



SOCIO-ECONOMIC ANALYSIS

Of the impacts of non-renewal of Lead (Pb) exemption for test & measurement industrial type products (Category 9) Exemption 34 – Annex III

SUBSTANCE: Lead (Pb)

CAS: 7439-92-1

FROM: Test & Measurement Coalition (TMC)

INTENDED USE: in cermet-based trimmer potentiometer elements.

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Exemption 34 – Annex III

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ABBREVIATIONS

- B2B:** Business-to-Business
- EBIT:** Earnings Before Interest and Taxes
- ECHA:** European Chemicals Agency
- EEA:** European Economic Area
- EEE:** Electrical and Electronic Equipment
- EU:** European Union
- EUR:** Euro (currency)
- IQ:** Intelligence Quotient
- IVF:** In vitro fertilisation
- MIC:** Minimum Inhibitory Concentration
- NPV:** Net Present Value
- Pb:** Lead
- PTF:** Polymer Thick-Film
- R&D:** Research and Development
- RoHS:** Restriction of Hazardous Substances in Electrical and Electronic Equipment
- SAGA:** Suitable Alternative Generally Available
- SEA:** Socio-Economic Analysis
- SEAC:** Committee for Socio-Economic Analysis
- SME:** Small and Medium Enterprise
- SVHC:** Substance of very high concern
- T&M:** Test & Measurement
- TC:** Temperature Coefficient
- TMC:** Test & Measurement Coalition
- WEEE:** Waste from Electrical and Electronic Equipment

1. SUMMARY OF SOCIO-ECONOMIC ANALYSIS

Purpose and methodology

RoHS stands for Restriction of Hazardous Substances and impacts the entire electronics industry and many electrical products. The principal RoHS, also known as Directive 2002/95/EC,¹ originated in the European Union in 2002 and restricted the use of six harmful chemical substances in electric and electronic equipment (EEE), allowed in the EU market. Test & measurement instruments (current Category 9 - industrial) were initially excluded from the scope of RoHS 1. Moreover, **in 2011, the RoHS 1 was revoked and replaced with Directive 2011/65/EU,² which is known as RoHS-Recast or RoHS 2. It expanded the scope of products covered in RoHS 1 and imposed new obligations on EEE importers and manufacturers by adding Categories 8 (medical devices) and 9 (monitoring and control instruments).** RoHS 2 included a long transitional period for Category 9 industrial products, extending to mid-2017. On 4 June 2015, the European Commission Delegated Directive (EU) 2015/863³ amended Annex II of EU RoHS 2 by adding four additional phthalates onto the original list of six restricted substances. Category 9 – Industrial equipment again required an extended transition period before these additional substance restrictions applied in July 2021.

Industrial test and measurement instruments 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 & measurement (T&M) 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. In comparison with other categories of equipment in scope of RoHS 2, **Category 9 – Industrial equipment contributes a fraction of one percent of the total annual quantities of RoHS substances.**

In line with the **existing official guidance from ECHA on the preparation of the Socio-Economic Analysis,⁴ this SEA aims to gather 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 members as well as the relevant EEA supply chain and society are expected to face from the non-renewal of the exemption 34, lead (Pb) exemption in cermet-based trimmer potentiometer elements, which would otherwise expire on 21 July 2024.**

¹ Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32002L0095>.

² Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) Text with EEA relevance. Available at: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32011L0065>.

³ <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32015L0863&from=EN>.

⁴ 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

This SEA has been performed by EPPA⁵ 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.

This SEA is based on information and data gathered from the industrial and professional test and measurement equipment manufacturers. A survey has been conducted by providing a detailed questionnaire to gather information and data from actors likely to be affected by a non-renewal of the RoHS exemption in the EU.

TMC manufacturers industrial and professional test and measurement equipment have participated to the survey. The market share covered by this survey represents approximately 70% of the EEA market. The assessment is, therefore, highly representative and can serve as a basis for defining the anticipated socio-economic impacts resulting from the non-renewal of the RoHS exemption.

The TMC manufacturers indicated that the exemption 34 (Annex III), pertaining lead in cermet-based trimmer potentiometer elements, is widely used across the varying business units for use in a wide portfolio of products in the professional, scientific, laboratory, analytical, clinical and industrial applications. The information reported in this SEA are relevant for the industrial applications in products groups of:

- **bioprocessing equipment automation product** (ranging from large chamber, mixers for processing of drug intermediaries)
- **laboratory products** (ranging from medical devices, and industrial monitoring capital equipment for control instruments including autoclave sterilizers, baths and circulators, biological Safety Cabinets, blood culturing devices, centrifuges, chillers, electrophoresis, environmental chambers, freeze dryers, furnaces, heat controllers, heat exchangers, ovens, refrigerators, freezers, mixers, water purification and many more)
- **chemical analysis related products** which include handheld XRF analysers, dosimetry personnel contamination monitors, and laser spectroscopy.
- **Chromatography, Mass Spectrometry, Gas Chromatography, and Smart Docking Solutions**
- **microbiology product group** which is composed of parts in titration types of equipment.
- **material and structural analysis related products** including electron microscopes and range of spectroscopy products.
- **Clinical Diagnostics**, including drugs of abuse testing, therapeutic drug monitoring, quality control, sepsis diagnosis, prenatal screening.

TMC members have been carefully instructed to base their statements and estimations as much closer to real data or perception of future changes as possible, to have conservative estimates, always putting the protection of the human health and environment upfront.

This SEA covers the safe use of test and measurement equipment, the technical difficulties associated with their substitution via alternatives, the social and economic impacts at different level of the supply chain, and the EU macroeconomic impacts.

⁵ www.eppa.com

Main findings

It is shown that 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 **the re-designing of the test & measurement equipment could take three to five years to matriculate through our portfolio once the component manufacturers have provided a compliant alternate**. Hence, losing the ability to apply Annex III, exemption 34 when considering RoHS conformity for the associated test and measurement industrial products would entail the development of a fairly large number of new alternative compliant materials as well as the increased costs connected to the redesign, retesting, requalification, and replacement of the assembly process.

Overall, the **total impact of a non-renewal of this exemption is monetized in the range of 0.3 billion EUR and 1 billion EUR** (public range; 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 for test and measurement industrial type products' manufacturers, and social impacts (i.e., unemployment in the EU-27).

2. AIMS AND SCOPE OF THE SEA

2.1 Purpose, scope and methodology of SEA

RoHS stands for Restriction of Hazardous Substances and impacts the entire electronics industry and many electrical products. The exemptions listed in Annexes III and IV must adapt to scientific and technical progress as defined in article 5 of Directive 2011/65/EU.⁶ This application is specifically for the **renewal of the Annex III exemption 34, lead (Pb) in cermet-based trimmer potentiometer elements, which would otherwise expire on 21 July 2024**.

This ex-ante Socio-Economic Analysis (SEA) aims to identify and to assess in both qualitative and quantitative terms the socio-economic impacts that are expected to occur should this exemption not be renewed (i.e., the likely impacts in the non-exemption scenario as compared to the baseline business-as-usual scenario).

A survey has been conducted by providing a detailed questionnaire to gather information and data from industrial and professional test and measurement equipment manufacturers likely to be affected by a non-renewal of the RoHS exemption in the EU.

