9th Adaptation to scientific and technical progress of Exemptions 8(e), 8(f)(b), 8(g), 8(j) and 14 of Annex II to Directive 2000/53/EC (ELV), Stakeholder Consultation Questionnaire

Application for continuation of Annex II ELV directive Exemption No. 8(f)(b)
"Lead in compliant pin connector systems other than the mating area of vehicle harness connectors"

With this application the automotive industry, represented by their associations ACEA, JAMA, KAMA, CLEPA et alt. asks to extend above mentioned exemption with commitment to further developing Lead-free alternatives and for a further revision in 2024.

In this section we take reference to the questionnaire[i] from OEKO Institute published on 29th May 2018.

Questions (Answers in blue color)

1. Please explain whether the use of lead in the application addressed under Exemption 8(f)(b) of the ELV Directive 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.

   All answers in this document refer to all types of vehicles, as compliant pin connectors are applied broadly, there is no major difference related electronic equipment.

   In summary, Lead-containing coating of press fits is still unavoidable due to safety and reliability reasons in some cases. Overall the amount of Pb used by this exemption is very limited and we want to point out that since 2009 a significant reduction of Pb has already been achieved, despite an increase of electrification and vehicles put on the EU market:

   2009: estimated 0,8 t Pb put on the EU market
   2018: estimated 0,15 t Pb put on the EU market

   Assumption is based on calculation in section 4 and verified by various vehicle manufacturers (for details see section 4).

   For the technical details related to the above mentioned exemption, we refer to the previous input from ACEA, JAMA, KAMA et al and the report of the Oeko Institut (see attachment 1 & 2).

   Requirements in automotive industry are not comparable with EEE applications covered by RoHS (2011/65/EU), e.g. consumer electronics. Automotive applications have additional requirements for temperature, vibration, durability and safety aspects.
   Due to safety critical and high reliability specifications reasons, different handling compared to RoHS still is required.
   Additional details can be found in the previous input of ACEA, JAMA, KAMA et al and the report of Oeko Institut (see attachment 1 & 2).

In addition, we want to point out that any kind of press fit applications are more material efficient than soldering. Small and medium sized companies might need more time to adopt and realize change.

For end-of-life vehicles a clearly defined take back and recycling route is established in EU. Exposition coming from Pb in this application therefore is unlikely due the additional fact that the contained Lead is part of the base metal of the pin, and is part of the metal recycling process.

We´d like to point out that the application of Indium and Bismuth as a substitute for Lead may interfere with the EU Report on Critical Raw Materials and the Circular Economy[ii]

2. 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.

Compliant Pin Connector Systems (CoPiCS) are widely used in automotive applications, with a large variance in the numbers of pins used. The CoPiCS are pre-coated for technical reasons in joining technology with thin layers.

In the past years intensive research has been done related to geometry, thickness and alternative surface materials and alternative technologies. Industry research as well has thoroughly investigated the mechanisms of whisker formation and growth and there is now a high level of scientific based knowledge and understanding on the issue.
However, due to the quantity and complexity of influencing factors, in practice unexpected whisker growth is still observed at times and cannot be fully eliminated. In the past this has impacted safety relevant applications.
Whisker growth elimination/reduction is a target of the new pin plating technologies in development. However, for high reliability and safety critical automotive applications, CoPiCS pins containing Lead are still required, as a fallback solution.

In addition to Tin (Sn), Tin Silver (SnAg) and Tin Lead (SnPb) surface finishes, Indium (In) and Bismuth (Bi) finishes are under development and approval (for details see section 3 & 4). These systems are demonstrating good results to date, however they are not yet completely verified, means usable for all applications.

As a result promising new technologies have been developed and are being tested and validated for a use in new application and series production (for details see section 3 & 4).

3. 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.

In the past few years some major applications have been achieved with Lead-free plating alternatives for CoPiCS and successfully implemented. The implementation of those Lead-free alternatives has been actively driven and new production capacities are being build up.

To describe the roadmap three steps have been considered, showing the efforts made on implementing alternative solutions. This includes an assumption on timeline.
The three steps are: design and product validation, long-term reliability tests and ramp-up production of Lead-free plated CoPiCS. They are described in detail as follows, considering all available technologies.

Step 1: Design and product validation

- Status for Sn:
  - Available on market as of 2003
- Status for SnAg:
  - Start of production (SOP) 2013
  - Available on market as of 2013, multiple sources in evaluation
- Status for In:
  - SOP 2018
  - Available on market as of 2016
- Status for Bi:
  - SOP 2019
  - Available on market as of 2018

Step 2: Long-term reliability tests

- Status for Sn
  - Field experience for specific products e.g. Airbag-ECU's
  - Multiple pin families
  - CuSn6, CuNiSi Basematerial
  - iSn[iii],iAg[iv] and OSP[v] PCB[vi] plating technology
  - Several plating lines and production Design of Experiment series (DoE)
  - Sn is not IP protected, free to use by everyone
- Status for SnAg
  - Field experience for specific products e.g. Airbag-ECU's
  - Laboratory scale long time experience since 2011
  - Long time field experience since 2014
  - Multiple pin families
  - CuSn6, CuNiSi Basematerial
  - iSn, iAg and OSP PCB plating technology
  - Several plating lines at different suppliers
  - Several SnAg solutions are available, partly IP protected

