular battery, although device weight would be 60% higher (i.e. 9,0–9,6 additional kilograms).

PbC® manufacturer Axion Power Limited responded that solutions were with one battery, despite the increased battery load during idling in a microhybrid vehicle. Axion Power was expected to send more information on the subject but did not deliver it in due time before final drafting of this recommendation.

Stakeholders' arguments about costs of possible alternatives and standards are not relevant to the rationale of the ELV Directive. The ELV Directive does not give grounds for a lead-use exemption to be based on economic arguments but on basis of the unavoidability of the use of lead.

In the current state of the revision procedure, it seems that the use of lead-acid batteries containing 9–9,5 kg of lead could be avoidable since supercapacitors, hybrid batteries and alternatives are expected to be developed in several years.

Supercapacitors coupled with a lead-acid or even lead-free battery has not yet been investigated or researched much. It can thus be concluded that a huge improvement potential seems to exist for alternative technologies that remains to be explored. Or at least, stakeholders will in future need to prove on a fact and evidence basis that the use of such an alternative is not possible.

A short screening of the main to be solved technical difficulties or limitation factors is listed in Table 11.

Table 11 Main difficulties remaining from possible alternatives

Possible alternative	Crucial technical problems	Possible solutions	Limitation
Li-Ion	CCA ability is not reliable	-	
PbC	Has sufficient power output, but not sufficient energy content.	In order to reach the sufficient energy output, 100% increase of weight is required.	Some questions with regard to long term stability and lifetime under real vehicle conditions are still not fully clarified.
Supercapacitor alone	No CCA problem has sufficient power output, but insufficient energy output.	Supercapacitor coupled with a battery system	Unknown, research and investigation required

Review date

To avoid misunderstandings, it should be stressed that the proposed 5 year review date in the below recommendation does not fix a total ban date and is not intended either to be the beginning of a full phase-out. It is too early to draw a conclusion on further technological vehicle battery development- be it lead-free or led reduced. Several battery technologies relevant research projects funded by EU FP7 have been and are carried out (Research Project). The intention of a review date is to obtain sound evidence for re-evaluating the exemption in light of currently ongoing and promising technologies. The assessment procedure will still be done under the provisions of the ELV Directive (2000/53/EC). That means, a termination of an exemption can only be recommended under the condition that the substitution of this substance is scientifically or technically possible without negative environmental, health and/or consumer safety impacts. As long as this is not possible, no total ban or full phase-out will be initiated.

In addition, a 5 year review period is already a quite long compared to the usual expiry, review or phase-out timelines. 5 years are considered a good period to i) gather the missing facts & figures for sound evidence and ii) give better information on the status quo of technological battery development (even if not completed). Research projects will be finalised by then. For R&D 5 years is a quite significant amount of time to make more concrete statements.

An earlier review date would not make much sense since technological development would not be as advanced as necessary for a better assessment of the further need for an exemption.

Conclusion

In a nutshell, there is no doubt that lead-acid batteries as a long-term marketed technology perform their reliability in the area of safety and control. Nevertheless, there is also no doubt that battery technology has still a huge improved potential from the point of view of a lead reduction through the use of alternative technologies. Further in-depth investigation and research on the use of such alternatives in the automotive industry is needed and should be promoted.

Therefore, carrying out a life cycle assessment being a robust scientific method could contribute to identifying the environmental impacts associated with the possible alternatives compared to the use of lead-acid batteries with a holistic approach.

4.5.5 Final recommendation

It is recommended to continue the exemption. The stakeholder presented plausible information showing the current technical superiority of lead-acid batteries. Their short-term substitution by lead-free alternatives would reduce the functionality and reliability of vehicles, the use of lead in this function hence is unavoidable at the time being and in the near future. At least in the industrialized countries, a proper collection and recycling system enabling a high collection and recycling rate of lead from these batteries is in place.

A roadmap or strategy of industry to replace lead-acid batteries in this function was unfortunately not provided and should be requested in the context of future evaluations. Moreover, by means of screening the feasibility of alternative technologies, it appears that there are some promising technologies which should thus be investigated more deeply in the near future.

It is therefore recommended to set a review date of this exemption 5 years after its entry into force aiming at the verification of corresponding research & development efforts into alternative battery technologies for fuel combustion vehicles.

4.5.6 References

ACEA 2010	ACEA position paper and letter to European Commissioner Mr K.F. Falkenberg (provided on 31. 03. 2010 via e-mail)
BDI 2010	BDI-Position paper “Innovative Antriebstechnologien, Elektromobilität und alternative Kraftstoffe für unsere Mobilität von morgen” – finale Version vom 01.02.2010 (provided by Mr. Eckhard Fahlbusch on 31.03.2010 via e-mail)
Dickinson 2009	Personal communication with Mr. Enders Dickinson from Axion Power Applications Ltd. on 17.10.2009
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EUROBAT 2009b	EUROBAT stakeholder document "Eurobat ELV SLI position paper – January 2008.pdf", submitted to Otmar Deubzer via e-mail on 11 January 2008
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Pers. communication by stakeholders 2009	Conference call with stakeholders on 16.12.2009
Pers. communication by stakeholders 2010	Conference call with stakeholders on 31.03.2010
Research Project	Actual EU projects for batteries in FP7 and information from website (provided by Mr. H.F. Schenk on 30.03.2010 via e-mail)

4.6 Exemption no. 6

"Vibration dampers"

The evaluation of exemption 6 under the current contract was based on the contributions received during the current consultation and on previous studies (Sander et al. 2000; Lohse et al. 2001; Lohse et al. 2008). Insufficient information was received during the previous Annex II revision in order to assess the situation and provide a well founded recommendation. Initial statements have been received from stakeholders in the context of the second stakeholder consultation (ACEA et al. 2009a). Further questions have been sent and stakeholders from ACEA/JAMA/KAMA/CLEPA provided a common response (ACEA et al. 2009c).

The outcome of this information gathering exercise and of the exchange with the above mentioned stakeholders is reflected in the following.