⁶ Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast) Text with EEA relevance. Available at: <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32011L0065>.

The participating company has provided socio-economic data in view of extrapolating (based on a large total market share) the impacts for the whole market in a conservative approach, as further detailed below. Based on the weight of RoHS substances used in their products, the market share covered by this survey represents approximately 70% of the EEA market. **The estimates reported in this socio-economic analysis should be considered as a minimum (lower bound) of the expected impacts of a non-renewal of the Annex III, exemption 34.**

From a geographical perspective, this analysis focuses on the European Economic Area (EEA) territory, comprising the European Union (EU-27), Iceland, Liechtenstein, and Norway. For this study we have followed “SEAC’s approach to assessing changes in producer surplus”.⁷ As there is no alternative available in general (SAGA)⁸ to lead (Pb), a **4-year time horizon for this assessment** has been considered, starting from the year 2024, (year of the expiry of the current exemption). In other terms, the SEA accounts for the costs and benefits to the EEA society in the event of RoHS substance is not granted the renewal of the RoHS exemption in test and measurement industrial type products.

Future monetary values have been estimated by using the concept of net present value (NPV), adopting a 4% annual discount rate, which is the standard discount rate, adopted by the European Commission and European agencies (e.g., ECHA) in impacts assessments. All monetized values have been adjusted to a base year, assumed to be 2024. Information and data have been aggregated and anonymized. Statements and estimations from the participating company are as close to real data or perception of future changes as possible.

2.2 Overview of industrial test and measurement instruments and their value chain

General overview

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 are widely diversified, with TMC members each having typically 2,000 to 3,000 products currently made available on the market. These are highly complex, sophisticated electronic

⁷https://echa.europa.eu/documents/10162/0/afa_seac_surplus-loss_seac-52_en.pdf/5e24c796-d6fa-d8cc-882c-df887c6cf6be?t=1633422139138

⁸https://echa.europa.eu/documents/10162/13637/ec_note_suitable_alternative_in_general.pdf/5d0f551b-92b5-3157-8fdf-f2507cf071c1

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 necessary 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.

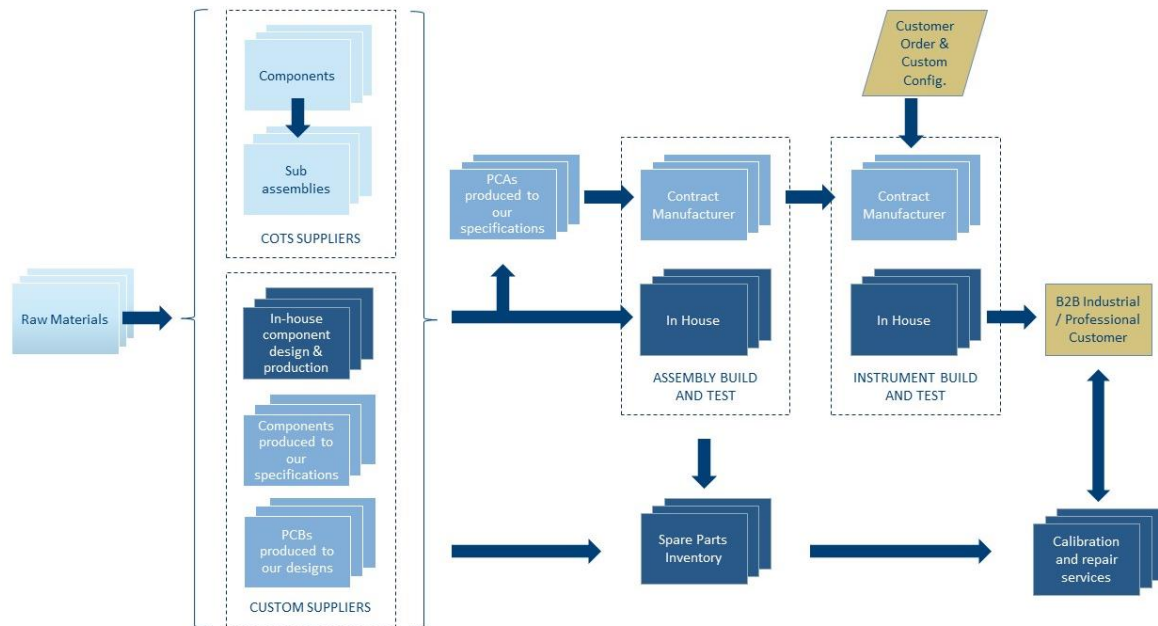
Considering the EU added-value, test and measurement equipment is manufactured and sold in relatively small volumes (per instrument design) and placed on the global market. There is an added value in community level action, which guarantees more coherent and consistent rules across Europe. But with the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

The 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. The nature of the tests and measurements made by industrial equipment necessitates that the equipment performing those tests are 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 than a typical consumer product.

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 typically made by sole, boutique 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.

Typical supply chain

The typical supply chain for test and measurement industrial type products is as follows:



- Raw materials are manufactured globally for component production;
- Components are manufactured and are then assembled into printed circuit board (PCB) sub-assemblies. These are either manufactured as commercial off-the-shelf (COTS) products or custom made according to in-house Test & Measurement designs and specifications;
- Sub-assemblies are integrated into printed circuit assemblies (PCA);
- Assemblies are built and tested, either in-house or by contract manufacturers;
- In response to customer orders or for inventory, finished devices are configured, built, and tested at a single site for global distribution;
- End products are supplied into the EU market either directly or through distributors to industrial and professional customers (B2B market);
- Spare parts are made available from the supply chain and utilised in the ongoing support (including servicing, calibration, repair, and refurbishment services) typically provided in-house by Test & Measurement members.

3. ANALYSIS OF ALTERNATIVES

3.1 Function and technical performance of Lead (Pb) and Pb-based industrial type 9 products

The cermet potentiometer is typically used to calibrate a specific measurement or control parameter so that the final product can meet that exacting measurement resolution or output control parameter that the application requires. Whenever there is a critical measurement that can vary production unit to production unit (because of component tolerances) then precise calibration adjustment is required to each product during the manufacturing process. Once calibrated in the factory, that setting must remain stable during storage, transport and use for the installed life of the product, only checked during annual calibration or the preventative maintenance program for the product in question. A drift in a measurement or control parameter would lead to previous passing results being questioned

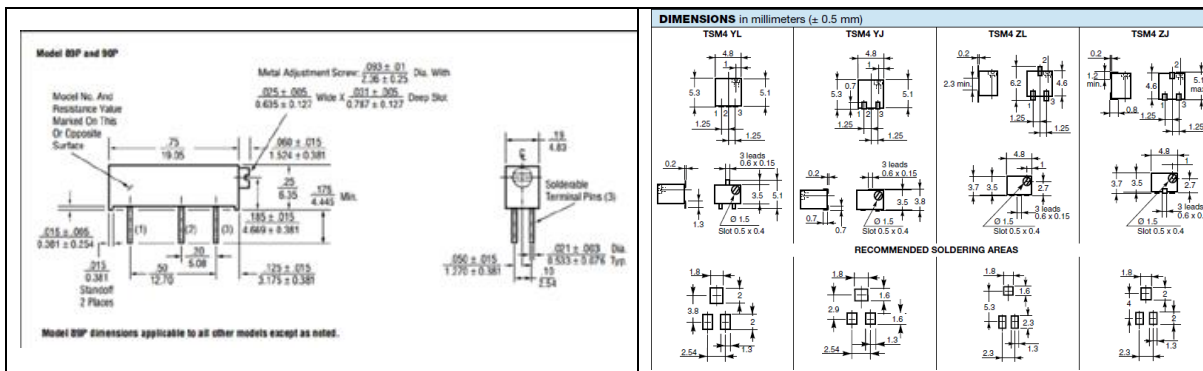
or repeated and the potential recall of products manufactured by the processors utilizing instrumentation relying on these cermet potentiometers that had been previously released.

