Exemption Request Form

Date of submission: 20 January 2023

1. Name and contact details

1) Name and contact details of applicant:

Company: Test & Measurement Coalition
Tel.: +32 2 735 82 30
Name: Meglena Mihova
E-Mail: meglena.mihova@eppa.com
Function: TMC Secretariat
Address: Place du Luxembourg 2, 1050 Brussels, Belgium

2) Name and contact details of responsible person for this application (if different from above):

Company: _____
Tel.: _____
Name: _____
E-Mail: _____
Function: _____
Address: _____

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2. Reason for application:

Please indicate where relevant:

☐ Request for new exemption in:

☐ Request for amendment of existing exemption in

☒ Request for extension of existing exemption in

☐ Request for deletion of existing exemption in:

☐ Provision of information referring to an existing specific exemption in:

☐ Annex III ☒ Annex IV

No. of exemption in Annex III or IV where applicable: 4

Proposed or existing wording: Existing.

"Lead in glass frit of X-ray tubes and image intensifiers and lead in glass frit binder for assembly of gas lasers and for vacuum tubes that convert electromagnetic radiation into electrons."

Duration where applicable: Maximum validy period.

☐ Other: _____

3. Summary of the exemption request / revocation request

Exemption 4(IV) is used for a few critical applications. Precision lasers with high spectral purity are manufactured with a borosilicate glass rod with glass frit containing lead oxide (PbO) to connect this glass to the metal pieces of the assembly. PbO glass frit has a low melting point and excellent wetting characteristics, which achieves a thermally matched bond of the glass rod to other components in the manufacture of precision lasers without damaging or distorting the glass. The materials and heat cycle for attaching glass to metal must be precisely controlled to avoid stresses caused by thermal expansion differences.

As further outlined in the submission, the unique characteristics of lead make the substance a necessary part for the functioning of glass frit, which cannot be substituted with other substances. The Test & Measurement Coalition therefore applies for a renewal of exemption 4 (IV) for the maximum validity period.

A thorough Socio-Economic Analysis was conducted in addition to the technical assessment and attached to this submission, further illustrating the negative socio-economic impacts a non-renewal of exemption of exemption 4(IV) would have at this stage. Overall, the analysis concludes that the total impact of non-renewal of this exemption is monetized in the range of 15 million EUR and 40 million EUR (conservative lower bound estimate).

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4. Technical description of the exemption request / revocation request

(A) Description of the concerned application:

1. To which EEE is the exemption request/information relevant?

   Industrial test and measurement instruments (category 9 – Industrial under the RoHS Directive) are very different from low mix, high-volume consumer products which are frequently re-designed to follow consumer trends and are placed on the market for a limited duration. Industrial test and measurement are high mix, low volume producers, managing portfolios of thousands of highly complex instruments. Each instrument is intentionally designed for high reliability and serviceability to support long useful lifespans, and are made available on the market for at least a decade. These instruments are designed: exclusively for professional and industrial use; to meet high performance requirements in critical applications; and last up to 40 years. Redesign is not frequent and happens every seven years on average (as compared to every 1.5 years or less for consumer products). Once test and measurement instruments are placed onto the market, they are typically accompanied with a long-term customer support arrangement to maintain reliability and calibration.

Product portfolios have a massive scale, with TMC members each having typically 2,000 to 3,000 products currently made available on the market. These are highly complex, sophisticated electronic instruments such as signal generators, power analysers, oscilloscopes, spectrum analysers, digital multi-meters, electron microscopes, chemical and biological analysers, complex chromatography systems and their detectors, each having many options and accessories. Each instrument can have a minimum of 2,000 and up to 40,000 parts; requiring a vast supply chain involving tens of thousands of suppliers and hundreds of thousands of items.

Considering the EU added-value, test and measurement equipment is manufactured and sold in relatively small volumes (per instrument design) and placed on the global market. There is an added value in community level action, which guarantees more coherent and consistent rules across Europe. But with the expansion of RoHS-like requirements beyond the EU, this creates a risk of discrepancies in RoHS-like national laws adopted in third countries.

