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...engineering UV

27 May 2021

RE: GEW (EC) Limited's Response to Consultation Questionnaire Exemption No. 4(f) of RoHS Annex III

Dear RoHS Exemption No. 4(f) Project Team:

As a manufacturer of mercury arc, LED, and excimer UV curing systems for printing, coating, and industrial applications, GEW (EC) Limited fully endorses the Exemption Request Forms submitted by LightingEurope AISBL on January 17, 2020 and VDMA e.V. on January 19, 2020. Both applications thoroughly present the case for extending RoHS exemptions for mercury containing lamps listed under Annex III 4(f) *Mercury in other discharge lamps for special purposes not specifically mentioned in this Annex*. Let the record show that GEW endorses the information, evidence, and data provided in the LEU and VDMA applications. Furthermore, GEW feels very strongly that a ban on mercury vapour lamps would be detrimental to industries, products, markets, employment opportunities, and end consumers both in the EU and outside the EU.

Founded in 1991, GEW is headquartered in the United Kingdom with operations in Germany and the United States. GEW employs over 130 individuals, manufactures all saleable goods in the United Kingdom, serves an international customer base, has built a world-leading position, and has completed over XXX[1] UV and UV LED installations on manufacturing lines across the globe with XXX[2] of these inside the EU. Installations consist of multiple UV lampheads with lamp lengths ranging from 20 cm to 2.5 meters. We have distribution partners covering over 110 countries around the World with around 15 of those distribution companies located in the EU.

GEW is 100% focused on the manufacture of UV curing systems for the graphic arts printing coating and converting market. This includes the lamphead assembly, power cabinet, cooling system, cables, hoses, ducting, mounting brackets, and ancillary integration components. Our mercury arc lamp, UV LED, and excimer curing systems are renowned for their rugged construction, effective designs, and energy-efficient operation. Our focus on long term support and customer care ensures GEW UV systems run efficiently throughout the life of the machine to which they are fitted. We are committed to supplying effective UV curing solutions which allow users to run manufacturing lines faster, longer, with less energy, and minimal downtime.

GEW ships approximately XXX[3] mercury vapour lamps annually. These lamps are provided as part of new systems and as spare parts. There are roughly XXX[4] machines currently using GEW mercury vapour technology globally. While many of these curing systems are installed on narrow-web flexo label printers, GEW's UV curing technology is widely used across the numerous market segments including:

- label converting
- packaging converting
- commercial printing
- direct to product decoration
- industrial coating, converting, and finishing
- other industrial

[1] **See Annex 1 - 2**
[2] **See Annex 1 - 3**
[3] **See Annex 1 - 6**
[4] **See Annex 1 - 2**

Within these market segments, GEW's UV curing systems are integrated onto industrial manufacturing lines and enable the practical and efficient implementation of the following material application methods.

- Flexographic (flexo)
- offset
- screen
- rotary screen
- digital inkjet
- coaters
- gravure
- extruders

GEW began developing mercury arc curing systems in 1991 and LED UV curing technology in 2014. Because we supply both technologies and are deeply engaged across the supply chain, we are uniquely positioned to provide a fair and honest assessment of the existence of viable alternatives to mercury vapour lamps. GEW is fully committed to transitioning our customer base to LED technology as applications become technically, economically, and practically feasible. At the present time, however, more work is necessary to facilitate a viable migration away from mercury vapour lamps for all markets, all applications, and all processes.

While UVA LED UV curing lamps have been evolving since 2005, narrow spectrum LEDs are relatively new in comparison to broadband mercury vapour lamps. Mercury vapour lamps emitting UVC, UVB, UVA, UVV, visible and infrared output were introduced as prototypes in the 1890s and commercialised for UV curing in the 1950s and 1960s. Inks, coatings, adhesives, extrusions, and composites must be specially formulated to react to narrow band UVA output and cure with an LED lamp. A large portion of existing chemistry developed over decades and intentionally designed for broadband UV output is simply not viable for LED today. In addition, it is not currently possible to reformulate many formulations for use with UV LED lamps as a significant portion of the chemistry requires UVC output to achieve full cure and deliver desirable final product properties. UVC LEDs do not yet provide outputs, price points, and lifetimes that make them commercially viable for UV curing.