The components that utilize this specific exemption are used as a calibration tool for test and measurement boards T&M companies specifically design, and also used by T&M instrument vendors for critical components they provide to the T&M Coalition (like switch mode power supplies or modular temperature controllers or calibratable probes). This includes:

1. Multi-turn trimmers



These are PCB mounted for both plated through and surface mount application, so any replacements would need to match the footprint or require a complete PCB re-layout to accommodate any footprint alterations.



As these are used for precise parameter calibrations which will need to be adjusted, corrected during periodic, on site, calibrations, then the profile of the trimming pot is also critical. To enable access to the trimming screw during an energized service phase, openings in protective enclosures have sometimes been aligned based on the trimming pot profile to allow adjustments to be made safely, especially where hazardous voltages are present. T&M companies have already sought out alternatives for these trimming devices, but all that matched our criteria, regardless of the manufacturer utilize this same exemption.

Parameter	Range	Notes
Electrical		
Resistance, tolerance, input voltage, slider current, etc.	Varied range based on application in question	Easiest to be able to select a like for like comparison
Dielectric strength, insulation resistance	Varied range based on application in question	Easiest to be able to select a like for like comparison
Resolution	Essentially infinite	This infinitesimal adjustment is critical.

Contact resistance variation, maximum	1% or 1Ω	The PbO in the glass substrate makes this possible
Environmental		
Temperature Coefficient	±100 ppm/°C	The PbO in the glass substrate makes this possible
Operating Temperature range	-55°C to +125°C	These parameters ensure stability through the ISTA transport requirements
Thermal Shock	5 cycles, -55°C to +125°C	
Shock, 6ms sawtooth	100G's	
Vibration	20G's	

Types of products that utilize these trimming cermet pots:

- Relative Humidity sensors
- Power supplies
- Dosimetry Readers
- Temperature controller modules
- Sample Prep Liquid Chromatography
- Liquid Chromatography / Mass Spectrometry
- CO₂ Incubators
- Environmental Chambers
- Minimum Inhibitory Concentration (MIC) Lab test automation
- Spectroscopy Equipment
- Electron Microscopes

When factory set calibrations are relied upon – for example CO₂ incubators and environmental chambers that use RH sensors that utilize these trim pots, these calibration parameters must retain their calibration point while in storage and transport – including the ISTA transport vibration tests and thermo cycling with transport temperatures up to 70°C. Furthermore, for incubators they operate in laboratory environments at up to 33°C and relative humidity up to 80% RH and have an internal decontamination temperature routine that operates at up to 90°C and yet must still maintain the calibration accuracy for critical incubation (e.g., IVF) at +/- 0.5°C.

Based on the full material disclosure included below, the RoHS exemption 34 Annex III part is used specifically as PbO within the glass matrix of the conductor (the potentiometer sweep arm) and the resistor itself which represents only 0.14% of the mass of the potentiometer. Out of a total mass of 1.2g per cermet potentiometer, the PbO totals 0.7mg. The types of products listed above are typically cap expenditure purchases and represent < 3K products sold into the EU, so the total PbO import is ≤ **10g** per year for Cat 9, Industrial.

Full material disclosure for the most common cermet trim pot family used:

Model 89LF BOM-style material declaration. BI Technologies Corporation

8/16/2010

No content here is banned per E.U. R.o.H.S.. Average mass of 89LF trimmer is 1.2 grams each. Prepared by Eric Arnold (714) 447-2565
Weights above 1 milligram rounded to the nearest mg. Values less than 1 milligram given in scientific notation.

Sub-component	Material	% of total mass	Substance name	CAS #	Substance Weight (grams)	Special classification
Housing	PBT blend	33.0%	PBT	26062-94-2	0.303	
			Fiberglass	65997-17-3	0.081	
			SbO	1309-64-4	0.020	Fire retardant
Shaft	Brass	28.8%	Cu	7440-50-8	0.217	
			Zn	7440-66-6	0.125	
			Pb in brass	7439-92-1	0.011	Pb in copper alloy (RoHS exempt)
Slider block	PBT blend	2.1%	PBT	009002-84-0	0.019	
			Fiberglass	65997-17-3	0.006	
			PTFE	009002-84-0	0.001	
Contact	Cu alloy wire	0.13%	Cu	7440-50-8	8.43E-04	
			Zn	7440-66-6	4.14E-04	
			Ni	7440-02-0	2.76E-04	
	Nickel alloy bar	0.08%	Cu	7440-50-8	5.00E-07	
			Ni	7440-02-0	8.46E-04	
			C	7440-44-0	6.00E-07	
			Mn	7439-96-5	2.50E-06	
			Fe	7439-89-6	1.50E-04	
			S	7704-34-9	5.00E-07	
			Si	7440-21-3	5.00E-08	
Terminals	Cu wire	4.9%	Cu	7440-50-8	0.060	
	Sn plating	0.002%	Sn	7440-31-5	1.73E-05	
Potting	Epoxy	11.0%	SiO2, amorphous	7631-86-9	0.007	
			modified aliphatic polyamine	trade secret	0.027	
			hydantoin epoxy resin	15336-82-0	0.007	
			epichlorohydrin / polyglycol epoxy resin	26142-30-3	0.007	
			epichlorohydrin/bisphenol A epoxy resin	unknown	0.081	BPA
			cycloaliphatic epoxy resin	2386-87-0	0.007	
Substrate	Alumina	19.8%	Al2O3	1344-28-1	0.233	
			SiO2, amorphous	7631-86-9	2.42E-03	
			TiO2	13463-67-7	1.21E-03	
			FeO2	1345-25-1	0.001	
			MnO2	1313-13-9	0.002	
			MgO	1309-48-4	0.001	
			CaO	1305-78-8	0.001	
Conductor	AgPd thick film	0.05%	Al2O3	1344-28-1	4.34E-06	
			SiO2, amorphous	7631-86-9	1.90E-05	
			TiO2	13463-67-7	4.34E-06	
			PbO	1317-36-8	2.59E-05	RoHS exemption 34
			ZnO	1314-13-2	4.71E-06	
			B2O3	1303-86-2	1.60E-06	
			ZrO2	1314-23-4	3.84E-07	
			BaO	1304-28-5	4.93E-06	
			Ag	7440-22-4	5.17E-04	
			Pd	7440-05-3	5.76E-05	
Resistor	Ruthenate thick film	0.09%	Al2O3	1344-28-1	1.47E-05	
			SiO2, amorphous	7631-86-9	1.24E-04	
			TiO2	13463-67-7	1.47E-05	
			MnO2	1313-13-9	6.66E-06	
			PbO	1317-36-8	3.24E-04	RoHS exemption 34
			ZnO	1314-13-2	3.54E-05	
			B2O3	1303-86-2	4.14E-05	
			ZrO2	1314-23-4	9.94E-06	
			BaO	1304-28-5	1.68E-05	
			Ag	7440-22-4	4.00E-05	
			Pd	7440-05-3	5.10E-05	
			Steatite	14807-96-6	2.22E-06	
			Bi2Ru2O6	unknown	5.00E-05	
			Pb2Ru2O6+x	unknown	3.55E-04	RoHS exemption 34
			RuO2	12036-10-1	2.33E-05	