The nature of the tests and measurements made by industrial equipment necessitates that the equipment itself is highly complex; with upwards of 40,000 components necessary to produce a single instrument. Even a relatively simple hand-held instrument incorporates significantly more components that a typical consumer product. The professional test and measurement products provide the tools for engineers to develop new solutions and businesses to bring them to market. These instruments are used in Research, Quality Control and Testing laboratories (including field testing) in Universities, Manufacturing and clinical facilities and by Governmental Agencies for conformance verification and environmental testing. They are essential to the good functioning of electronic communications networks, heavy industrial processes such as steel manufacturing, the testing of vehicles for compliance with emissions standards, and the monitoring of complex and critical systems of all types.

Historically, between 25 - 35% of the components used in test & measurement products are custom designed. The features of the TMC manufacturers' equipment necessitate the development and production of unique components that are not commercially made available on the open market and are made by sole suppliers. These components have their own development lifecycle and take years to bring into production. When these suppliers are unable to deliver compliant parts that meet current RoHS regulations, the product would be stopped from being sold into the EU.

Name of applications or products:

- ***Laser Interferometers and Calibration Systems*** (Monolithic Laser Combiners & Precision Optics).
- ***Application-Specific Test Systems and Components.***
- ***Used Equipment in the above categories.***

a. List of relevant categories: (mark more than one where applicable)

☐ 1	☐ 7
☐ 2	☐ 8
☐ 3	☒ 9
☐ 4	☐ 10
☐ 5	☐ 11
☐ 6	

b. Please specify if application is in use in other categories to which the exemption request does not refer: _____

c. Please specify for equipment of category 8 and 9:

The requested exemption will be applied in

☒ monitoring and control instruments in industry

☐ in-vitro diagnostics

☐ other medical devices or other monitoring and control instruments than those in industry

2. Which of the six substances is in use in the application/product?

(Indicate more than one where applicable)

☒ Pb ☐ Cd ☐ Hg ☐ Cr-VI ☐ PBB ☐ PBDE

a. Function of the substance: The unique characteristics of Pb in glass frit in lasers is vital to successful manufacturing of long-lasting lasers. The specific advantages of lead are:

- Melting point below 490°C, allowing usage with borosilicate glass which has a maximum processing temperature of 500°C, and avoiding damage to the sensitive optics. Alternatives melt at 540°C (for example bismuth Bi-based frit) or higher.

- Good match for coefficient of thermal expansion, which reduces stresses and prevents cracking of the seal or the glass. Heating of the laser rid tunes the cavity length. Thermal expansion and contraction of the heating element / glass frit / glass rod must be closely matched to allow for this tuning and to prevent damage.
- Good wetting, allowing penetration into tighter spaces and effective sealing. Bi-based frit flows poorly below 540°C.

3. Content of substance in homogeneous material (%weight): Approximately 90% of Pb by weight.

4. Amount of substance entering the EU market annually through application for which the exemption is requested: Approximately 5.8 kg of Pb.
   Please supply information and calculations to support stated figure.
   The amount of substance entering the EU market annually through application for which the exemption is requested is based on the replies provided by the TMC members (for the preparation of the Socio-Economic Analysis – see attached).