Despite the challenges of LED curing, approximately XXX%[5] of GEW's total system sales by volume in 2020-21 were LED curing lamps. While we expect the portion of LED lamps to continue growing, it is not possible for most of GEW's customer base to switch to LED curing should an all-inclusive ban on mercury lamps be implemented. The technical, economic, and practical feasibility of LED UV curing varies significantly by market, application, and customer. The use of UV curing in each application is unique and often requires a somewhat customised solution as well as successful lab, pilot line, and press trials before a process can be converted to LED. As a result, LED curing is still in its infancy with significantly more innovation required to make it feasible across the entire curing industry.

Due to the need for further lamp, formulation, and process development, mercury UV curing lamps are required for the foreseeable future. This is necessary to enable operation, upgrade and modification of existing UV curing systems, allow manufacturers to continue producing products across numerous industries where LED formulated chemistry does not exist or is not possible, ensure expensive and viable manufacturing lines are not immediately rendered useless, and ensure the production of goods that require UV curing technology are not relocated outside the EU. Relocating production of wide-ranging consumer and industrial goods outside the EU would have an immediate and immensely negatively impact on employment within the EU. It also has the potential to increase the cost of many everyday goods purchased by EU residents.

[5] **See Annex 1 – % difference between 10 & 11**

What follows are GEW's responses to Bio Innovation Service, UNITAR, and Fraunhofer IZM's request for stakeholder consultation. GEW has answered the questions as outlined in the *Consultation Questionnaire Exemption No. 4(f) of RoHS Annex III*.

1. **VDMA and LightingEurope requested the renewal of *No. 4(f) of RoHS Annex III* 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 criteria 4 in Art. 5(1)(a).**

   GEW agrees with the suggested wording and proposes two additions as noted in response (1b).

   GEW strongly supports extending exemptions for mercury UV curing lamps listed under 4(f) to at least 2026 and beyond. The reasons are:

   - It is not possible to substitute metallic mercury inside medium-pressure mercury vapour lamps with any other substance. Attempts to replace mercury with an alternative substance while delivering the uniquely beneficial properties of mercury discharge lamps have been ongoing for over a century and have all failed. No other substance produces a similarly defined broadband output consisting of VUV, UVC, UVB, UVA, UVV, visible, and infrared wavelengths of comparable irradiance (W/cm^2) and energy density (J/cm^2).

     Specific wavelength and minimum threshold irradiance levels are necessary to crosslink UV chemistry. A minimum amount of energy density is then needed to achieve the desired manufacturing line speed. Determining the optimal configuration of wavelength, irradiance, and energy density requires significant development and experimentation, both of which demand time and resources. What is required to cure a mercury vapour formulation is simply not the same as what is required to cure an LED formulation.

   - Since the first UV photopolymerization patent was granted by the US Patent Office in 1945, the UV curing industry has been evolving, developing, and building upon base chemistry and unique formulations that react to the precise UV output of mercury vapour lamps. A considerable portion of this extensive and proprietary intellectual property is widely used today. Without the ability to initiate photopolymer reactions using mercury vapour lamps, these valuable and useful corporate assets have no value.

   - Similarly, manufacturing lines and OEM presses have been developed over the decades specifically for use with relatively small and purposefully designed mercury lamphead form factors and the defined UV output of medium pressure mercury lamps. It is not always possible or straightforward to reconfigure these existing manufacturing lines for alternative use or alternative drying/curing technologies. As a result, many of these existing corporate assets would have little to no value if mercury vapour lamps were unavailable. The same applies to the existing designs and configurations of new printing machinery which may have to be significantly redesigned to incorporate new or different curing technologies at significant cost and effort on behalf of machinery manufacturers

