SOCIO-ECONOMIC ANALYSIS

Of the impacts of non-renewal of Cadmium (Cd) exemption for test & measurement industrial type products (Category 9)
Exemption 8(b) – Annex III

SUBSTANCE: Cadmium (Cd)
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FROM: Test & Measurement Coalition (TMC)
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PREPARED BY:
EPPA SA/NV
Place du Luxembourg 2
1050 Brussels, Belgium
EU Transparency Register: 31367501249-92

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PERFORMED BY:
EPPA: Jonathan Blanckaert, Rudy Colacicco, Giacomo Miele, Meglena Mihova, Tobias Steinbrecher, Karin Steiner, Julius Waller

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The views expressed in this report are, unless otherwise stated, those of the authors and do not necessarily represent any official view of TMC and/or any other organization mentioned in this report.

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ABBREVIATIONS

AgCdO: Silver Cadmium Oxide

B2B: Business-to-Business

CAGR: Compound Annual Growth Rate

CAR: Competent Authority Report

Cd: Cadmium

COTS: Commercial Off-The-Shelf

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)

NPV: Net Present Value

PCA: Printed Circuit Assembly

PCB: Printed Circuit Board

R&D: Research and Development

RoHS: Restriction of Hazardous Substances in Electrical and Electronic Equipment

SAGA: Suitable Alternatives Generally Available

SEA: Socio-Economic Analysis

SEAC: Committee for Socio-Economic Analysis

SME: Small and Medium Enterprise

T&M: Test & Measurement

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 Moreover, **in 2011, the RoHS 1 was revoked and replaced with Directive 2011/65/EU,[2] which is known as RoHS-Recast or RoHS 2.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) 2015/863[3] 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 8(b) on cadmium and its compounds in electrical contacts, which would otherwise expire on 21 July 2024.**

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[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

The SEA has been performed by EPPA[5] 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 cadmium (Cd) 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 in 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 member companies indicated that the exemption 8(b) (Annex III), pertaining cadmium (Cd) and its compounds in electrical contacts, is widely used across the companies' portfolios. The information reported in this SEA are relevant for the industrial applications in the product groups reported in Annex I to this report.

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, so as 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.

Main findings

It is shown that there are currently no suitable cadmium-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 four to six years per product line**. Hence, losing the ability to apply Annex III, exemption 8(b) 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 1.6 billion EUR and 2.3 billion EUR** (conservative estimates in net losses; potential gains for suppliers of other components have been already taken into account), consisting of:

[5] www.eppa.com

- **[CONF.]** EUR of economic impact for test and measurement industrial product types manufacturers (EBIT losses);

- **[CONF.]** EUR of substitution costs for test and measurement industrial product types manufacturers;

- **[CONF.]** EUR of social impact deriving from unemployment.

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 8(b), cadmium (Cd) and its compounds in electrical contacts,** 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.

The participating companies have 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 8(b).**

[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.

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 "SEAC's approach to assessing changes in producer surplus".[7] As there is no alternative available in general (SAGA)[8] to cadmium (Cd), 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 companies 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 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 unique components.