5. Name of material/component: Glass frit.

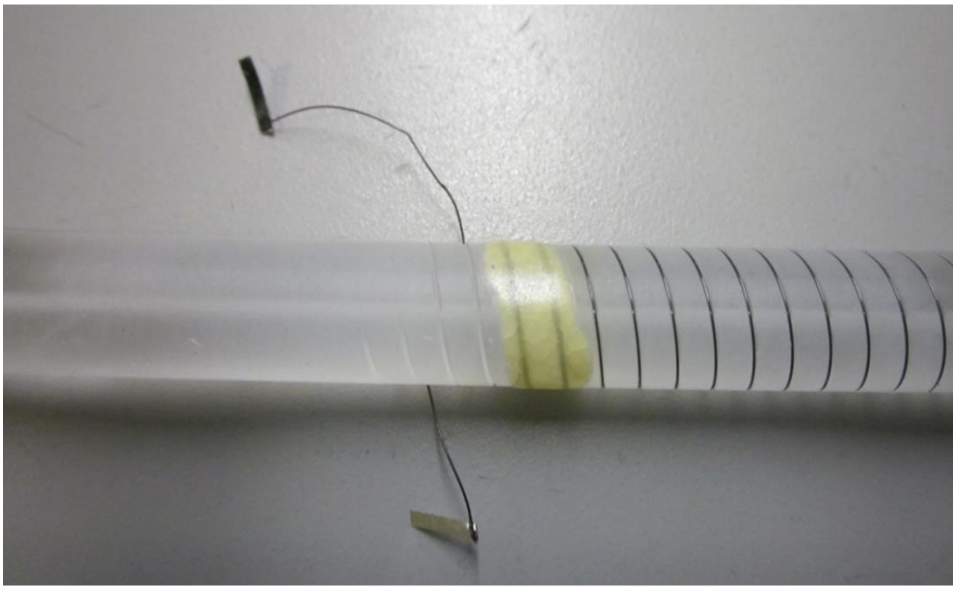
6. Environmental Assessment: _____
   LCA: ☐ Yes
   ☒ No

(B) In which material and/or component is the RoHS-regulated substance used, for which you request the exemption or its revocation? What is the function of this material or component?

Exemption 4, Annex IV is used for a few critical applications. Precision lasers with high spectral purity are manufactured with a borosilicate glass rod with glass frit containing lead oxide (PbO) to connect this glass to the metal pieces of the assembly. PbO glass frit has a low melting point and excellent wetting characteristics, which achieves a thermally matched bond of the glass rod to other components in the manufacture of precision lasers without damaging or distorting the glass. The materials and heat cycle for attaching glass to metal must be precisely controlled to avoid stresses caused by thermal expansion differences.

The coefficient of thermal expansion (CTE) for each material – glass, metal and frit – is slightly different. The higher the temperature, the more these different expansions induce stress either in heating to melt the frit or in cooling after the seal is made. This stress leads to fracture of the seal or the glass. The composition of the glass and the process are therefore carefully controlled to achieve a low stress product.

Example of metal attached to laser tube. The glass frit used for this attachment is not visible.



Heater wire is attached to laser tube with PbO-containing glass frit.

The unique characteristics of Pb in glass frit in lasers is vital to successful manufacturing of long-lasting lasers. The specific advantages of lead are:

- Melting point below 490°C, allowing usage with borosilicate glass which has a maximum processing temperature of 500°C, and avoiding damage to the sensitive optics. Alternatives melt at 540°C (for example bismuth Bi-based frit) or higher.
- Good match for coefficient of thermal expansion, which reduces stresses and prevents cracking of the seal or the glass. Heating of the laser rid tunes the cavity length. Thermal expansion and contraction of the heating element / glass frit / glass rod must be closely matched to allow for this tuning and to prevent damage.

- Good wetting, allowing penetration into tighter spaces and effective sealing. Bi-based frit flows poorly below 540°C.

In highly precise, spectrally pure lasers, a heating element is attached to the glass rod to adjust the rod length to allow tuning; this attachment also uses PbO-based glass frit. In the electronics industry, lasers are used in the manufacturing of semiconductors. Lithography using lasers creates patterns down to the nanometer scale. Lasers, such as from Industrial Monitoring and Control companies, are used for precision measurement of the alignment of etched layers, critical to integrated circuit manufacturing. The measurement uses interferometry, a technique that uses the interference of 2 light beams of very stable wavelength to make nanometer scale measurements. The measurement must be more precise than the feature being measured.

A further description of the lithography process and the use of laser for precise pattern generation in the semiconductor manufacturing process can is provided by ASML technology.[1]

Additionally, lithographic solutions in a semiconductor manufacturing facility may be considered large scale installations, however these customers of T&M companies require compliance to RoHS substance restriction limits within the products or subassemblies incorporated into these solutions.

(C) What are the particular characteristics and functions of the RoHS-regulated substance that require its use in this material or component?

