QuestionnaireExemption Request No. 7

"Lead used in pin connector systems used at temperatures below -20 °C requiring non-magnetic connectors"

Background

The Öko-Institut together with Fraunhofer IZM has been appointed for the technical assistance in reviewing the requests for exemptions from the requirements of the RoHS Directive 2011/85/EU (RoHS II) by the European Commission. You have submitted the above mentioned request for exemption which has been subject to a first completeness and understandability check.

As a result we have identified that there is some information missing and a few questions to clarify before we can proceed with the online consultation on your request. Therefore we kindly ask you to reformulate your request taking the following points into consideration.

Questions

1. You calculate around 100 g of lead used for the requested exemption in Europe. Please substantiate this calculation:
   a) How much lead per connector? Total pin area approx 200 mm^2 (depends on gender, worst case), covered by 10 µm 90 Sn-10 Pb (conservative estimate) -> 2 mm^2 of Sn90Pb10 -> 1.5 mg of Pb
   b) How many connectors per MEG? Approximately 1000
   c) How many of such devices are sold annually worldwide and in the EU? Current level 10, about half within EU
   d) How much lead would be used in this exemption in equipment put on the market in Europe and worldwide? 15 g, about half within EU and 15g in the rest of the world.
2. You state that the connectors would be cooled down to 4 K. In your request you ask an exemption for connectors used at temperatures below – 20 °C (253 K). Why can the exemption not be limited to connectors operated at 4 K and lower? Current technology utilizes low-Tc superconductors which are immersed in liquid Helium bath. Inside the cryostat several connectors are needed, part of which are not in liquid Helium bath but in (cold) helium gas phase. As the temperature rises gradually from 4.2 K to room temperature at the access opening on top of the cryostat, the temperature range must cover the whole range where tin pest could occur.

3. Why can the connector not be placed more distant from the detector in a warmer zone using, for example, cables? Connectors at low temperature are needed for modularity of structure. This is a must for various reasons:
    - The conductive path from the sensor to room temperature is made of dissimilar materials. For example the portion from RT to liquid Helium bath is made of a high-resistive alloy to reduce thermal conductance along the wires according to Wiedemann-Franz's law to reduce liquid Helium boil-off. Such high-resistive materials cannot, however be used at parts nearest the sensors because of noise issues.
    - Certain electronic components are needed at low temperature end, mounted on printed circuit boards. However, because of noise reasons these components cannot be mounted directly on the sensors themselves.
    - The wiring from a whole-head MEG sensor array to room temperature incorporates about 2000 distinct wires (length about 1 m). Having all wiring fixed from sensors to room temperature without any connectors is totally impractical for a field-serviceable unit. As the sensors must to be replaceable for service operations (e.g. if a sensor does not meet noise specification), modularity and low-temperature connectors are unavoidable.
4. On page 4 (lower end) you state that an investigation (N.D.Burns,"A tin pest failure") found that 5% lead addition was effective at preventing tin pest, but 0.5% bismuth or antimony were less effective. It may be natural that 5 % of lead addition have less effect than 0.5 % addition of bismuth. Can higher additions of bismuth solve the problem more effective? Tin alloy electroplated coatings with higher bismuth content can be produced. However, research at the Open University (see table 1 of request dossier) has shown that tin pest occurs significantly more rapidly with tin/zinc alloys having 3% bismuth (SnZn3Bi solder was used) than occurs with eutectic SnPb solder. The fact that bismuth is less effective than lead means that the lifetime of coatings at very low temperature made with lead-free alloys is uncertain but <u>will</u> be shorter than with SnPb. Further research is needed to determine if the lifetime is sufficiently long for the safe use of medical devices and this exemption is needed until this work is completed. It is not possible to accelerate tin pest because it does not occur at >13°C and so this work will take many years. No research has been carried out at low temperatures with tin having 5% bismuth and so it is not possible to know if this will have a greater resistance to tin pest than the few SnBi alloys that have been tested.

5. You claim that "Extraction and refining of lead from its ores is well controlled in most countries so that lead pollution does not occur." Around 50 % of the world lead mining happens in developing and emerging market countries like Bolivia, China, Peru, South Africa. "[…]Tianying, a lead mining and processing center [in China, addition Otmar

Deubzer] —made the top 10 on a list of the world's most polluted cities by the Blacksmith Institute." (http://factsanddetails.com/china.php?itemid=394&catid=10&subcatid=66)

"The scientific investigations have shown the lake waters to have concentrations in heavy metals –like cadmium, lead, mercury, antimony, nickel, cobalt, chromium, zinc, copper and arsenic– far in excess of standard limits for drinking water. The team's biologists also revealed high levels of contamination in fish, particularly cadmium and sometimes lead, in Lake Poopó. (The impact of mining in Bolivia, http://en.ird.fr/layout/set/popup/content/view/full/19413);

Please provide evidence for your claim that extraction and refining of lead are well controlled. We are referring to countries in the EU where industry must comply with the Industrial Emissions Directive. This imposes limits on emissions of hazardous substances fro lead extraction, refining and recycling installations. We agree that these strict controls are not imposed in some developing countries so that harmful emissions do occur. However this is a problem with mining of many metals so that harmful emissions will also occur when mining and extracting the potential substitutes. Some of the potential substitutes; silver and bismuth are often mined as by-products from lead mining and so switching to lead-free would not affect this problem.