- Status for In
  - Limited field experience (starting 2018) on Body Electronics
  - Product validations on different product families (e.g. Body controller, Airbag ECUs)
  - Laboratory scale long time experience since 2011
  - Multiple pin families tested, 2 different CoPiCs in production
  - iSn and OSP PCB plating technologies tested, iSn in series production on first product
  - High temperature long time reliability tested
  - 2 plating lines at 1 location
  - In is not IP protected
- status for Bi
  - No field experience
  - Product validations on different product families ongoing
  - Laboratory scale long time experience since 2013
  - Multiple pin families tested
  - iSn, iAg and OSP PCB plating technologies tested
  - High temperature long time reliability tested
  - 2 plating lines at 1 location available, extension planned
  - Bi is not IP protected

Step 3: Ramp-up production of Lead-free CoPiCS:

In general:

- Must be considered and feasible for production in all regions, as supply chain is globally located
- Industry is committed to use Pb free solutions for new developments, nevertheless SnPb is still required as fallback due to whisker risk for existing legacy components
- Therefore, another review date for exemption 8(f)(b) in 2024 is suggested, to allow a transition time with commitment to further develop Lead-free alternatives
  - Field and global production experience for newly developed alternatives is still missing
  - For migration from one to another technology
  - For new vehicle type approvals
  - Carry-over parts need to be allowed to use layers as specified when approved

Sn: no issue

SnAg:

- Available in Germany on several production lines at various suppliers
- There are 3 different plating technologies in production
- Roll out plan for Asia and NAFTA as of 2020
- Overall capacity exceeds volume of current SnPb press-fit plating

In:

- Available in Germany at one location
- Roll out plan for Europe (2018 ff), Asia (2019ff) and NAFTA (2020ff)
- Roll out plan for multiple product groups (2019 - 2021)
- long term manufacturing and field experience is required to complete implementation

Bi:

- Available in Germany
- Roll out plan for Asia and NAFTA as of 2020

4. What is the amount of lead that will be contained in the applications in the scope of this exemption in vehicles … in case the exemption remains valid? Please provide a substantiated estimate clarifying how you have arrived at the stated result.

   a. Vehicles placed on the EU market and

Please find below an estimation of Lead used by exemption "Lead in compliant pin connector systems other than the mating area of vehicle harness connectors" 8(f)(b), for EU28 + EFTA in 2017.

Value	**Unit**	**Description**
3.2	mm	Circumference of pin
7.0	mm	Length of surface
0.8	µm	Thickness of layer
7%	Pb portion of layer	
0.0012544	mm^3	Volume of Pb per pin
0.011342	g/mm^3	Specific mass density of Pb
14.2274	µg	Weight of Pb per pin
7 – 10 – 16 Average: 10 *(2013: 14,2274)*	mg Pb/vehicle	Weight of Pb per vehicle Calculation, assuming all pins contain Pb, typical amounts: 1.600 (simple electronic equipped) – 2.200 (medium electronic equipped) – 3.500 (high electronic equipped) pins per wire harness in average (means per vehicle), thereof 90% contacts for ECU, thereof 70% press fit technology thereof max 50 % with leaded pins Multiplied with weight of Pb per pin (for details see table 2)
15.659.624 *(2013: 12.340.000[vii])*	vehicle	New vehicles in European Union 2017[viii]
0,15 *(2013: 0,19)*	**t**	Pb

Table 1: overall calculation (exemption 8(f)(b))

	Vehicle Type		
	simple electronic equipped	Medium electronic equipped	high electronic equipped
pins per wire harness of a vehicle	1.600	2.200	3.500
thereof 90% contacts for ECUs, thereof 70% press fit technology	1008	1386	2205
thereof max. 50 % leaded pins: Max. Pb in mg / vehicle	7,2	9,8	15,7
Average market share	50%	30%	20%
Average Pb in vehicles on market in mg	10		

Table 2: calculation related electronic equipment (exemption 8(f)(b))

The calculation is based on parameters as listed in table 1 and 2 and has been cross-checked by OEM feedback.

b. worldwide

ACEA, JAMA, KAMA, CLEPA et al. can provide assumptions on Lead used in vehicles put on the EU28 + EFTA market.

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

Due to given arguments in chapter 1 – 4:

- Some major applications with Lead-free alternatives have been successfully implemented
- The implementation of Lead-free alternatives has been actively driven and new production capacities are being build up.
- Whisker growth elimination/reduction is a target of the new pin plating technologies in development. However, for high reliability and safety critical automotive applications, CoPiCS pins containing Lead are still essentially required, as a fallback solution.

ACEA, JAMA, KAMA, CLEPA et al. ask to extend the exemption 8(f)(b) with commitment to further develop Lead-free alternatives and for a further revision in 2024.

[i] http://elv.exemptions.oeko.info/index.php?id=64

[ii] https://ec.europa.eu/commission/publications/report-critical-raw-materials-and-circular-economy_en

[iii] iSn: immersion tin

[iv] iAg: immersion silver

[v] OSP: organic surface protection

[vi] PCB: Printed Circuit Board

[vii] 2013 input of ACEA, JAMA, KAMA et al

[viii] http://www.oica.net/category/sales-statistics/