Function of lead (Pb)

The physical function of lead in the components that are utilised by the T&M products are like those outlined in a previous exemption renewal request for exemption 7(c)-I submitted by Bourns Inc. and the Umbrella Project:⁹

Thick film is a resistive and conductive film greater than 0.0001” thick resulting from firing a paste or ink that has been deposited on a ceramic substrate. The PbO within the glass substrate with the resistive ink allows the thick film to be fired at lower temperatures. This makes the resultant cermet to have the thermal characteristics and resistive value stability of the ceramic material and enable the electric resistance of the material to remain stable under changing temperatures.

Specifically, the lead containing cermet potentiometers have the following advantageous characteristics:¹⁰

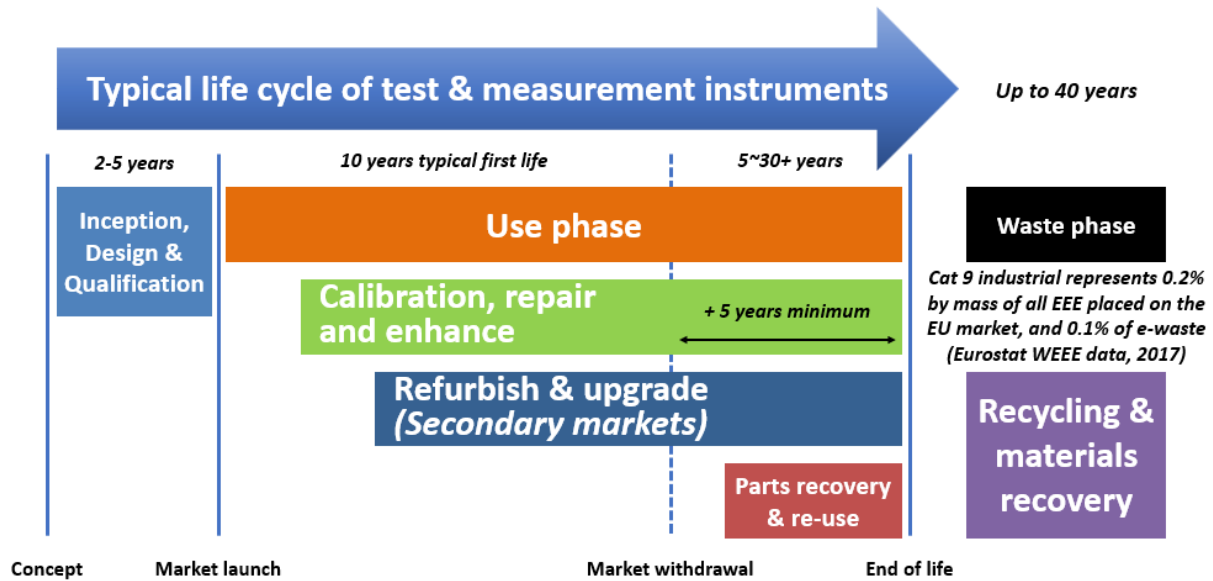
- Long lifetime, typically up to 50,000 rotation cycles (non-lead solutions are usually rated at 25,000 cycles)
- Low temperature coefficient (TC). The TC for a typical cermet potentiometer is 150 ppm/°C, which is lower than other types of potentiometers.
- High level of heat dissipation
- Wide operating temperature range (-55°C to +125°C)
- Higher wattage rating, e.g., 3 watts
- Low reactance at high maximum frequency
- Good resolution (resolution is the smallest possible change in resistance ratio)
- Low electrical noise when resistance is adjusted
- Small size enabling use in high density microelectronic circuits
- Preliminary tests with LF inks suggest that a lubricant is necessary. However, even with a lubricant, the same performance will not be reached with all ohmic values.

3.2 Typical Industrial Test and Measurement End-to-End Life Cycle

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.

⁹ Previous RoHS exemptions requests are publicly available and downloadable from the EU Commission webpages. Available at: https://environment.ec.europa.eu/topics/waste-and-recycling/rohs-directive/implementation-rohs-directive_en

¹⁰ Ibid.



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 negligible. Nevertheless, test and measurement equipment does enter the waste stream, typically many decades after it is placed on the EU market.

3.3 Assessment of potential alternatives to lead (Pb)

There are certain studies that have been conducted to investigate the suitability of alternative substances. As outlined in renewal application for exemption 34 by the Umbrella Project, comparisons between a Thick-Film (Cermet) Device and a Polymer Thick-Film (PTF) Device, which is the current closest alternate substrate material for a potentiometer with infinite resolution, have been made (as detailed below):

ELECTRICAL CHARACTERISTIC	Cermet	PTF	Notes
STANDARD RESISTANCE RANGE	10Ω to 1MΩ	1kΩ to 1MΩ	
RESISTANCE TOLERANCE (TRIMMED)	±0.5%	±1%	

INDEPENDENT LINEARITY	Down to $\pm 0.5\%$	Down to $\pm 2\%$	
RESISTIVITY	Down to $3\mu\Omega.cm$	$10\mu\Omega.cm$	
<u>ENVIRONMENTAL CHARACTERISTIC</u>	<u>Cermet</u>	<u>PTF</u>	<u>Notes</u>
POWER RATING	0.5W	0.2W	
TEMPERATURE RANGE	-55°C to +150°C	-10°C to +125°C	
HUMIDITY ¹¹	$\pm 1\%$ TRS	$\pm 10\%$ TRS	See Footnote
VIBRATION ¹²	$\pm 1\%$ TRS	$\pm 2\%$ TRS	See Footnote
SHOCK ¹³	$\pm 1\%$ TRS	$\pm 2\%$ TRS	See Footnote

The environmental characteristics alone make a PTF unsuitable for many trim pot applications that can be used in a laboratory environment.

In addition, the Test & Measurement Coalition has conducted an AI assisted research on potential other suitable alternatives.

3.3.1 Challenges with substitution with alternatives

Members of the Test & Measurement Coalition have pointed out that they principally rely on their component suppliers to find alternatives since most of the exemptions used in their products are not produced on-site by the company but bought off-the-shelf from suppliers. Therefore, meeting with suppliers to understand their (potential) alternatives, getting samples, measuring, and testing is the typical process to evaluate the suitability of potential alternatives which can take up to 4 years, as reported by the companies. The process would then be followed by the validation of the potential suitable alternatives accompanied by testing done by the manufacturers by the finished T&M equipment with the validation of the functionality and performance being their responsibility as well. However, the companies noted the impacts deriving from their suppliers as, depending on the complexity, there can be little to significant time and resources needed to validate alternatives.

