

# Questionnaire 4 for Exemption 2 of RoHS Annex IV

## Acronyms and Definitions

### 1. Background

Bio Innovation Service, UNITAR and Fraunhofer IZM have been appointed<sup>1</sup> by the European Commission through for the evaluation of applications for the review of requests for new exemptions and the renewal of exemptions currently listed in Annexes III and IV of the RoHS Directive 2011/65/EU.

You submitted information to substantiate your request for the renewal of the above-mentioned exemption. This information was reviewed and as a result, we ask you to kindly answer the below questions for further clarification of your request until 14 August.

### 2. Questions

- 1) You pointed out that X-ray tubes with liquid metal bearings use more lead for internal lead shielding and give the below example:

- Rotating anode tube example with lead bearings: 5.4 kg of lead shielding
- Rotating anode tube with liquid metal bearings: 8.3 kg of lead shielding

You explained that X-ray tubes with liquid metal bearings are generally larger with larger surfaces to be shielded with lead.

In this context, we have a further question for our better understanding of the situation. To make our line of thought clear, we would like to differentiate between the X-ray tube and the entire X-ray device. We understand that X-ray devices operating with liquid metal bearings are larger due to the reasons you already explained.

The X-ray tube (the pure tube, not the X-ray device) generates the X-rays. We assume that it is the surface of this X-ray tube that needs to be shielded with lead to protect the rest of the X-ray device and human beings from unwanted exposition to X-rays.

We wonder why the X-ray tube should be larger in an X-ray device with liquid metal bearings but otherwise identical performance (generating the same frequency/intensity of X-rays) like an X-ray device operated with lead bearings.

Could you please kindly help our correct understanding of the situation?

The choice of bearing type depends on the amount of waste heat generated by X-ray generation. Liquid metal bearings are able to conduct away more heat than solid bearings so are needed for X-ray tubes that generate higher X-ray energy than tubes than is possible for use of solid bearings. X-rays tubes use liquid metal bearings because they generate more X-ray energy (and associated waste heat) than the types of X-ray tubes that are able to use solid metal bearings. The two illustrative examples given in our exemption renewal request that you have reproduced here do not generate the same X-

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<sup>1</sup> It is implemented through the specific contract 070201/2020/832829/ENV.B.3 under the Framework contract ENV.B.3/FRA/2019/0017

ray intensity, we included these only to illustrate a typical difference (in lead shielding quantity) between these two types of X-ray tube bearings.

To generate the same physical function (e.g., friction loss, rotation dynamics, axial stabilities, ...) liquid metal bearings will always be larger than conventional small ball bearing design, even if they would be used X-ray tube constructions that generate less waste heat. Continuous anode rotation must be ensured with e.g., present hydrodynamics, by mechanical construction of liquid metal bearings enlarging these bearings compared to ball bearing structures.

Larger size bearings will always require more lead shielding than smaller-size bearings.

- 2) In the previous questionnaire you mention a research project for silver bearings, and that from the experiences of this project it is clear that a substantial amount of development work is still required. Could you please let us know what these experiences are and what next development steps would be?

Research is on-going, with technical challenges still being discovered and effort expended to try to overcome them. During the course of the project a stick slip effect was observed at increased temperatures, which would have a significant impact on its technical performance, as well as the bearing lifetime. Work will be undertaken to try to resolve this by considering aspects such as the bearing gap and coating thickness.

Although research is still on-going to investigate silver bearings, there is still concern that not all of its technical challenges will be able to be overcome, noise generation is of particular concern due to the reasons outlined in the exemption request. As such, silver coated bearings may not be able to offer an alternative solution to lead coated bearings for medical imaging applications.

**Please be informed that answers to these questions may be published as 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.**

**It would be helpful if you could kindly provide the information in formats that allow copying text, figures and tables to include them into the review report.**

### 3. Literaturverzeichnis

Goodman (2006): Review of Directive 2002/95/EC (RoHS) Categories 8 and 9. Final Report. ERA Report 2006-0383. Unter Mitarbeit von Paul Goodman, ERA Technology Ltd. ERA Technology Ltd. Online verfügbar unter [https://ec.europa.eu/environment/pdf/waste/weee/era\\_study\\_final\\_report.pdf](https://ec.europa.eu/environment/pdf/waste/weee/era_study_final_report.pdf), zuletzt geprüft am 06.12.2013.