   - One of the most significant differentiators of electrode arc, LED, and excimer lamps is spectral distribution. Mercury vapour lamps are broadband in that they emit a mix of VUV (100 to 200 nm), UVC (200 to 285 nm), UVB (285 to 315 nm), UVA (315 to 400 nm), UVV (400 to 450 nm), visible (400 to 700 nm), and infrared (700 nm to 1 mm) wavelengths. LED curing lamps predominantly emit narrow UV bands centered at one of the following: UVA (365, 385, 395 nm) or UVV (405 nm) while excimer lamps emit narrow UV bands centered at VUV (172 nm), UVC (222 nm), or UVA (308, 351 nm).

Shorter wavelengths such as VUV and UVC have relatively minimal penetration through formulations coupled with relatively greater energy per photon. By contrast, longer wavelengths such as UVA and UVV have relatively greater penetration through formulations but contain less energy per photon. Mercury vapor lamps provide a useful combination across the spectrum that is impossible to replicate with current LED technology. The relationship between wavelength absorption and depth of transmission for each ultraviolet band of energy is illustrated in Figure 1.

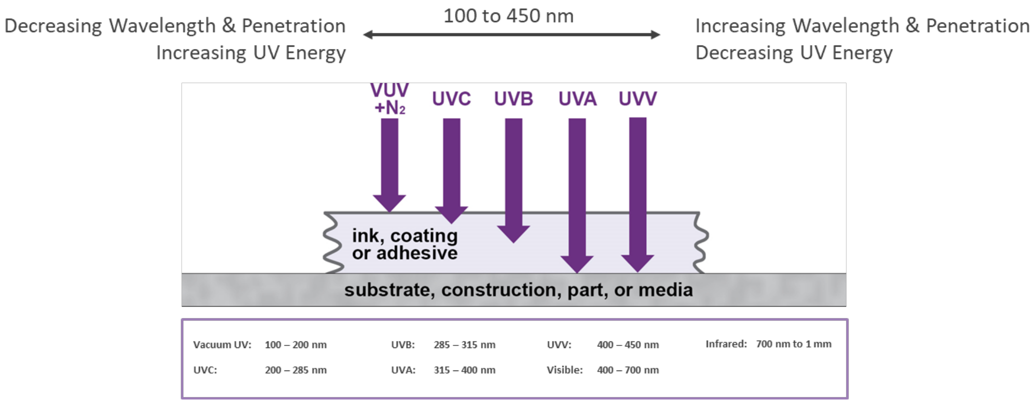

Figure 1: Wavelengths of VUV and UVC are absorbed at the formulation surface while wavelengths of UVA and UVV are absorbed throughout the formulation thickness.

- Many commercially available photoinitiators only absorb and react to UVC wavelengths. Swapping UVC photoinitiators for ones that react to UVA or UVV does not always render the same final cure properties such as hardness; resistance to chemicals, marring, and scratching; weatherability; and other desirable functional characteristics.

- There are fewer reactive molecules that align with the narrow spectral output of UV LEDs, and due to increasing regulation of chemicals, it is very difficult to get new materials approved. As a result, it is not always possible to formulate chemistry for LED lamps. In some cases, UVC LEDs or new molecules are required. Even when it is possible, UV LED formulations are often significantly more expensive which can be prohibitive to their adoption in many applications.

- Any and all UV curing process that have been certified or approved for quality, safety, and performance must be recertified or reapproved whenever a change in formulation and/or curing/drying method occurs. This is common practice in the manufacture of medical devices, automotive components, and many consumer packaged goods (CPGs). In many cases, this is required for each and every product affected by the change and would inflict an expensive and burdensome recertification process that could drive manufacturing of these products outside the EU.

- Mercury vapour lamps are environmentally friendly and provide manufactures with numerous solutions to common manufacturing challenges. These solutions are highlighted in Figure 2. Switching to non-UV curing technologies prevents manufactures from leveraging the value of UV curing technology and would drive users toward less environmentally friendly processes that deliver inferior properties in final products.

cure formulations instantly at fast line speeds
reduce heat transfer to substrate or construction
reduce energy consumption
reduce carbon footprint
eliminate solvent chemistry
eliminate thermal ovens
eliminate afterburners
eliminate greenhouse gases
adhere to a wide range of materials
generate bold and vibrant colors
provide hard, durable surface properties
provide scratch, mar, scuff and chemical resistance
provide superior functional properties
provide superior aesthetic properties
finish inline
provide immediate finishing off-line
reduce WIP inventory
reduce lead times
ship products faster
reduce lead times

Figure 2: Manufacturing solutions delivered through mercury vapour UV curing

- Reputable UV lamp manufacturers source elemental mercury from non-mining sources such as exiting reserves and byproducts of other processes such as oil and gas refining. As a result, the production of UV curing lamps does not generally contribute to increases in global mercury inventories. Reputable lamp manufacturers also implement safety and quality protocols that protect employees during manufacturing processes and ensure all mercury is safely and securely contained within the lamp prior to shipment, during shipment, and with proper use.

  When purchasing from reputable lamp suppliers, integrators, OEM machine builders, and end users always receive sealed and tested lamps in proper packaging. At the location of intended use, lamps are securely installed within lamphead assemblies which are then installed in larger manufacturing systems. Users are advised to recycle spent lamps through recycling centers capable of safely recovering mercury or transporting lamps to dedicated facilities with appropriate recovery equipment.

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

GEW agrees with the wording, scope and requested duration; however, please consider adding *extrusions* and *composites* to the list of UV curing uses as these are distinct from inks, coatings, and adhesives.

*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, sealants, **extrusions, and composites**), …"*

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.

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

Photopolymerization, or UV curing, is a chemical reaction that uses ultraviolet energy to transform specially formulated liquid-like materials that are wet-to-the touch into solid polymers that are dry-to the touch. Photoinitiators (PI) within inks, coatings, adhesives, and extrusions absorb UV wavelengths and produce energised free radicals. Free radicals transfer energy by reacting with other free radicals and materials within formulations such as monomers and oligomers to create crosslinked polymers. The total reaction occurs within a fraction of a second, producing fully cured materials immediately ready for further processing or shipping.

UV curing is not drying. It is a chemical reaction that maintains the applied 100% solids formulation following cure. No part of the formulation must be evaporated and exhausted to the atmosphere and little is discarded as waste. In addition, UV curing immediately provides superior mechanical properties, chemical resistance, and performance characteristics that are not possible or similarly achieved in other ways.

UV curing surfaces include webs, sheets, and 3D parts that are produced from a wide range of natural and synthetic materials. These surfaces can be flat, complex in shape, and even consist of populated assemblies. Widths span just a few millimetres all the way to 2.5 meters and beyond. Line speeds range from a few meters per minute to 1000 mpm or more. In other cases, cure surfaces are stationary during UV exposure and are positioned under a lower energy UV source for periods that span a few seconds to tens of seconds and longer. Complicating things further, UV curing is utilised across numerous industries with vastly different performance, dynamic material handling, integration, and certification requirements. Production environments include the cleanest of clean rooms as well as the dirtiest, non-climate-controlled plants located everywhere from sea level to mountain-high elevations.

This means an infinite number of process permutations span all the various UV formulations, formulation application methods, cure surface materials, final cure properties, process set-ups, and installation environments. As a result, each current use or application category potentially needs a slightly different and somewhat customised solution that must be developed, tested, proven, and implemented. Each solution requires all necessary components work together within the larger process while simultaneously delivering desired results.

Alternatives to UV curing include thermal drying of water-based and solvent-based formulations; metering and mixing of two-component formulations; and electron beam curing. A potential UV alternative to mercury vapour curing is LED curing.