The companies reported that the validation period alone would take a minimum of 6 months and up to a year after the delivery of suitable alternatives per product. It is significant to note that this validation period would only apply if the component were a fit, form, and function drop-in replacement. If any design changes to the exemption-free part of the product would be required to accommodate for the alternative, a validation period would be required for each redesigned product that used to utilize the component that relied on the exemption. Moreover, the validation 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.

¹¹ Cermet is tested to MIL-STD-202 Method 106 which cycles from 25% RH to 100%RH, PTF is only tested at 50%RH

¹² Cermet is tested at 30G vibration, PTF is only tested at 15G vibration

¹³ Cermet is tested at 100G shock, PTF is only tested at 30G shock

If a new substance free part is available, this part must be qualified for use by performing a variety of tasks, as described above. Due to the complexity and diversity of the applications, this must be done individually by each company for each product group. This process would divert resources from other projects and increase the cost to ensure continued availability of these products. This validation and testing process varies according to part complexity and impact upon the final product design; which can be categorised as low, medium, and high:

- **Low complexity** parts are the off-the-shelf components or hardware parts that do not have a substantial performance impact. Replacement can be done based on supplier information, assuming a form/fit/function compliance, with standard manufacturing, testing, and validation processes. Based on process timescales reported by a T&M coalition company, the average time that it can take for these parts to be replaced ranges from **3 to 6 months**.
- **Medium complexity** parts are more complex sub-assembly electronic parts, such as small motors, which need additional validation for their performance. These parts are often commercial assemblies that are generally available to the electronic industry, and are utilised by the Test & Measurement coalition companies. Replacement of these assemblies, like-for-like, requires testing and validation prior to being integrated into the manufacturing process. The average time to find an alternative for medium complexity parts for production is reported to range from **6 to 12 months**.
- **High Complexity** parts are the complex sub-assemblies or parts that have a significant impact on performance of the company's products or play a critical role in overall safety of the products. These parts need to go through extensive validation for performance and/or compliances for varying regulations before the appropriate files can be updated and the proper competent authorities or regulatory bodies can be notified prior to purchase of parts for validation. The average time that it would take to find an alternative for high complexity parts for production is up to 1 year for additional testing. Where the exemption directly impacts the performance of that component (e.g., a centrifuge rotor) the evaluation of the replacement could take from **3 to 5 years**.

Taking everything into consideration, the substitution process would take a minimum of 5-7 years and would result in expenses of at least [CONF.] EUR for the participating companies.

3.4 Overall conclusion on suitability and availability of alternatives

EPPA and TMC conducted a study with FINDEST to search for a suitable replacement for lead in potentiometer devices or similar electronics components where infinite sliding variability is the primary function in question. There is an extensive list of secondary constraints which includes electrical and environmental properties such as long lifetime, low temperature coefficient, wide operating temperatures, high wattage and high level of heat dissipation. The objective of the AI search was to identify a material capable of replacing lead oxide that would match the environmental stability of lead oxide (heat, shock, vibration, etc.) while avoiding a redesign of the trimmer parts by the changing material. The constraints were:

- Material which can enable infinitely variable contact resistance.
- Match electrical stability of lead oxide; resistance, resolution, etc.

- Cermet materials as a substrate.
- Non-toxic to avoid any regrettable substitutions.
- Melting point.

The reference substrate material that is already suitable for the mechanical and vibration resistance and is currently used in a PbO based cermet potentiometers is Aluminium Nitride. To substitute both the substrate and the oxide would have made the search an order of magnitude more complex and so was not approached at this time. The material properties for Aluminium Nitride (AlN) are:

- High thermal conductivity – up to 321 W/(m.K)
- An electrical insulator
- Temperature stability, melting point:
 - o In inert atmospheres 2200°C
 - o In a vacuum 1800°C
 - o In air, 1370°C, assuming that a 5-10 nm surface oxide layer has formed which happens at room temperature when it is exposed to air

Material	Toxic (Y/N)	Melting point	Notes
Lead oxide (PbO)	Y	888°C	Current metal oxide in use today.
Barium Oxide BaO	Y	1923°C	Melting point too high and toxic, so a regrettable substitution.
Zinc oxide (ZnO)	N	1975°C	Melting point too high, so would need an alternate substrate or a new manufacturing process that employed an inert atmosphere.
Lithium Oxide (Li ₂ O)	Y	1438°C	Melting point too high and toxic, so a regrettable substitution.
Magnesium Oxide (MgO)	N	2852°C	Melting point too high, so would need an alternate substrate
Indium Tin Oxide (ITO)	Y	1526 - 1926°C	Melting point too high and toxic, so a regrettable substitution.
Iron / Ferric Oxide (Fe ₂ O ₃)	N	1539°C	Melting point too high, so would need an alternate substrate or a new manufacturing process that employed an inert atmosphere or a vacuum.
Strontium Oxide (SrO)	Y	2531°C	Melting point too high and toxic, so a regrettable substitution.
Cerium Oxide (CeO ₂)	Y	2400°C	Melting point too high and toxic, so a regrettable substitution.
Bismuth Oxide (Bi ₂ O ₃)	Y	817°C	<u>Though a potential substitute, the toxicity may make it a regrettable one.</u>
Sodium Bismuth Titanate (NBT)	N	1290°C	<u>May be a viable alternate</u>
Calcium Titanate Perovskite (CaTiO ₃)	Y	1975°C	Melting point too high and toxic, so a regrettable substitution.
Silicon Dioxide (SiO ₂)	N	1610°C	Melting point too high, so would need an alternate substrate or a new manufacturing process that employed an inert atmosphere or a vacuum.

Lanthanum Oxide (La₂O₃)	N	2315°C	Melting point too high, so would need an alternate substrate.
Lignocellulose-lead oxide (LC/PbO₂)	Y	-	A regrettable substitution as lead dioxide is a probable carcinogen.
Lead-free halide perovskites (Cs₃Sb₂I₉)			Too early to report.
Potassium sodium niobate (KNN)	Y	-	Toxic, and current KNN-based ceramics have a deteriorative microstructure that restricts further developments.

Summary:

Of the alternates investigated, most were eliminated either because they were also toxic or had a melting point too high for current substrate materials and the manufacturing processes employed. Only Sodium Bismuth Titanate has the potential to be used but would require further investigation. Bismuth Oxide is another alternate though the toxicity needs to be assessed to see if it would be a regrettable substitution. However, in both cases we currently have not identified any alternates cermet resistor that employ these materials and are commercially available.

4. ANALYSIS OF IMPACTS

4.1 Human health and environmental impacts

Lead is considered to be a reproductive toxin. Given its hazardous properties, lead is on the REACH candidate list of SVHC. Annex II of the Directive 2011/65/EU (RoHS) specifies the restricted substances referred to in Article 4(1) and maximum concentration values tolerated by weight in homogeneous materials. The maximum concentration value for lead (Pb) tolerated by weight in homogenous materials is 0.1% unless there is an application listed in Annex III or IV available to the product category of EEE.