Please refer to point B.

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5. Information on Possible preparation for reuse or recycling of waste from EEE and on provisions for appropriate treatment of waste

1) Please indicate if a closed loop system exist for EEE waste of application exists and provide information of its characteristics (method of collection to ensure closed loop, method of treatment, etc.)

There is no specific closed loop system in place. Please find below some specific considerations on the typical End-to-Life Cycle of category 9 industrial Test and Measurement instruments:

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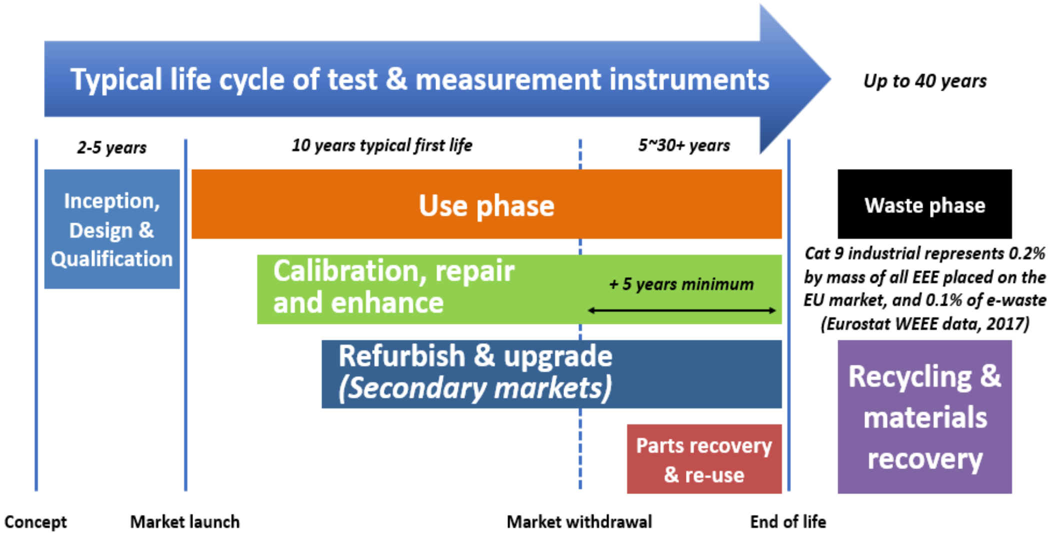
[1] ASLM technology / Supplying the semiconductor industry https://www.asml.com/en/technology?icmp=navigation-homepage-link-technology

The market sectors addressed by industrial test and measurement equipment can in some cases require that the instruments can be maintained in use for decades. The end-to-end lifecycle model below helps to illustrate how the members contribute to the circular economy by assuring the materials they consume to produce the equipment are kept in use for as long as possible.



The nature of industrial test and measurement instrument applications demand highly accurate and reproducible results throughout their life. With a typical first use of 10 years and a total life of up to 40 years, great care is taken during the design and qualification phases to ensure that the stringent performance and reliability requirements are met and must incorporate design for serviceability. This provides a continuous supply chain of equipment for refurbishment with extended life through resale providing great economic and environmental benefit. Whilst the instruments are designed for long-term reliability, failures do occur during such an extended period of use requiring ability to service and replace parts. After market withdrawal, equipment is normally supported for a minimum of five years. Moreover, refurbishing and reselling on the secondary market are crucial in this sector and often account for 4–5% of producer turnover for test and measurement manufacturers.

Due to the cost, reliability, and unique applications of T&M equipment, many customers do not dispose of the equipment, but instead keep it for use at a later date or place it on the secondary market. Therefore, Category 9 Industrial equipment's contribution to the Waste Electrical and Electronic Equipment stream is very small (0.2% by weight of EU WEEE) with industrial WEEE being collected through B2B systems. Consequently, the environmental impact of industrial test and measurement products is insignificant. Nevertheless, test and measurement equipment does enter the waste stream, typically many decades after it is placed on the EU market.