Thermal Drying

Thermal drying requires the use of energy consuming drying ovens and tunnels that can be up to tens of meters long. These ovens take time to warm-up and often include forced air or spray powders which can contaminate or disrupt the surface of the ink, coating, adhesive, extrusion, or composite. Solvent-based chemistry is less environmentally friendly as solvents contain volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) which may require after-burners to incinerate chemicals in exhaust air to meet local air-pollution requirements. Permits of use are often necessary and cannot always be obtained.

Many thermally sensitive plastics such as shrink film and injection moulded pots, tubs, tubes, cups, lids, and containers among other items cannot be coated or decorated using thermal dryers as heat melts and deforms the product shape and integrity. Water-based formulations do not provide the same adhesion and physical performance properties as UV curing and result in final products with shorter useful life and weatherability. Thermally dried formulations are not as robust and often require processed materials to be scrapped and rerun to meet customer quality requirements.

Two Component

Two component materials require separate chemical parts of the formulation be precisely metered and mixed immediately before application. Once mixed, the formulation must be quickly used and cannot be saved for later use as it will cure in the container or pan. Once applied, two component formulations require one to several days to fully cure, often in an elevated temperature warehouse. Two component formulations must be fully cured before the goods can be further processed, used, or shipped. As a result, two components formulations are wasteful compared to UV curable formulations which do not cure until exposed to UV light. Two component formulations also result in significantly more work in progress inventory (WIP), require larger warehouses to store goods throughout the cure time, and eliminate the ability to immediately process goods inline. All of this is costly to producers.

Electron Bean Curing

Electron beam (EB) curing is used in mid and wide web converting for food packaging where low migration properties are required. For these applications, EB is already being used instead of UV as it eliminates the need for photoinitiators (PI). EB is generally not considered a viable alternative in many non-food packaging applications. This is because the capital investment for EB is significantly greater than UV curing. EB is also not practical for use with narrow webs, materials that are not flat, and 3D parts and assemblies. EB curing always requires a nitrogen inerted environment which is an additional cost of operation. EB systems also necessitate greater production space on manufacturing lines than UV.

LED UV Curing

The two main requirements for successful LED UV curing are that 1) LED formulated chemistry be used instead of chemistry designed for broad-spectrum UV lamps and 2) the energy emitted by the LED curing system must be matched to the needs of the chemistry and production process. A single LED system and formulation set that is universally suitable for every existing mercury vapour curing application simply does not exist.

The requirements of the chemistry and the output of the LED system are two incredibly critical factors. While progress is being made, it has not yet been possible to re-formulate all SKUs of conventional UV chemistry for the narrow spectral band of LED curing systems. In addition, not all LED curing systems, even when specified at the same intensity and wavelength, emit the same total energy. As a result, it is incredibly difficult for users of mercury vapour lamps to determine whether an LED solution is possible, and if it is, how to select a LED UV curing system that meets their specific needs.

In cases where LED chemistry does not yet exist, LED chemistry is not currently possible due to lack of UVC wavelengths emitted from LED lamps, or the LED system cannot physically or economically deliver enough energy for the chemistry or production process, mercury lamps remain the only UV curing option. For these latter applications, additional development and innovation in semiconductors, lamp assemblies, and chemistry are necessary to make LED UV curing feasible. Consequently, the feasibility of UV LED technology always depends on the specific needs of each application and production process, the LED system, and the chemistry.

Many variables affect curing processes and the viability of LED UV curing. They include the requirements of the chemistry, the specific output of the LED lamphead(s), the distance the LED lamphead(s) must be mounted from the cure surface, integration of the LED system and ancillary components into the machine or production line, the press or line speed, the dwell time, and the final performance requirements of the cured material(s). All of this must be thoroughly tested and proven viable before applications can migrate to LED.

With respect to industrial coatings that deliver more demanding performance properties, suppliers and end users have only recently begun to explore the use of LED UV curing for hardcoats, clearcoats, topcoats, overcoats, silicone release, hotmelt adhesives, and other functional coatings. Significant challenges remain in developing these LED solutions. While suppliers are increasingly committing resources and continued progress is expected over the coming decade, UV LED curing systems are not viable for most functional UV coatings today.

For each application category, all aspects of conventional UV curing must be re-assessed and re-deployed for LED technology just as it was originally done for mercury lamp technology. Unfortunately, this can be a resource intensive exercise requiring financial outlays, time and staffing, close collaboration throughout the supply chain, and clear and reliable forecasts from potential users.

Even when UV LED formulations and curing lamps provide suitable performance for a given application the cost of the UV LED formulation is to GEW's knowledge at least 10% more expensive and sometimes up to 300% more costly than equivalent formulations designed for mercury containing lamps. This formulation cost increase is rarely recouped by other benefits of UV LED curing technology (such as reduced energy consumption). Therefore in many applications, if a user was forced to use LED, the cost of the LED produced end product would increase leaving EU manufacturers at a significant disadvantage compared to those not covered by EU regulation.

Finally, the cost of the UV LED curing system itself is significantly higher than the existing mercury vapour curing technology available today. A typical GEW vapour lamp curing system costs XXX[6] compared to a typical GEW UV LED curing system costing XXX[7] - roughly double the investment cost for a typical printer.

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.

It is widely accepted across the curing industry that UV LED curing will become a viable alternative to UV mercury vapour lamp technology. It is also widely accepted that it is not a viable alternative in all circumstances today.

The best way to achieve widespread LED UV curing adoption is through industry collaboration that works to deliver complete solutions with clearly demonstrated and measurable benefits. All aspects of the process should be engineered as a proven solution and not supplied as discrete, disparately engineered components.

The LED emitting source is only one part of a total UV LED solution. Other necessary parts include availability of suitable chemistry; the ability to integrate the lamphead and system design into existing machines and incorporate ancillary technologies such as chilled rollers, chilled plates, and nitrogen inertion; and provide an attractive ROI in comparison to alternatives. Initial capital expenditures, operating costs, and scrapping existing and viable mercury lamp installations with remaining life all factor into the practicality of substitution.

While LED UV curing progress is being made in all areas, feasibility varies widely by market segment and application. For markets where LED UV curing is not currently used, remaining challenges typically lie in reformulating more demanding chemistry, potentially creating new molecules, developing LED UV emitting systems with shorter UVC wavelengths to cure chemistry that does not react to UVA, designing efficient and economical LED lampheads that can cure at desired production speeds and/or when mounted further from the cure surface, and the time and resources necessary to demonstrate capabilities and optimise processes on existing manufacturing lines.

Almost all UV curing system providers in the industry now provide a UV LED curing product in addition to mercury technology. 5 years ago, only a small handful of UV curing providers offered

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[6] See Annex 1 – 12
[7] See Annex 1 - 11

LED technology for sale. Significant efforts are underway at most manufacturers to advance their LED technology. The transition to UV LED curing is underway and making very significant progress but it is many years from being complete.

Most, but not all, ink and coating manufacturers provide a UV LED compatible formulation for sale. Often these are only available for a subset of their full product range. Significant R&D efforts are underway to rapidly expand ink and coating ranges, improve their performance and reduce their costs. Again the landscape was very different 5 years ago but the transition still has many years ahead.

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.**

All aspects of LED UV curing technology are improving and trending in the right direction. A complete universal shift to LED UV curing, however, is not possible today and requires ongoing collaboration throughout the supply chain for at least another 10 to 15 years or more. Suppliers need to identify and/or develop suitably matched LED UV curing systems and formulations for all existing applications as well as new ones and be given time to enable these formulations to become cost competitive with existing mercury UV technology. Once viable lamps and chemistry are commercially available, it can take up to a decade or more for new technology to penetrate the intended market segment. It simply takes time for users to self-educate, gain confidence in the technology, begin replacing ageing systems, direct new lines to LED UV, and requalify jobs and processes particularly those in the food packaging, medical, and automotive industries.

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?**

GEW is not aware of any manufacturers producing devices of comparable features and performance to medium pressure mercury vapour UV curing lamps that do not utilize mercury. The closest alternative to a mercury lamp system is an LED lamp system. While LED technology is employed in a few select markets and applications and almost all curing suppliers to the market provide a solution, it is not possible to cure 100% of formulations even in markets that have been early adopters of the technology. Alternative drying and curing methods such as water-based, solvent-based, two component, and electron beam do not deliver the same process benefits, operational efficiencies, and final product properties; often require greater capital investment; demand a larger footprint; result in greater costs of operation; and more negatively impact the environment due to increased energy consumption, the release of hazardous air pollutants, and the emission of volatile organic compounds (VOCs).

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?**

GEW does not know exact figures for the entire market of 4(f); however, the volume of EEE is significant. GEW alone ships more than XXX[8] mercury containing lamps per year. The total revenue to GEW due to manufacture and sale of UV curing lamps, systems, and peripherals

[8] **See Annex 1 - 6**

exceeds £XXX[9] million annually. The value of new machines and manufacturing lines where GEW's UV curing systems are utilized is significantly larger.

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?**

Since it will be nearly impossible to retrofit most lines with alternative drying/curing technologies should mercury vapour lamps be banned at this time, most manufacturing lines and presses currently in operation would be idled and needlessly scrapped as waste. This would be dire to label converters, direct to product decorators, furniture and cabinet manufacturers, and many manufactures of industrial components as well as UV formulation and processing machine suppliers.

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 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.**

A ban on mercury-based UV technology would have an immediate impact on all users. Even in cases where LED technology is a possible alternative, there do not exist enough resources in the industry to immediately convert all manufacturing lines. Even lines that are similar have unique features that require a customized retrofit. It is estimated that it could take decades to physically engineer and retrofit existing machines with LED. As a result, many companies and factories would cease to exist.

GEW does not have access to exact figures, but we estimate that there are thousands of companies in the EU that employ UV technology utilizing mercury vapour lamps. All these companies directly and indirectly provide sources of revenue to lamp, power supply, transformer, quartz, chiller, exhaust fan, controls, cable, ducting, hose, radiometer manufacturers, machine builders, consumable suppliers (mechanical and formulation) suppliers. All would be negatively impacted.

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).**

This is very difficult for GEW to estimate, we would refer to the knowledge of industry groups such as RadTech, VDMA and others.

5. **Any additional information which you would like to provide?**

A small amount of elemental mercury is utilized in mercury vapour lamps and is necessary for UV lamps to function. The physics of elemental mercury result in the emission of ultraviolet, visible, and infrared light when mercury is vapourised into a high-temperature plasma within a sealed, inert gas-filled quartz tube under medium pressure. No other gas discharge material produces the same spectral output as mercury, and for the last 70 years, UV curable chemistry has been specifically formulated to react to the broad-spectrum output generated only by vapourised metallic mercury. UV LED curing systems are not a direct replacement.

The amount of elemental mercury contained inside UV curing lamps varies across designs and lamp lengths; however, typical quantities are between 10 and 100 mg per lamp. GEWs contribution to mercury

[9] **See Annex 1 - 4**

within the EU therefore is less than Xkg[10] per year which is an inconsequential figure compared to other industries. Reputable UV lamp manufacturers source elemental mercury from non-mining sources such as exiting reserves and by-products of other processes such as oil and gas refining. In addition, spent lamps can and should be recycled. As a result, the production and use of UV curing lamps does not meaningfully contribute to increases in global mercury inventories and can be kept out of circulation in the biosphere.

GEW embraces the market shift to LED UV curing and works closely with clients and formulators to determine whether a mercury or LED UV solution is best for each set of circumstances. Research and development efforts are almost 100% focussed on UV LED. While the shift to LED is well underway, the full transition will likely span the next 15 years with the specific length of time dependent on unique requirements for each industry and application.

Should you require any additional information, please feel free to contact:

Robert Rae
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Sincerely,

FOR AND ON BEHALF OF
G. E. W. (EC) LTD.
SIGNED
ROBERT RAE DIRECTOR

[10] See Annex 1 - 14