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

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

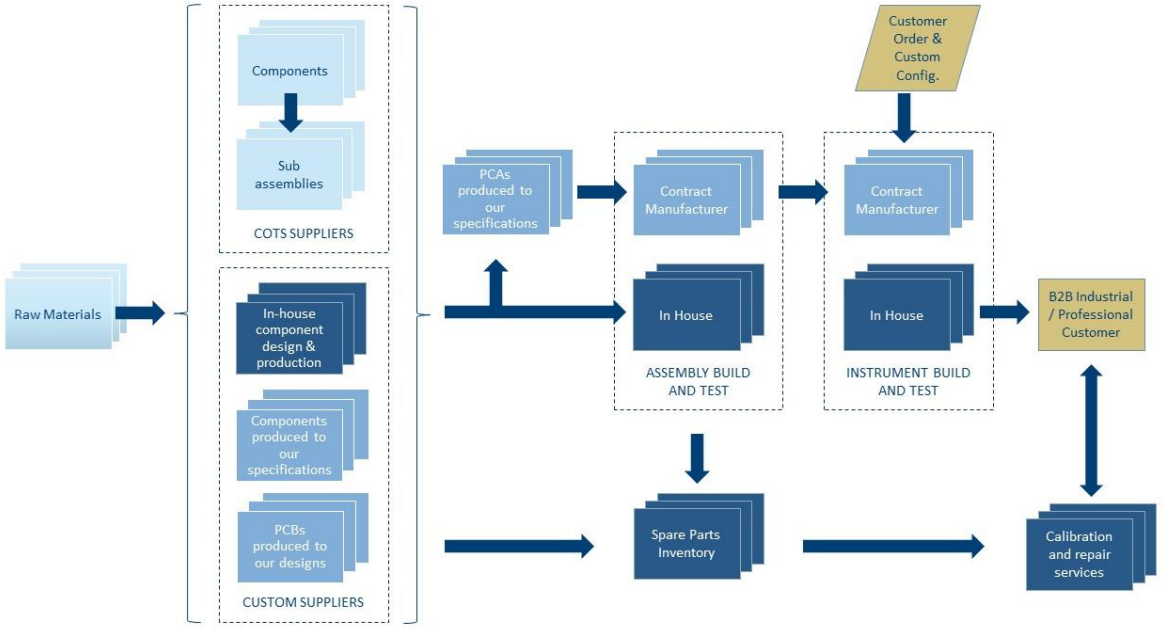
Considering the EU added-value, test and measurement equipment is manufactured and sold in relatively small volumes (per instrument design) and placed on the global market. There is an added value in community level action, which guarantees more coherent and consistent rules across Europe. But with the 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 of all types. 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.

Historically, between 25 - 35% of the components used in test & measurement products are custom designed. The features of the TMC 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 globally sourced for component production;
- Components, sub-assemblies and printed circuit boards (PCBs) are manufactured and sourced globally. These are either produced as commercial off-the-shelf (COTS) products or custom made according to in-house Test & Measurement producers' designs and specifications;
- Printed circuit assemblies (PCAs) are produced and tested to Test & Measurement producers' designs and specifications;
- Assemblies are built and tested, either in-house or by contract manufacturers;
- In response to customer orders or for inventory, finished equipment is configured, built, and tested for global distribution;
- Equipment is 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 producers.

3. ANALYSIS OF ALTERNATIVES

3.1 Function and technical performance of Cadmium (Cd) and Cd-based industrial type 9 products

The silver cadmium oxide (AgCdO) is a thin layer coating on the surface face of open switching contacts utilized when physical isolation is required. Whenever that open contact de-energizes a circuit which has any level of inductance to it, the inductive fly-back voltage causes electrical arcing (which makes it a potential ignition source if it were in an explosive atmosphere). This arcing can cause pitting on the surface which can ultimately cause the contacts to weld shut.

The need for creating an open contact (vs solid state switching) is typically for electrical isolation purposes, where the safety standards require a minimum electrical clearance between contacts if it is being relied upon for safety isolation. A common example includes supplemental circuit breakers on equipment for configuration or servicing, where relying on the power cord as the disconnect device is not practical.[9]

Other examples of use include whenever high voltages are being actively applied and disconnected or where inductive loads (e.g., motors, pumps, compressors) are being energised via relays which are especially prone to creating arcs whenever they are switched (which could be multiple times an hour) due to the running load currents. If the open contact is being relied upon as a safety critical component, then it is essential that arc welding does not occur as the point of operation is at the worst-case current load for the motor (e.g., a locked centrifugation rotor condition or thermal current trip where the instantaneous current of the motor is 20 times the normal run load amps).

[9] See EN 61010-1:2017 clause 6.11 for disconnect requirements for Category 9, industrial equipment. Additionally, the circuit breaker itself needs to comply with IEC 60947-2.