TMC members emphasized that the quantity of lead utilized in their homogeneous materials varies based on the application. Therefore, based on literature review, companies indicated that the homogeneous materials typically contain approximately 44.6% lead by weight with the annual amount of less 10 g of Pb entering the EU market annually through application for which the exemption is requested.

4.1.1 Reduction in the quantity of lead (Pb) placed on the EEA market

The participating companies have reported that no change in releases of lead to the environment are likely during equipment production or use phases of the concerned products over the next seven years as a consequence of the revocation of the RoHS exemption. During test and measurement equipment production, the solder is internal to the component and does not create an exposure during assembly. At component manufacturers, waste and exposure to lead is considered controlled through good OSH management practices.

Under normal conditions of equipment use, the lead content associated with the application of Exemption 34 is encapsulated within the equipment enclosure and will neither be touched nor released to the environment.¹⁴ As this equipment is sold B2B for professional/industrial use only, equipment that finally reaches end-of-life will be appropriately processed by certified recyclers who are obliged to have suitable controls to avoid any environmental releases and are notified of the presence of the substance under the producers' obligation to provide a SCIP notification.

As a result of the participating companies' relatively low consumption of parts, in comparison to the product Categories 1-7 and 10, renewing this exemption for Category 9 will have a minimal impact on the environment. As previously indicated, Category 9 Industrial producers are only responsible for 0.2% of annual WEEE production. The number of components relying on this exemption that are specialized for test and measurement applications combined with their collective use provide a strong rationale to keep the specialized components, that rely on this exemption, in production. The manufacturing of specialized components represents a minute fraction of the total exemption usage referenced in this report. The majority of the components that utilize this exemption, that constitute Category 9 industrial usage, are common to all product categories. The component manufacturers therefore rely on volume use of the other categories to justify their continued production. Renewing this exemption for only Category 9 for the full 7 years will not extend the production life of these higher volume components beyond the exemption renewal period assigned to Categories 1-7 and 10. It will, however, enable the Test & Measurement coalition members to buy sufficient (relatively small) quantities to update the design and continue to use the relevant components for an extended period. As a result, a renewal of this exemption will have a minimal environmental impact and has a positive socio-economic impact by enabling the continued production of Category 9 products critical to the health and welfare of the EU (and global) society whilst the multi-year redesign process is executed.

4.1.2 Additional waste in case of a non-compliant stock

There are no, or at least minimal, expected additional waste before the end of the regular lifetime (non-compliant stock) reported by the companies. Finished goods inventory is expected to be minimal as T&M equipment manufacturers' production is based on short-term demand, or even per order. Any non-compliant materials will be consumed through sale to other non-EEA markets.

Conversely, T&M equipment manufacturers emphasised that exemption 34 is utilized in part to improve reliability and longevity of components. A reduced product lifetime would be expected leading to an increase in electronic waste and virgin material use in the replacement.¹⁵

4.2 Economic impacts

The sections below provide a general overview of the social and economic impacts, considering business impacts on manufacturers of test and measurement equipment, market impacts (i.e., on the

¹⁴ All substance is captured in sealed electrical enclosures and chemically or metallurgically bound in alloys, glasses, or ceramics.

¹⁵ Specific data on the difference between alternatives are not available.

product market), substitution costs, and broader macroeconomic consequences resulting from a potential non-renewal of the exemption 34.

4.2.1 Business impacts on manufacturers

A survey of TMC members was utilized in preparation of this report. **TMC manufacturers of industrial ana professional test and measurement equipment have participated to the survey. The data received have been aggregated.** These companies are among the biggest producers in the EEA test and measurement equipment market. The market share covered by this survey is more than 70% of the whole EEA test and measurement equipment market. The assessment is, therefore, highly representative. This market share can be used to obtain reliable estimates for the EEA market via extrapolation, as detailed below for the assessment of the economic impacts.

Products manufactured by these companies are typically made available on the market for a period of 10 years from market launch until discontinuance. A further five to seven years of guaranteed support life follows discontinuance to assure availability of spare parts. The lifetime of any given unit can often be extended through regular maintenance and servicing. Under normal conditions of use and availability of spare parts, products can remain in use by customers for more than 25 years, supported by companies' repair and calibration services.

Due to the very specialized nature of the industrial test and measurement equipment, sales volumes are in many orders of magnitude lower than those of consumer products. Industrial test and measurement equipment are not subject to fast-paced changes in market patterns. The specialized nature reflects in the prices. The prices of these products vary greatly, depending on factors such as cost, size, and complexity.

The T&M Coalition member companies have declared that several product lines that apply to this exemption would be impacted. During 2021, >3000 units of these products were placed on the EEA market. This was a typical sales year and the volumes are considered representative for annual volumes. **The income generated through the sale of these products, likely to be affected by a non-renewal of the Annex III exemption 34, is estimated at approximately [CONF.] EUR/year.**

Therefore, the non-renewal of the Annex III exemption 34 exemption would have significant impacts on their business and customers. The company reported that due to the specificity of the equipment, there are no known methods to produce compliant equipment meeting the specific performance specifications of production today. Should the exemption not be renewed, this equipment would have to be withdrawn from the EEA market.

Consequently, the TMC manufacturers would lose business in the EEA. The direct cost of a non-renewal of the exemption is represented by the loss of the contribution to the EEA economy of the EBIT generated by T&M manufacturers using lead within their instruments. The relevant economic measure to quantify this economic impact is given by EBIT. The monetization (net present value, NPV, with 4% discount rate) of this economic impact (lost EBIT) is reported below.

Therefore, if Annex III, exemption 34 would not be renewed,¹⁶ it is estimated that the T&M manufacturers would face a net EBIT loss of approximately [CONF.] EUR/year (rounded). **Over four years, the total impact is expected to be approximately [CONF.] EUR (NPV, 4% d.r.)¹⁷ for the TMC member companies** (manufacturers of test and measurement instruments).

We can use the market share of the test and measurement equipment manufactured by the participating companies to extrapolate **the total economic impact in the EEA across all manufacturers**. The market share covered by this survey is more than 70% of the whole EEA test and measurement equipment market. This market share is used for the extrapolation of the impacts for the whole EEA market in a conservative approach. **The total impact for the EEA market (manufacturers of test and measurement equipment) would therefore be in the range of [CONF.] EUR (derived above) and [CONF.] EUR ([CONF.] EUR x 1/0.70).**

Other companies may benefit from a negative regulatory outcome for lead, especially, competitors based outside the EEA. Indeed, RoHS restrictions would affect equally the whole EEA T&M industry. The corresponding loss in value added (i.e., loss in EBIT) can be considered an EEA industry-wide impact.

It must be noted that what occurs in Europe also has repercussions on other markets, such as the Asian market. This is because CE mark is used by T&M equipment manufacturer as evidence that their products are suitable for the EU and therefore are considered of acceptable quality in a non-EEA location. Consequently, the economic consequences of a non-renewal for lead in exemption 34 would result in larger impacts for the industry than those reported above.

Given the specificity and complexity of industrial test and measurement instruments, it is extremely challenging for the test and measurement sector to adapt to frequent changes of the lead restriction in scope. The main challenge that has been raised by the company is the fact that deadlines provided by authorities are considered too tight for business adaptability and to develop alternative products. The existing maximum renewal duration of up to 7 years is considerably shorter than product development lifecycles. This renewal request is therefore made to cover the full seven-year maximum duration.