2) Please indicate where relevant:

☒ Article is collected and sent without dismantling for recycling
☒ Article is collected and completely refurbished for reuse
☐ Article is collected and dismantled:
  ☐ The following parts are refurbished for use as spare parts: ______
  ☐ The following parts are subsequently recycled: ______
☐ Article cannot be recycled and is therefore:
  ☐ Sent for energy return
  ☐ Landfilled

3) Please provide information concerning the amount (weight) of RoHS substance present in EEE waste accumulates per annum:

No detailed data available.

☐ In articles which are refurbished ______
☐ In articles which are recycled ______
☐ In articles which are sent for energy return ______
☐ In articles which are landfilled ______

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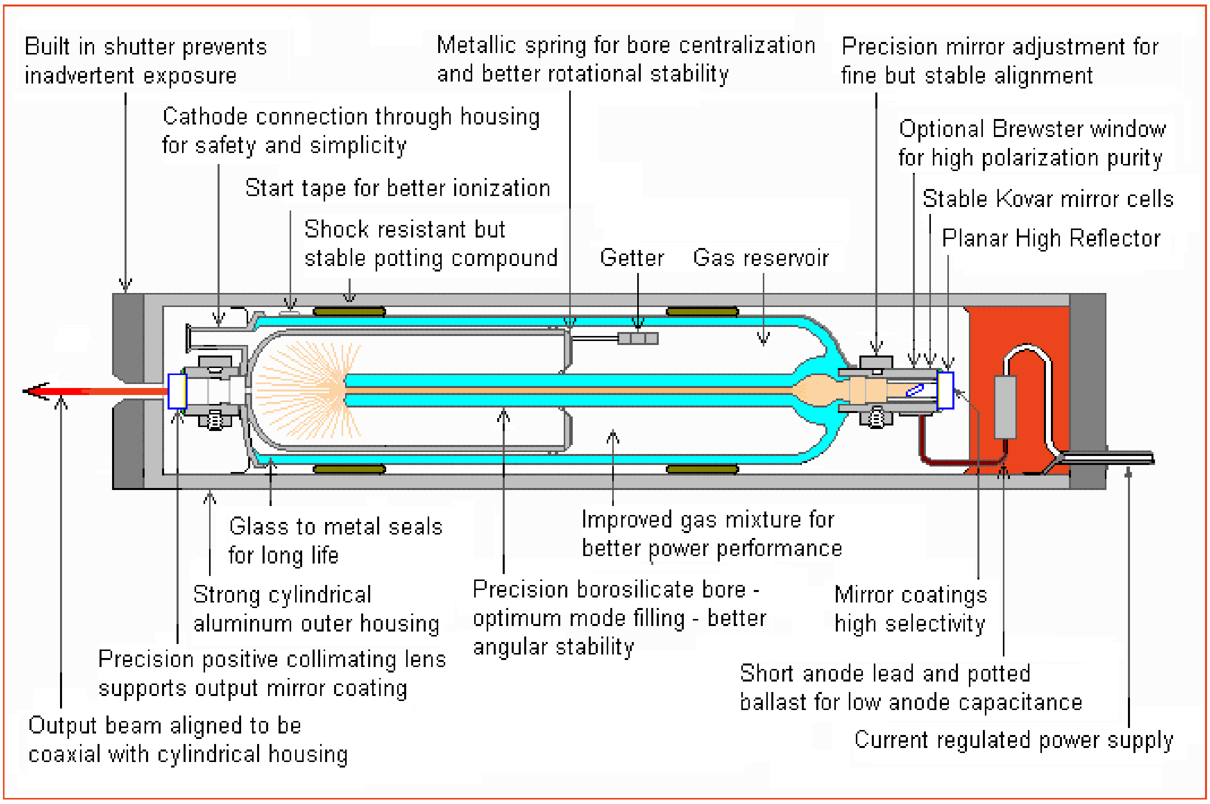
6. Analysis of possible alternative substances

(A) Please provide information if possible alternative applications or alternatives for use of RoHS substances in application exist. Please elaborate analysis on a life-cycle basis, including where available information about independent research, peer-review studies development activities undertaken

