Consultation Questionnaire Exemption 1(c) of RoHS Annex IV

Current wording of the exemption:

Lead, cadmium and mercury in infrared detectors

Expires on 21 July 2021 for equipment of cat. 8 and 9 other than in-vitro diagnostics and industrial monitoring and control instruments

1. Acronyms and Definitions

FTIR	Fourier transform infra-red
HgCdTe	Mercury cadmium tellurium (MCT)
JBCE	Japan Business Council in Europe
LWIR	Long wavelength infrared
MCT	Mercury cadmium tellurium
MWIR	Medium wavelength infrared
PbSe	Lead selenide
PbS	Lead sulphide
PPTF	Polish Technological Platform on Photonics
PZT	Lead zirconate titanate
IR	Infrared
S/N	Signal over noise

2. 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.

COCIR, JBCE, LASER COMPONENTS, PerkinElmer and PPTF have submitted requests[2] for the continuation of the above-mentioned exemption. The requests have been subject to a first completeness

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

[2] Exemption requests available at https://rohs.biois.eu/Ex_1c-IV_COCIR_Renewal-Request.pdf, https://rohs.biois.eu/Ex_1c-IV_JBCE_Renewal-Request.pdf, https://rohs.biois.eu/Ex_1c-IV_LC_Renewal-Request.pdf, https://rohs.biois.eu/Ex_1c-IV_PE_Renewal-Request.pdf, https://rohs.biois.eu/Ex-1c-IV_PPTF_Renewal-Request.pdf

and plausibility check. The applicants have been re-quested to answer additional questions and to provide additional information, available on the request webpage of the stakeholder consultation.[3]

SUMMARY OF THE EXEMPTION REQUEST OF **JBCE**

JBCE requests the renewal of the exemption in its current scope and wording:

Lead, cadmium and mercury in infrared detectors

According to JBCE, "Infrared (IR) analysis and measuring instruments provide a rapid, accurate analysis of materials to provide information on the chemical composition, surface properties and spatial distribution of substances. The technology is utilised by a wide variety of industry sectors, researchers and for educational purposes, examples of which are given in this exemption request.

The choice of semiconductors intrinsically affects the infrared range detectable and usefulness of the signal produced. The current infrared detectors have features such as higher sensitivity and wider measurement wavelength ranges than their substitutes; as such substitutions are not capable to fulfil the requirements of analysis and measuring instruments."

The applicant requests a renewal of this exemption for 7 years for all equipment of cat. 8 and 9.

SUMMARY OF THE EXEMPTION REQUEST OF **COCIR** AND **LASER COMPONENTS**

COCIR and Laser Components request the renewal of the exemption with the following scope and wording:

*"**Lead in infra-red light detectors**".*

Both applicants request a renewal period of 7 years.

According to COCIR, "PbSe infrared detectors are used in medical devices called capnometers, which are used to monitor the breathing of patients in EU hospitals and clinics. PbSe is the only detector material that meets all of the essential criteria and is able to detect small changes in breathing using a capnometer that can be indicative of health conditions as well as difficulties with breathing. All potential substitutes either do not adequately respond to changes in CO_2 concentrations in patients' exhaled breath, they respond too slowly, or the detectors require cooling. Cooling requires extra bulky equipment and would cause condensation of water from exhaled air onto the detector's surface. This will freeze and the ice crystals will block infrared light and so make the detector insensitive."

According to Laser Components, "PbSe and PbS infrared detectors have unique characteristics that enable them to be used in a wide variety of applications. They are used in near infrared analysers used by very many diverse industries, medical devices for analysis of carbon dioxide in patients' breath and in spark detection systems. These detectors are used because of their high sensitivity in the near infrared range and can be used without cooling. Another advantage over thermal heat detectors is the very fast response times of the lead based detectors, which is essential in many applications."

SUMMARY OF THE EXEMPTION REQUEST OF **PPTF**

PPTF requests the renewal of the exemption with the following scope and wording:

[3] Clarification questionnaire available at https://rohs.biois.eu/Ex_1c-IV_COCIR_Questionnaire-1_Clarification.pdf, https://rohs.biois.eu/Ex_1c-IV_JBCE_Questionnaire-1_Clarification.pdf, https://rohs.biois.eu/Ex_1c-IV_LC_Questionnaire-1_Clarification.pdf, https://rohs.biois.eu/Ex_1c-IV_PerkinElmer_Questionnaire-1_Clarification.pdf, https://rohs.biois.eu/Ex_1c-IV_PPTF_Questionnaire-1_Clarification.pdf

*"**Cadmium and mercury in infra-red detectors"***

According to PPTF, "The variable band gap $Hg_{1-x}Cd_xTe$ (also called in short HgCdTe or MCT) has been undeniably the champion among the large variety of material systems, offering 2x up to 100x better detectivity levels in the MWIR (3 to 8µm) and especially LWIR (8 to 14µm) spectrum. The are possible substitutes used in less demanding measurement applications – III-V compound semiconductor detectors. However, despite many years of development there have not been yet any commercially available detectors matching MCT detectors in terms of detectivity."

The applicant requests a renewal of this exemption for 7 years.

SUMMARY OF THE EXEMPTION REQUEST OF **PERKINELMER**

PerkinElmer requests the renewal of the exemption with the following scope and wording in the clarification questionnaire:

*"**Cadmium and mercury in infra-red detectors of Fourier transform infra-red (FTIR) spectrometers and microscopes**"*

PerkinElmer claims "[…] that MCT [mercury cadmium telluride] is the only detector material currently available which is able to provide all of the following characteristics required for FTIR spectrometers and microscopes:

- *Photoconductor with an electrical resistance that decreases as the level of incident infra-red light increases;*
- *High sensitivity to small infra-red light level changes producing a strong signal;*
- *Low dielectric constant, ensuring that the signal to noise ratio is maximised;*
- *Relatively low electrical resistance when not exposed to infra-red light;*
- *Low noise, otherwise averaging methods have to be used which increases measurement time by a factor of 4 for an improvement of the signal to noise ratio of two due to a square law relationship;*
- *Ability to detect over a wide range of IR regions therefore requiring both low and high carrier concentrations; and*
- *FTIR spectrometers for kinetics studies must have very fast response to changes in concentration of substances with typical requirements being the ability to measure spectra in times that are 1000 times shorter than the overall changes in concentration."*

The applicant requests the renewal of this exemption for 7 years.

The stakeholder consultation is part of the review process for the request at hand. The objective of this consultation and the review process is to collect and to evaluate information and evidence according to the criteria listed in Art. 5(1)(a) of Directive 2011/65/EU.[4]

To contribute to this stakeholder consultation, please answer the questions below by December 2nd, 2020.

[4] Directive 2011/65/EU (RoHS) available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32011L0065:EN:NOT

3. Questions

1. The applicants have requested the renewal of exemption 1(c) of RoHS Annex IV with partially different scopes and wording.

   a. Please let us know whether you support or disagree with any of the above wordings, scopes and requested durations of the exemption. To support your views, please provide detailed technical argumentation / evidence in line with the criteria4 in Art. 5(1)(a).

SIEMENS, especially the business unit SI BP, supports the request "Lead in infra-red light detectors" for a renewal period of 7 years.

Lead-containing infrared detectors are used in the safety-critical application of industrial and heating burners to detect the flame and switch off the fuel/gas valves when the flame is extinguished.

Siemens and other market participants offer a range of flame sensor products. However, there are applications depending on burner construction and fuel, which require flame detection in the infrared range.

Alternative detectors for infrared detection were examined by SIEMENS, a suitable product, which fulfills safety and availability requirements, could not be identified.

   b. If applicable, please suggest an alternative wording and duration and explain your proposal.

2. Please provide information concerning possible substitutes or elimination possibilities at present or in the future so that the requested exemption could be restricted or revoked. Please specify which of the requested exemption scopes and wordings you address in your answers.

   a. Please explain substitution and elimination possibilities and for which part of the applications in the scope of the requested exemption they are relevant.

   b. Please provide information as to research to find alternatives that do not rely on the exemption under review (substitution or elimination), and which may cover part or all of the applications in the scope of the exemption request.

   c. Please provide a roadmap of such on-going substitution/elimination and research (phases that are to be carried out), detailing the current status as well as the estimated time needed for further stages.

As alternatives photodiodes and photovoltaic elements based on InAsSb, InGaAs and InAs as well as thermopiles were considered.

However, the following properties in comparison with PbS detectors of these components prevent the replacement in the burner application:

Dark current / Extraneous light detection

With possible alternative detectors, the dark current (signal of the sensor element in the absence of light) is significantly increased (factor >> 10) at elevated temperatures of more than 30 °C, as typical in burner applications, and increases further with rising temperatures.

The safety check of the sensor element for extraneous light during cold burner start would be successful, but if the flame extinguishes when the burner is heated to operating temperature, a flame would be detected by mistake and the fuel valves would not be switched off. A safety critical situation due to uncontrolled fuel leakage e.g. natural gas would be the consequence.

Lower sensitivity

Alternative infrared detectors have a much lower sensitivity than PbS detectors. To obtain a usable signal, a higher amplification would be necessary. Thus, the signal-to-noise ratio is worse. The most important recognition feature for flame, the flickering of the flame as a higher frequency signal component is no longer reliably distinguishable from the noise level of the sensor element which leads to unreliable operation of the burner.

The cooling of the detectors to improve the dark current characteristics proposed by some manufacturers of alternative elements is not practicable and could cause a reliability problem of the burner application.

A cooling device at the detector requires more space and additional power supply, thus resulting in a larger and incompatible flame scanner product. The installation situation in the commercially available burners would partly require a redesign of the burner incl. new approval.

If the sensor element is cooled to reduce the dark current, condensation and icing of the optical elements of the flame scanner from the combustion product H2O is to be expected. The resulting reduction in sensitivity can lead to burner failure.

This is particularly relevant for environmentally friendly energy sources such as hydrogen, which contains a very high proportion of water in the exhaust gas. Due to the higher flame speed when hydrogen is burned, flame sensors are dependent on highly sensitive flame detectors.

Response times

The special feature of PbS - Infrared detectors mentioned in the request of COCIR and Laser Components, that they react particularly fast, is also required for flame detection in burner applications:

As already mentioned, reliable flame detection is based on the evaluation of the higher frequency flicker component of the flame signal. This signal component would be filtered out by a significantly slower response of an alternative detector.

3. Do you know of other manufacturers producing devices of comparable features and performance like the ones in the scope of this exemption request that do not depend on RoHS-restricted substances, or use smaller amounts of these substances compared to the applications in the scope of this exemption?

No

4. As part of the evaluation, socio-economic impacts shall also be compiled and evaluated. For this purpose, if you have information on socioeconomic aspects, please provide details in respect of the following:

    a. What are the volumes of EEE in the scope of the requested exemptions which are placed on the market per year?

    b. What are the volumes of additional waste to be generated should the requested exemption not be renewed or not be renewed for the requested duration?

    c. What are estimated impacts on employment in total, in the EU and outside the EU, should the requested exemption not be renewed or be renewed for less than the re-quested time period? Please detail the main sectors in which possible impacts are expected – manufacturers of equipment in the scope of the exemption, suppliers, re-tail, users of MRI devices, etc.

    d. Please estimate additional costs associated should the requested exemption not be renewed, and how this is divided between various sectors (e.g. private, public, industry: manufacturers, suppliers, retailers).

Volumes of lead in the scope of the requested exemptions

The annual quantity of flame sensors based on PbS infrared detectors brought into the European market by the manufacturers is a few thousand pieces. The lead quantity of a typical detector is 1,3 x 10E-5 g per piece according to manufacturer's specifications.

The total amount of lead introduced by the burner application is therefore approx. 0,13 grams/year.

Please specify which of the requested exemption scopes and wordings you address in your answers.

5. Any other information you would like to share?

Please note that answers to these questions can be published in the stakeholder consultation, which is 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.

Please do not forget to provide your contact details (Name, Organisation, e-mail and phone number) so that the project team can contact you in case there are questions concerning your contribution.