Substitution costs for test and measurement equipment manufacturers

Most of the components utilizing exemption 34 incorporated into T&M equipment are COTS parts. Consequently, T&M manufacturers are heavily reliant on their suppliers to identify alternatives.

¹⁶ Company was asked to consider how the revenues (and EBIT) for year 2022 were impacted under the assumption that a RoHS restriction on lead in test and measurement industrial products types were to be fully adopted with immediate effect (i.e., in 2023).

¹⁷ Using the Excel function =PV(4%,4,-[CONF.],0,0).

Overall, it is anticipated that three to five years are needed for re-designing (i.e., implementing the substitution, or concentration reduction of lead) in a full product.¹⁸ This if a substitution candidate could be identified. Moreover, this is highly dependent on the complexity of change and the final product.

As the companies do not manufacture the majority of parts incorporated into test and measurement equipment and purchase the most parts from the respective suppliers, **implementing re-designing would result in longer timelines to convert the entire portfolio and significant cost increases.** The change would involve researching an alternate component, assembling it into a test product, and evaluating the new product for functionality, hardware and software performance, reliability, EMC, safety, manufacturability etc.

As mentioned previously, most products use various components throughout the product and various exemptions. It is common that a single component may use several exemptions. Exemption 34 would be especially burdensome (if feasible) since it is used in complex PCBA components. Changing out these components may require complex board re-design and a full suite of product validation.

Therefore, **the T&M Coalition member companies have indicated that the implementation of substitution or concentration reduction of lead would cost approximately [CONF.] EUR (rounded),¹⁹** including validation and testing, engineering, quality and administrative costs. This also includes incremental investment necessary to characterize potential substitutes, and where practicable, tailor production processes to assure existing product's published specifications can be maintained.

In reality, the switching costs are likely to be much larger than the estimate above. By making use of the market share of about 70% covered in this SEA, we can extrapolate a **total switching cost of approximately [CONF.] EUR (= [CONF.] EUR * 1/70%)** for all manufacturers of test and measurement equipment industrial products.

4.3 Wider economic impacts

It is also important to consider the wider macroeconomic impacts and consequences on the EU society at large, by focusing on the expected consequences for the EEA market. In particular, there are concerns on the overall EU trade balance (increase of imported test and measurement industrial product types) and on the competitiveness of EEA market.

Impacts on the market – Quality and costs

¹⁸Average of the estimated timelines provided by TMC manufacturers.

¹⁹ECB exchange rate on 11 October 2022 (1 EUR = 0.9723). Available at: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-usd.en.html.

If Annex III, exemption 34 would no longer be available for use in test and measurement equipment, sectors relying on these products would be particularly affected. Manufacturers of chips and electric and electrical equipment may experience a decreased availability for test and measurement industrial equipment.

For the products that utilize Annex III, exemption 34 it is not possible to remove the exempt components. Conversion to become exemption-free, should the use of alternatives be feasible, would be prioritized by EEA revenue as it likely would not be worth the investment to re-design all products to be exemption-free. Even if there were suitable alternatives on the market today, it is expected to take several years or more to convert the entire companies' portfolio. This would likely result in a withdrawal of products from the market until products are converted. Any low revenue products that require significant re-design, or products that are within a few years of obsolescence, are likely to be withdrawn from the EEA market.

The impact of reduced volumes manufactured will also have a **significant impact on the fixed costs of various supply chain actors**. Participating companies would also be strained by increased costs associated with addressing new product development and resourcing components for manufacturing. As a result, prices of final products would increase.

Companies participating to the survey anticipated a price increase in the range of 20-30% due to the use of specialty components and loss of economies of scale.

Impacts on suppliers

The TMC manufacturers' businesses maintain a large supply chain that supplies components, materials, and performs contract manufacturing operations on its behalf. This supply chain is global and not limited to businesses located in the EEA. There are a number of actors in the production of the impacted equipment produced by the TMC manufacturers: component and sub assembly suppliers, contract manufacturers for printed circuit assembly production, and contract manufacturers for selected products' assembly. Most of these suppliers leverage RoHS exemptions in their supply chain, especially for electrical components.

If this exemption was not renewed, there would be a decreased demand for the services of each actor. These suppliers are at a risk of losing these sales and the need to develop new technologies to replace their existing products. Depending on the speed of R&D, they could permanently lose sales if a competitor brings a replacement to market faster.

The greatest direct impact would be on the component and subassembly producers whose core business is to provide such items to the electronics market. Reduced product volumes from equipment producers would also affect contract manufacturers' profitability (reduced volumes vs. fixed costs). The OEM partners, who also provide product and portfolio support, will also be impacted by the need to resource off-the-shelf parts. **The supply chains of the participating companies would require a lengthy transition period in case of non-renewal** as they would need to resource alternative materials, validate the production of components with new materials, and build the critical sub-components that are used to assemble and manufacture equipment on behalf of the TMC manufacturers.

Impacts on the market – Competitiveness

As the RoHS regulation applies to all producers equally when placing equipment on the EEA market and since the majority of the production is based outside of the EEA (mainly in the US), **a non-renewal of the Annex III, exemption 34 for test and measurement industrial product types in the EEA would disadvantage the EEA markets in their competition with the rest of the world.**

Indeed, as other regions have RoHS-equal regulations which are not market restricting but rather mainly notification based, if the exemption 34 is removed, the risk is that test and measurement equipment manufacturers will be forced to look at other growth areas, such as, for example, the Asia-Pacific region. T&M equipment manufacturers' supply chain is global and not limited to businesses located in the EEA. Their portfolio is often highly specialized and so equipment is built for global distribution. Therefore, manufacturers cannot afford to regionalise the production. **The manufacturing of a specific variant of a product for distribution only within the EEA is not an economically viable option.** As a result, the latter would keep having access to these instruments while the European industries currently relying on these products would be left behind or forced to move outside the EEA.

On the one hand, expiring exemptions, particularly lead (Pb), will prevent the rest of the world from doing business with EEA. Lead is widely used in free machining brass, steel, and aluminium for small parts with very precise features. These materials are widely used in electrical pin, contacts, connectors, etc and the industry has not yet been able to replace these types of components with Pb-free versions. This would effectively prohibit the electrical components and microelectronics business from doing business in the EEA, as well as have significant impact on EU based businesses that also relying on leaded materials to make precision micro machining technically feasible. Furthermore, many semiconductor components utilize lead (leaded titanates and leaded glass/ceramics) that do not yet have an economically or technically feasible replacement. **This gap in availability of products to the EEA will again impact the ability of many to perform the necessary functions to compete with non-EEA markets.**

On the other hand, non-EEA competitors are likely to gain market share if the restrictions are applied in the EEA market. In particular, the Asia-Pacific region could greatly benefit in terms of possibility of increasing their market share by taking advantage of the opportunity of additional production.

Impacts on the market – Innovation and R&D

The revocation of Annex III, exemption 34 is expected to have wider impacts on innovation in Europe. A major use of the Category 9 products is for industrial research and development processes, both within private companies and for state sponsored research. The limited access to test and measurement equipment in the EEA will constrict investment in both innovation and commercialization of new technologies in a wide variety of sectors, from life science to chemical and from engineering to material science. The limited access to test and measurement equipment in the EEA will be the main driver for investment in both the development and production of all electronic equipment to other non-EEA regions. This will have a market impact on the innovation and the know-how in the EEA. The removal of products from the market due to the non-renewal of exemption 34, will therefore have a **direct negative impact on the research and innovation output within the EEA.**

It is anticipated that chip producers would be particularly impacted due to the non-availability of test equipment exclusively needed for these sectors. In the context of the increased focus on increasing investment and reducing supply chain reliance for the electronics industry on production in other geographies (i.e., the recently proposed EU Chips Act), a non-renewal of lead exemption would be a significant step back for innovation in the semiconductor industry.

The current R&D efforts and resource would inevitably be redirected towards redesigning legacy products to accommodate alternate component and will only exacerbate the lack of and decrease in funding R&D for T&M equipment products. This will significantly hamper and standby innovation in this sector.

Impacts on the market – Trade

When assessing this aspect, it is important to consider the trade balance of the EU. **A non-renewal of Annex III, exemption 34 in the EEA would disadvantage European companies in their trade with the rest of the world.** Indeed, the exports from the EEA would be particularly hard hit by a potential restriction (non-renewal of the exemption). As a result, the overall EU trade balance would be adversely impacted.

Moreover, the TMC manufacturers has highlighted the expected risk of an increase of illegal smuggling of partially completed products in the EEA. Hence, the use of non-RoHS compliant products could be a concrete risk to European consumers as a result of the decrease in product availability in the EEA market.

4.4 Social impacts: unemployment

A non-renewal of lead in Annex III, exemption 34 will not have a direct impact on the headcount of the manufacturer. The headcount is dynamically changing based on different factors, including customer relationships, opportunities and market dynamics.

In general, it is difficult to estimate the unemployment because this depends on whether the end user market can be addressed in the future with products that do not rely on Annex III, exemption 34 and if that transition is capable of retaining the same precise product specifications and reliability performance.

However, the TMC manufacturers declared that the impact of a RoHS restrictions would very likely lead to unemployment within the company. With the loss of business, action would be deemed necessary to reduce workforce, especially high-skilled (e.g., scientists, engineers, microbiologists, and quality experts). It is estimated that, assuming a RoHS restriction is implemented, [CONF.] high-skilled workers in the company participating in the survey will face layoff in the EEA. Here we report the monetization of the likely social costs of unemployment for these workers.

The average annual salary across these European (high-skilled) workers (including the employer's social security contributions) is approximately [CONF.] EUR.

A well-known guideline in monetizing the social impact of unemployment has been developed by the European Chemicals Agency (ECHA) for evaluating such impact in different regulatory processes.

Estimates have been made in accordance with the ECHA document on the evaluation of unemployment (SEAC/32/2016/04)²⁰ and the paper of Dubourg (2016)²¹ endorsed by ECHA. Therefore:

- Using Table A7 (column G, considering the gross wages including the employer's social security contributions) in Dubourg's paper, the total social cost of unemployment in EU is equal to 2.16 times the annual gross salary.²²
- Table 1 presents the statistics from Eurostat (data for 2021-Q3) on the average duration of unemployment for both men and women in the age of 15-64 years in EU-27.²³
- Only 75% of the average duration of employment is considered, to reflect the fact that some affected workers are highly skilled and could find employment sooner.

²⁰ECHA (2016). The Social Cost of Unemployment. Available at: https://echa.europa.eu/documents/10162/13555/seac_unemployment_evaluation_en.pdf/af3a487e-65e5-49bb-84a3-2c1bcbc35d25

²¹ Richard Dubourg, 2016. Valuing the Social Costs of Job Losses in Applications for Authorization. The Economics Interface Limited.

²² This value is greater than one (1) because it takes into account the following components: lost wage, costs of job searching, recruitment costs, the impact of unemployment status on future wages (scarring effect) and employment possibilities, and leisure time (which is a benefit and therefore subtracted from the previous components).

²³ Data extracted from http://appsso.eurostat.ec.europa.eu/nui/show.do?wai=true&dataset=lfsq_ugad

Table 1: Duration of unemployment in EU-27

Duration Grouping	Thousand units	Proportion (A)	Assumed duration (B)	Weighted average (A*B)
Less than 1 month	1673.7	0.12415159	0.5	0.062075795
From 1 to 2 months	2463.6	0.182744732	1.5	0.274117097
From 3 to 5 months	1975.2	0.146516234	4.5	0.659323052
From 6 to 11 months	1794.7	0.133127119	8.5	1.131580509
From 12 to 17 months	1501.1	0.11134848	14.5	1.614552967
From 18 to 23 months	939.0	0.06965307	20.5	1.427887932
From 24 to 47 months	1618.9	0.12008664	35.5	4.263075713
48 months or over	1514.9	0.112372136	48	5.393862519
Total	13481.1	1		14.826475584

The social costs of unemployment would therefore be equal to:

[CONF.] EUR x **[CONF.]** people x 2.16 x 14.826475584/12 x 75% = **[CONF.]** EUR.

Although companies along the supply chain would face a reduction in sales over the years, we assume for simplicity that the entire workforce will continue working for other three years. Therefore, we discount the monetized impact derived above by three years due to the assumed delay in the layoff, using discount rate of 4% per year, as follows: **[CONF.]** EUR x $(1 + 0.04)^{-3}$ = **[CONF.]** EUR.

One can use the market share to extrapolate the total social impact of the unemployment in the EEA across all T&M manufacturers: **[CONF.]** EUR x 1/0.70 = **[CONF.]** EUR (rounded).

One can affirm with a high likelihood that the total social impact of a restriction of lead used in cermet-based trimmer potentiometer elements *along the whole supply chain* would be much larger than **[CONF.] EUR, once one considers all other economic operators having business linked to test and measurement industrial equipment products.**

Moreover, other (low-skilled) workers would be impacted, even though the TMC manufacturers is not in a position today to quantify the unemployment effect.

5. CONCLUSION

This SEA identifies the main potential negative consequences that the EU society at large would face in the framework of the potential restriction of non-renewal of Annex III, exemption 34, lead in cermet-based trimmer potentiometer elements. It has been performed in line with existing ECHA guidance for the preparation of the Socio-Economic Analysis. The results are based on a survey focused on the EU test and measurement equipment industry, with market share coverage of approximately 70% of the EU market. It therefore provided sufficiently reliable data for a representative extrapolation of the EU market.

Overall, the results of the SEA demonstrate the safe use of lead in cermet-based trimmer potentiometer elements and can reasonably justify the renewal of this exemption, on the grounds that a broad restriction would have disproportionate negative impacts on society when compared with the risk to human health, animal health or the environment.

Overall, the **total impact of a non-renewal of this exemption is monetized in the range of 0.3 billion EUR and 1 billion 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 for test and measurement industrial type products' manufacturers, and social impacts (i.e., unemployment in the EU-27).

In terms of **business and market impacts**, a non-renewal would constraint most of the companies currently supplying RoHS-based test and measurement industrial products to cease production and business activities of all products that include lead.



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