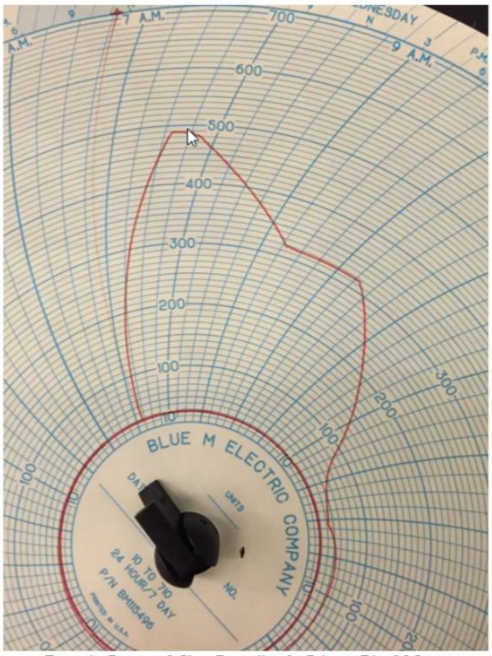
Glass frit bonding uses fine glass particles in a medium that acts as flux and enables adhesion to the mating surfaces. Alternatives that have been suggested or tried are barium oxide (BaO) with a melting point of 1923°C, or strontium oxide, melting point 2531°C.

However, these require processing at conditions well above the maximum workable temperature for borosilicate glass and coefficients of expansion are too different to be usable. PbO, on the other hand, melts at 880°C and when used as a flux in the joining of glass to other materials, it can be processed below 500°C.



Cross Sectional View of a Melles Griot HeNe Laser Head Showing Details of the Plasma Tube

Image from https://www.laserforum.cz/index.php?topic=1215.0. This is an example that shows the glass to metal seals which ensure the gases do not escape and the “borosilicate bore” that is heated to precisely tune.



Example: Program 3 Chart Recording for Primary Blue M Ovens

An example of the thermal profile used to form the glass-metal seal in a helium-neon laser[2] housed in borosilicate glass[3]. Note that the peak is at 490°C.

(B) Please provide information and data to establish reliability of possible substitutes of application and of RoHS materials in application

Please refer to point A.

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7. Proposed actions to develop possible substitutes

(A) Please provide information if actions have been taken to develop further possible alternatives for the application or alternatives for RoHS substances in the application.

There are currently no suitable lead-free alternatives that meet RoHS exemption criteria on the EU market for test & measurement industrial type products and that re-designing of the test & measurement equipment could take approximately four years if an alternative is found.

The unique characteristics of lead make the substance a necessary part for the proper functioning of glass frit, which cannot be substitute with other substances.

[2] A technical overview of laser interferometry equipment can be found via this link

[3] Further information on the characteristics of borosilicate glass (tradename Pyrex) can be found via this link

While certain alternatives have been tested, such as barium oxide and strontium oxide, these cannot be considered as viable alternatives as their melting points (1923°C and 2531°C respectively) require processing above the maximum workable temperature for borosilicate glass. Additionally, their coefficients are too different to be usable.

To the best of knowledge of the Test & Measurement Coalition, lead therefore is the only substance which has the necessary physical and technical characteristics when incorporated in the glass frit to reliably assemble T&M precision lasers. A continuation of exemption 4 Annex IV is therefore warranted as the elimination or substitution of lead is scientifically and technically impracticable.

(B) Please elaborate what stages are necessary for establishment of possible substitute and respective timeframe needed for completion of such stages.

TMC concludes that there are currently no suitable alternatives that meet the physical and technical performance criteria.

With the lack of alternatives for attachment of metal to glass for these lasers, some other method or fundamental design would need to be developed to achieve the necessary reliability.

TMC reports that for an alternative product design, the development time would take a minimum of 4 years. In addition, the validation of the alternative design would lead to the organizations incurring additional expenses. These include labour costs and costs arising from potential product resubmission requirements for testing to various notified bodies to ensure that substitution does not create any electrical and functional safety concerns.

