

[SEMI Response to](#)
[Consultation Questionnaire Exemption No. 4\(f\) of RoHS Annex III](#)
[May 2021](#)

Current wording of the exemption:

Mercury in other discharge lamps for special purposes not specifically mentioned in this Annex

Requested validity period: Maximum (5 years and 7 years (cat. 8 and 9) respectively)

ACRONYMS AND DEFINITIONS

UV	Ultra Violet
LED	Light-Emitting-Diode
Hg	Mercury
LEU	LightingEurope

1. INTRODUCTION

1.1. Background

Bio Innovation Service, UNITAR and Fraunhofer IZM have been appointed¹ 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.

VDMA and Lighting Europe submitted requests² for the renewal of the above-mentioned exemption. The request has been subject to a first completeness and plausibility check. The applicant has been re-

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 request available at [RoHS Annex III exemption evaluation - Stakeholder consultation \(biois.eu\)](#)

requested to answer additional questions and to provide additional information, available on the request webpage of the stakeholder consultation³.

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 below questions until the 27th of May 2021.

1.2. Summary of the Exemption Request

According to VDMA: *"The application for prolongation of the existing exemption refers to mercury-containing UV discharge lamps which are used for curing (e.g. of layers of inks and coatings, adhesives and sealants), for disinfection (e.g. of water, surfaces and air) and for other industrial applications (surface modification, surface activation) The application includes the following lamp types:*

- **UV medium-pressure discharge lamps (MPL) for curing, disinfection and other industrial applications** (internal operating pressure > 100 mbar). The UV medium-pressure lamps can be doped with iron, gallium or lead in addition to the mercury they contain.
- **UV low-pressure discharge lamps for special purposes** in the high power range. [...]

Typical applications to be covered by this application include curing, e.g. of inks and coatings, disinfection of water etc., and other industrial applications like surface activation and cleaning.

It is technically not possible to replace mercury in special UV lamps with other materials/chemicals in order to achieve the same widespread radiation distribution. LED-based technologies are increasingly being used, which in certain applications (e.g. curing) also offer many advantages over mercury-containing UV lamps. Nevertheless, LED technologies cannot be used as an equivalent replacement in many applications. "

According to LightingEurope, "[...] The renewal application concerns lamps and UV light sources defined as:

- High Pressure Sodium (vapour) lamps (HPS) for horticulture lighting,
- Medium and high-pressure UV lamps for curing, disinfection of water and surfaces, day simulation for zoo animals, etc...
- Short-arc Hg lamps for projection, studio, stage lighting, microlithography for semiconductor production, etc...

Replacement of mercury and mercury containing lamps is impracticable:

- *The lamps covered by exemption 4(f) must remain available on the EU market:*
 - o *For new equipment for certain applications where no functionally suitable alternatives are available*
 - o *As spare parts for in-use equipment as replacing end-of-life lamps avoids having equipment become electronic waste before due time"*

³ Clarification questionnaire available at [RoHS Annex III exemption evaluation - Stakeholder consultation \(biois.eu\)](https://biois.eu/rohs-annex-iii-exemption-evaluation-stakeholder-consultation)

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

2. QUESTIONS

1. VDMA and LightingEurope² requested the renewal of the above exemption for the maximum validity periods with the same scope and wording for all EEE of cat. 3 and 5 (VDMA) and cat. 1-10 (LEU).
 - a. Please let us know whether you support or disagree with the wording, scope and requested duration of the exemption. To support your views, please provide detailed technical argumentation / evidence in line with the criteria⁴ in Art. 5(1)(a). **YES, we support the exemption. We would like to clarify that *special purposes* (in the current wording of the exemption) includes all semiconductor manufacturing related applications such as photolithography and photostabilisation.**
 - b. If applicable, please suggest an alternative wording and duration and explain your proposal. **Not applicable.**
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.

Broadband UV radiation from mercury based lamps is not replaceable by LED or laser sources.

No alternatives are available with sufficient power at this wavelength that would enable semiconductor manufacturing. Current LED technology provides UV light at 385 nm. Current I-line lithography systems are designed to use 365 nm I-line technology still used in the production of any semiconductor chip. Switching to another UV wavelength means that the complete machines' optical system needs to be redesigned which is almost 50% of the total machine and its costs may be estimated between 1 to 10 million Euro per machine. And in addition, LED technologies do not provide sufficient power (between 500 and 7500 W). The available power for LED UV (385 nm) is less than 10 W. There is no roadmap available for eliminating those gaps.

Specialty UV bulbs containing mercury are also critical to the semiconductor process of photostabilization. Photostabilization ensures optimum resist stability and critical dimension (CD) control through etch and implant sequences, and is a key enabler of improved device quality. The photostabilization process is a balance of UV energy applied to the top of the wafer and thermal heating applied to the backside of the wafer to remove residual solvents from the photoresist and to further crosslink the resist.

- a. Please explain substitution and elimination possibilities and for which part of the applications in the scope of the requested exemption they are relevant. **If in the future other technologies with necessary power and wavelength (range) would become available a complete redesign of the equipment would be necessary. The European semiconductor industry will lose cost competitiveness to other regions.**
- 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. **The only substitution, but not economically viable, currently possible would be to use high-end technology at different**

wavelength (248 nm) which is a much higher costs technology. Semiconductor manufacturers would also need to adjust their processes to this new technology, instead of I-line, which also increases the costs. The European semiconductor industry will lose cost competitiveness to other regions which is in conflict to the EU plans to increase semiconductor industry in Europe and become more autonomous.

- 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. There is no roadmap because alternative technology viable for high volume production of semiconductor manufacturing at similar cost to the existing technology is not present nor identified.
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? We are not aware of any initiative in the semiconductor manufacturing equipment.
 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: Abandoning mercury lamps will provide a problem for existing semiconductor fabs in Europe.

If I-line technology cannot be used anymore, this will require the use of more expensive technology (248 nm) and the need to recertify processes to this new technology. Changing to different wavelengths also increases related costs such as for masks. The lamps are not generating much waste since typically semiconductor machines are using 6 to 10 lamps per year and after service life the lamps are returned to the lamp manufacturers.

If curing technologies based on mercury UV lamps will not be available anymore this will lead to complete process change. This may decrease long-term semiconductor technology competitiveness of Europe which is in conflict with the Europe's strategic autonomy.

- a. What are the volumes of EEE in the scope of the requested exemptions which are placed on the market per year? (1) I-Line lithography: 6-10 lamps per year, per machine. Each typical semiconductor fab has between 5 to 10 I-line machines. These lamps contain about 1 g Hg per lamp. (2) UV curing: 1-2 lamps per tool, estimated 10-20 curing tools per fab. These lamps contain less than 200 mg Hg per lamp.
- 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? Unknown.
- 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-requested 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. Lithography machine manufacturers and semiconductor fabs are affected. If 4(f) lamps exemption is not renewed and these mercury lamps are no longer allowed, it would put EU based semiconductor manufacturing at risk with fab closures and high skilled employment loss. There are around 40 fabs in the EU. Not renewing the exemption would also undermine the EU's clear commitment to reinforce the EU's semiconductor manufacturing capacity, which was again confirmed recently in the Joint Declaration of 19 EU Member States on 7 December 2020. The recent semiconductor chips shortage faced by the automotive industry is illustrating the EU's challenges. Limited production capacity, high entry costs and lack of a level playing field are threatening the EU's capacity to fully seize the opportunities of the digital transformation.

- 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). [Multimillion euro cost per fab.](#)

5. Any additional information which you would like to provide? [We are happy to provide you with additional information if requested.](#)

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.