You mention the US EPA LCA study on lead-free solders claiming that "extensive life cycle analysis comparing tin/lead with lead-free alloys […] shows that alloys containing silver have much larger environmental impacts than tin/lead in the production phase." The authors of this study " Note that comparisons should only be made within not across impact categories."

Please show how the mining and refining of silver for lead-free solders has an overall environmental impact which is higher than from lead-mining and refining. Please take into account the authors remark not to compare across impact categories. EPA does not compare across impact categories because weightings for these are not known although there has been research since the EPA study into this. The US EPA study gives comparative data across each impact category and overall SnPb had the largest impact scores for six categories whereas SAC had the largest impact scores for 10 categories. The environmental impact scores for energy use for the paste solders are:

Alloy	**10^4 MJ energy / 1000 cc solder**
SnPb	1.25
SAC (Sn3.9Ag0.6Cu)	1.36
SABC (Sn2.5Ag1Bi0.5Cu)	1.31

The US EPA study showed that SAC solder paste reflow consumes slightly more energy than all of the other solders and the main reason is energy for extraction and refining of silver and the higher melting temperature than SnPb.

Extraction and refining of silver creates significantly more waste than lead and so SAC and SABC have significantly larger environmental impacts

Alloy	**dm^3 waste created / 1000 cc solder**
SnPb	2.75
SAC	16.2
SABC	11.3

The US EPA study showed that SnPb solder had a greater impact score than SAC and SABC for occupational health and public health – non cancer but SAC had the largest public health-cancer impact score so the results are complex and difficult to compare.

6. You put forward that "Recycling of electrical scrap at end of life can be carried out safely using modern safe processes that are available in the EU and elsewhere."

   a) Please explain the EoL stages and treatments of MEG equipment.

      MEG is a medical device that would be treated in the same way as any other type of large-size medical equipment at end of life. As MEG are very large, they would be collected and transferred to a recycling facility by a professional recycler. The methods used in the EU to comply with the WEEE directive which for all types of WEEE should be to dismantle, separate printed circuit boards (PCBs), etc and metals, plastics and PCBs are recycled separately using traditional recycling methods. The dismantler/ recycler would probably treat the pin connectors as small PCBs which are usually smelted in the EU which recovers lead with a high yield (because emission limits are very strict as these processes are in scope of the Industrial Emissions Directive) but as no MEG has yet reached end of life, it is not yet known what recyclers practices will be.

   b) Please provide evidence that the connectors containing lead do not only undergo recycling processes, but that the lead is actually recycled in these processes and to which degree (in percentages). MEG are relatively new devices so none have yet reached end of life. The connectors will probably be recycled with the PCBs and in the EU, this is using smelting processes[1].

c) You say that there is a risk that unsafe methods using very hazardous chemicals such as nitric acid and cyanide might be used in developing countries where unsafe recycling occurs" for the recycling of gold and silver. What would happen to the lead in the MEG devices in developing countries?

   It is not known what would occur to an MEG if it were to reach end of life in a developing country as none have reached end of life yet. It is likely that they would be treated in the same way as any other large-size WEEE. Being very large, it is very difficult to transport to small villages in remote locations so it is more likely to be dismantled and recycled by more professional large-scale recyclers who will have access to safer processes. Nitric acid and cyanide extraction processes are used primarily to recover precious metals and so are not likely to be used with SnPb plated connectors but they are likely to be used with gold plated connectors. Lead is not intentionally recovered by "backyard" recyclers who would discard it with other unwanted materials. This is not desirable but as no MEG is likely to reach end of life in developing countries for many years, there would be sufficient time for the EU to stop the export of hazardous waste to developing countries and for the governments of these countries to stop dangerous processes being used.

7. We would propose a slightly different wording for the exemption: Lead used in non-magnetic pin connector systems used at temperatures below -20°C. Please let us know whether you agree with this modified wording. We think this is OK.

[1] This paper describes a typical PCB recycling process http://www.eco-cell.com/wp/wp-content/resources/EMC-2005-Umicore-WEEE.pdf