8. Justification according to Article 5(1)(a):

(A) Links to REACH: (substance + substitute)

1) Do any of the following provisions apply to the application described under (A) and (C)?

☒ Authorisation

- ☒ SVHC
- ☒ Candidate list
- ☒ Proposal inclusion Annex XIV
- ☐ Annex XIV

☐ Restriction

- ☐ Annex XVII
- ☐ Registry of intentions

☒ Registration

2) Provide REACH-relevant information received through the supply chain.
Name of document: _____

(B) Elimination/substitution:

1. Can the substance named under 4.(A)1 be eliminated?

☐ Yes. Consequences? _____

☒ No. Justification: Technically not feasible.

2. Can the substance named under 4.(A)1 be substituted?

☐ Yes.

- ☐ Design changes:
- ☐ Other materials:
- ☐ Other substance:

☒ No.

Justification: Technically not feasible.

3. Give details on the reliability of substitutes (technical data + information):_____
4. Describe environmental assessment of substance from 4.(A)1 and possible substitutes with regard to
   1) Environmental impacts: _____
   2) Health impacts: _____
   3) Consumer safety impacts: _____

⇨ Do impacts of substitution outweigh benefits thereof?
Please provide third-party verified assessment on this: _____

(C) Availability of substitutes:

a) Describe supply sources for substitutes: Please refer to point 7 of the submission form.

b) Have you encountered problems with the availability? Describe: Please refer to point 7 of the submission form.

c) Do you consider the price of the substitute to be a problem for the availability?

☐ Yes ☐ No

d) What conditions need to be fulfilled to ensure the availability? _____

(D) Socio-economic impact of substitution:

⇨ What kind of economic effects do you consider related to substitution?

☐ Increase in direct production costs

☐ Increase in fixed costs

☐ Increase in overhead

☒ Possible social impacts within the EU

☒ Possible social impacts external to the EU

☒ Other: Possible economic impacts in the EU.

⇨ Provide sufficient evidence (third-party verified) to support your statement:

A thorough Socio-Economic Analysis has been performed by EPPA[4] at the request of Test & Measurement Coalition (TMC), in view of providing regulators with strong evidence-based findings on the expected social and economic impacts that are expected to occur should the use of lead (Pb) be impacted by the non-renewal of the RoHS exemption.

In line with the existing official guidance from ECHA on the preparation of the Socio-Economic Analysis,[5] the SEA therefore gathers technical and economic information to describe ex-ante in both qualitative and (if feasible) quantitative terms the (orders of magnitude of) socio-economic impacts TMC as well as the relevant EEA supply chain and society are expected to face from the non-renewal of the Lead in glass frit of X-ray tubes and image intensifiers and lead in glass frit binder for assembly of gas lasers and for

[4] www.eppa.com

[5] The ECHA Guideline for the SEA preparation as a part of Application for Authorization is available at: https://echa.europa.eu/documents/10162/23036412/sea_authorisation_en.pdf/aadf96ec-fbfa-4bc7-9740-a3f6ceb68e6e ; The ECHA layout for an SEA to be used in Application for Authorization is available at: https://echa.europa.eu/documents/10162/13637/sea_format_with_instructions_v4_en.docx/0cbc5102-6ba2-2170-480a-0061d2798f55

vacuum tubes that convert electromagnetic radiation into electrons, which would otherwise expire on 21 July 2024. Please see the respective SEA attached.

Overall, the main findings from the SEA conclude that, the total impact of a non-renewal is monetized in the range of 15 million EUR and 40 million EUR (conservative estimates in net losses; potential gains for suppliers of other components have been already taken into account), consisting of: economic impacts (EBIT loss) on test and measurement industrial type products' manufacturers; substitution costs and social impacts (i.e., unemployment in the EU-27).

9. Other relevant information

Please provide additional relevant information to further establish the necessity of your request:

See Socio-Economic Analysis report attached.

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10. Information that should be regarded as proprietary

Please state clearly whether any of the above information should be regarded to as proprietary information. If so, please provide verifiable justification:
