Questionnaire 3 for Exemption 2 of RoHS Annex IV

Acronyms and Definitions

CT computer tomography

1. Background

Bio Innovation Service, UNITAR and Fraunhofer IZM have been appointed[1] 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 8 June latest.

2. Questions

1) Goodman (2006) found at least one manufacturer who had developed a new design of X-ray tube which did not have lead bearings. This new type of tube can used in a limited range of new product designs whereas most X-ray equipment will continue to use tubes with lead bearings.

   Could you kindly inform us about this technology and its current status?

   Given the timeframes since this information was first discovered and the fact that the design is patented, COCIR was unable to find futher information on this technology.

2) X-ray tubes use internal lead shielding based on RoHS exemption IV-5. You compare two tubes:

   - 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

   Why would x-rays with liquid metal bearings require more lead shielding than those with lead-bearings and otherwise identical performance?

   The quantity of lead shielding required depends on the size and design of X-ray tube. Large-size tubes will have a larger exterior surface area that needs to be covered with lead shielding than smaller tubes. Shielding is also needed to protect any electronics inside the tube assembly. Liquid metal X-ray tubes are on average larger and heavier than other types so typically require more lead. As such, additional shielding is required to protect hospital staff, patients and electrical equipment from radiation from these types of tube.

3) We are not quite sure whether we correctly understand the status of silver metal bearings in X-rays.

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

a. We understand that silver bearings are not used in any new X-ray designs any more. Is this correct? Yes, this is correct for X-ray tubes that are used for medical imaging (they may be used for industrial X-ray equipment, but COCIR has no information on these uses).

b. If not, please explain where they are still used in newly designed equipment and why.

Not applicable

c. You mention a research initiative of a manufacturer. Could you please give some more details about the direction, status and timing of this research?

Manufacturers are carrying out research to replace lead as required by RoHS and this is one option that is being considered. It is still not clear whether the problems associated with silver that are described in the exemption renewal request can be solved, so it is not possible to estimate accurate timescales.

Currently one manufacturer is investigating several failures observed during a development project into silver coatings. From the experiences of this project it is able to be determined that a substantial amount of development work is still needing to be undertaken.

4) You point out that the bearings have to be not only thermally, but also electrically conductive.

Which components of an x-ray are supplied with electricity via the bearings? Is it the anode only, or also or only other components?

The anode and cathode form the high voltage circuit that generates X-rays and so an electrical connection is needed to the rotating anode. This is possible only via the bearings.

5) You explain in the clarification questionnaire that, among other reasons, their poor resistance to shock loads limits the use of ceramics in bearings of x-rays.

How would such shocks occur in x-rays?

Shocks can occur when there are unintentional impacts during transport and installation of X-ray tubes or during the service life of the equipment (e.g., if patient beds accidentally impacting the x-ray machine).

6) Liquid metal bearings using gallium may have to be heated up before the X-ray can be used. You explain that some manufacturers therefore use metals that are liquid at room temperature.

a. Which metals are these?

b. What are the properties of these alternative metals in terms of friction, electrical and thermal conductivity, environmental impacts (energy consumption and carbon footprint in production, etc.)?

Alloys that are liquid at room temperature can be made by adding indium and other metals to gallium. Alloys with indium will however tend to dissolve nearly all metals and so a compromise is needed to obtain a low melting point alloy but not cause degradation of the surfaces in contact with the liquid alloy. Each manufacturer uses its own proprietary solutions.

The energy consumption during use for these alloys are still substantial as the higher friction, (which main cause of the higher energy usage) is still required as the drive unit needs to deliver permanent power to spin the bearing.

As outlined in the exemption renewal request the environmental impacts of liquid metal bearings in comparision in lead coated bearings is much larger.

7) Does each use of liquid gallium bearings include active cooling to prevent corrosion of the sliding bearing? If not, please explain in which devices/applications this is not required.

   This is used only in high power X-ray tubes (such as for some types of CT).

8) We assume that CT scanners always have rotating anodes to facilitate 3D-imaging. Is this correct?

   CT scanners always require rotating anodes to avoid hot spots on the anode that will cause melting and distortion. The entire X-ray tube assembly and detector also rotate around the patient to create the 3D image.

Please note 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, zuletzt geprüft am 06.12.2013.