The types of components that utilize this specific exemption are as follows:

Motor start relays		Control relays	
Motor Pumps		Pumps	
Safety Switches		Contactor	
Rocker switches		Circuit breaker	

These isolating components are utilized in turn in the following T&M products and instruments:

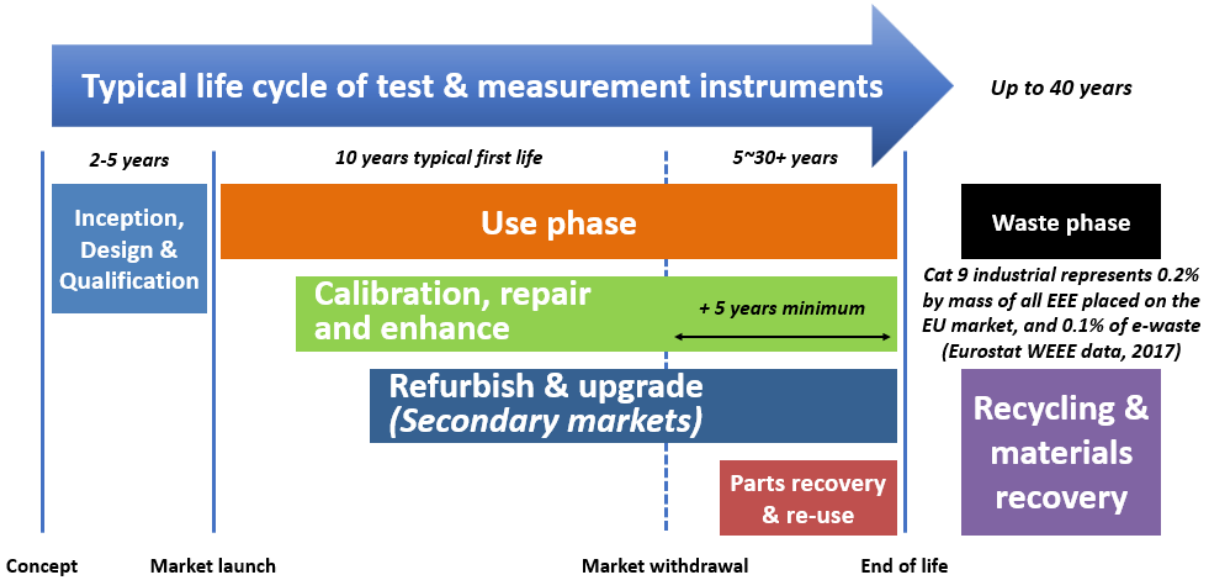
- Photon emission microscopy and laser scanning for electrical fault localisation
- Semiconductor packaging instrumentation using Lock-in IR Thermography
- Recirculating Chillers
- Thermo Cyclers & lab ovens
- Laboratory Refrigerators / Freezers / Ultra-low temperature freezers
- Liquid Chromatography / Mass Spectrometry
- CO_2 Incubators
- Environmental Chambers
- Thermoluminescence dosimetry
- Spectroscopy Equipment
- Electron Microscopes
- 6A power switches with unique package used in signal sources
- High performance RF connectors used in performance signal generators

The function of Cd and AgCdO as well as the chemical and physical advantageous properties of Cd/AgCdO in the components used for T&M instruments are similar to those outlined in the exemption renewal request submitted on 16th January for exemptions Annex III 8(b) and 8(b)-I by the Umbrella Project[10]. These properties include:

- Resistance to arcing
- Resistance to corrosion / pitting / material transfer
- Resistance to oxidation in order to keep the electrical contacts clean and free of insulating oxides. This enhances the life-span of connectors, especially those that are high frequency.
- Resistance against contact welding
- High electrical conductivity
- High thermal conductivity, which helps the effective dissipation of heat
- High melting point, which is required to avoid accidental overheating as a consequence of the fusion of contact points.

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.



[10] Previous RoHS exemption (renewal) requests are publicly available and downloadable from the Commission webpages via https://environment.ec.europa.eu/topics/waste-and-recycling/rohs-directive/implementation-rohs-directive_en.

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 cadmium (Cd)

As outlined in section 3.1, Cd and AgCdO exhibit certain unique physical and technical characteristics. The advantageous properties of AgCdO especially in relation to the impact of repeated arcs from high current DC loads is further outlined in a dissertation by Frederic Pons from the Georgia Institute of Technology.[11] The study investigates said impacts switched from a resistive load for a uniform and repeatable arc format and analysed the results on the contact faces using a scanning electron microscope to compare the response of AgCdO coated contact to arcs to $AgSnO_2$.[12] When the arc occurs, it causes the silver to melt but due to the close melting point temperature of the silver and CdO, there are CdO clusters finely distributed in the layer. This effectively restores the contact material skin reducing the impact of repeated arcs and yielding a consistent contact resistance. The $AgSnO_2$ did does not yield as good as a result as predicted by the dissimilar decomposition temperature of the alternate oxide to silver (see the extracted table below for reference).

[11] F.Pons, "Electrical contact material arc erosion: experiments and modelling towards the design of an AgCdO substitute", PhD Thesis, May 210, Georgia Institute of Technology, https://smartech.gatech.edu/bitstream/handle/1853/33816/pons_frederic_201005_phd.pdf.

[12] Ibid, chapters 2 and 3.

Table 3.3-1: Thermal properties of the major constituents in AgCdO and $AgSnO_2$

Material	Decomposition Temperature (°C)	Melting Temperature (°C)	Boiling Temperature (°C)	Density (kg/m^3)
Ag	--	962	2162	10490
Sn	--	232	2602	7360
SnO_2	1625	--	2250	7010
Cd	--	321	765	8650
CdO	1000	--	1385	7280

Based on additional available information and technical background, the substitution or elimination of cadmium and its compounds in electrical contacts is, in principle, scientifically and technically practicable for *some* applications. To the best knowledge of the Test & Measurement Coalition there is no single substitute available that would be suitable for all the applications identified and accordingly match the technical performance of cadmium-based electrical contacts. Each substitute that has been evaluated had differing properties and therefore no single "drop-in" replacement exists for cadmium and its compounds.

Since the RoHS directive was adopted, electric contact and switch manufacturers have researched potential alternative materials to the above-mentioned applications. There are "apparent" substitutes for several applications that rely on cadmium-based electrical contacts; when the chemical and physical properties of substitutes are compared with those of cadmium and its compounds, however, it becomes clear why these substitutes are not suitable for all applications:[13]

- **Nickel-PTFE** is not qualified for all applications. It is, in addition, a persistent bioaccumulative toxin
- **Silver Tin Indium Oxide** is presently not available from suppliers
- **Silver Copper Nickel**. Corrosion is likely to occur
- **Alloys with silver, gold, nickel, palladium, and tungsten** have technical limitations.

Scientific research, as well as testing by several manufacturers, has shown that alternative substances are more prone to electrical arc erosion and tack welding.[14] This will result in more product failures that are anticipated to impact product safety. Each substitute that has been evaluated had differing properties and therefore no single "drop-in" replacement exists for all applications that rely on cadmium and its compounds.

[13] Building a Better Cadmium Replacement. Available at: https://connectorsupplier.com/a-mil-plating-cadmium-061912/

[14] RoHS Umbrella Industry application (2019/2020). Previous RoHS (renewal) exemption requests are publicly available and downloadable from the Commission webpages via https://environment.ec.europa.eu/topics/waste-and-recycling/rohs-directive/implementation-rohs-directive_en

Therefore, based on the current state of the art, AgCdO still represents a stable solution to the repeated arc model which is inherent to an inductive switching load or other high voltage switching that currently continues to require the 8(b) and 8(b)-I exemption. The alternatives, thus far, will yield a poorer contact surface which will ultimately lead to premature component failure and potential unreliable results leading up to total component failure.

The renewal of exemption 8(b) should be granted on the basis that **currently available alternatives are not suitable for substitution or replacement in T&M instruments' critical components and their applications**. These applications include circuit breakers, thermal sensing controls, and high power / high frequency switches. More time is required to adapt designs, find contact materials, and for qualifying cadmium-free solutions in the supply chain and in the products of EEE manufacturers. This is required since the cadmium-free contact materials are not "drop-in" replacements. This echoes the stance of the Öko-Institut Report published in 2016.[15] No further technological developments have, to the best knowledge of the participating companies, occurred since then.

Thus, the unavailability of alternatives for all applications that use cadmium-based electrical contacts warrants the renewal of this exemption.

3.3.1 Challenges with substitution with alternatives

As outlined in the previous section, the companies have indicated that there are currently **no suitable alternatives for <u>all</u> applications** of cadmium and its compounds in electrical contacts that meet the required technical standards and performance expectations of their customers. The lack of a "drop-in" alternative enhances the difficulty of replacing or substituting cadmium in several applications especially (i.e., circuit breakers, thermal sensing controls, and high power / high frequency switches).

Members of the Test & Measurement Coalition have pointed out that they principally rely on their suppliers to find alternatives since most of the exemptions used in their products are not produced by the suppliers but bought off-the-shelf from their suppliers (and so forth, potentially many levels down). Therefore, meeting with suppliers to understand their (potential) alternatives, getting samples, measuring, and testing are part of the typical process to evaluate the suitability of potential alternatives. The process would then be followed by the validation of the potential suitable alternatives.

[15] Assistance to the Commission on Technological Socio-Economic and Cost-Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment. Available at: https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/RoHS-Pack_9_Part_SOLDERS_06-2016.pdf

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, an additional validation period would be required for each redesigned product that used to utilize the component that relied on the exemption, 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.

If a new cadmium 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; 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 complex sub-assembly parts and have a significant impact on the performance of the companies' products. These also have a critical role in the overall safety of the products. These parts need to go through extensive validation for performance and/or compliances, according to varying regulations, before the appropriate files can be updated and the proper competent authorities or regulatory bodies can be notified prior to the 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 of additional testing. Where the exemption directly impacts the performance of that component (e.g., a centrifuge rotor) the evaluation of the replacement could take **3 to 5 years**.

3.4 Overall conclusion on suitability and availability of alternatives

Since the RoHS directive was adopted, electric contact and switch manufacturers have researched potential alternative materials. The substitution or elimination of cadmium and its compounds is, in principle, scientifically and technically practicable for *some* applications.

Each substitute that has been evaluated had differing properties and therefore, to the best knowledge of the Test & Measurement Coalition, no single "drop-in" replacement exists for cadmium and its compounds for all applications. The renewal of exemption 8(b) should thus be granted on the basis that **alternatives are not suitable for substitution or replacement for all applications**. These applications include circuit breakers, thermal sensing controls, and high power / high frequency switches. This echoes the stance of the Öko-Institut Report published in 2016.[16]

[16] Assistance to the Commission on Technological Socio-Economic and Cost-Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment. Available at: https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/RoHS-Pack_9_Part_SOLDERS_06-2016.pdf

4. ANALYSIS OF IMPACTS

4.1 Human health and environmental impacts

Cadmium is considered to be a human carcinogen that has an impact on both the neurological and renal systems. 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 cadmium (Cd) tolerated by weight in homogenous materials is 0.01% 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 cadmium utilized in their homogeneous materials varies based on the application. Therefore, based on literature review, companies indicated that the homogeneous materials typically contain between 10 to 25% cadmium by weight. This is true for contacts in electrical switching devices. Nevertheless, fixed electrical contacts contain typically about 1% of cadmium in the homogeneous material of the paste/ink. Overall, through application for which the exemption is requested, between 5 and 6 kg of Cd enters the EEA market every year.

4.1.1 Reduction in the quantity of cadmium (Cd) placed on the EEA market

The participating companies have reported that no change in releases of cadmium to the environment are likely during either 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 equipment production, the switch contact faces are internal to the component and not exposed. At component manufacturers level, exposure and waste and exposure to cadmium is considered controlled through good OSH management practices.

Under normal conditions of equipment use, the cadmium content associated with the application of Exemption 8(b) is encapsulated within the equipment enclosure and will neither be touched nor released to the environment.[17] As this equipment is sold B2B for professional/industrial use only, equipment that finally reaches end-of-life will be appropriately processed by professional recyclers who are obligated 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.

The TMC member companies have only indicated a minor risk for substances to be released to the environment during the manufacture of the components. These are not produced by TMC members. Thus, data are not available, however the estimate is expected to be bounded by the total use of the substance (i.e., release to the environment is expected to be less than the mass of substance incorporated into the components).

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

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 specialised components, that rely on this exemption, in production. The manufacturing of specialised components will represent 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 only for 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 typically 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 into markets where there isn't a similar restriction .

Additionally, T&M equipment manufacturers emphasised that exemption 8(b) 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 in apparent conflict to the concepts proposed under the proposed Eco-design for Sustainable Product Regulation.[18]

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 product market), substitution costs, and broader macroeconomic consequences resulting from a potential non-renewal of the exemption 8(b).

4.2.1 Business impacts on manufacturers

[18] Specific data on the difference between alternatives are not available.

A survey of TMC members was utilized in preparation of this report. **TMC manufacturers of industrial and 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 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 TMC member companies have declared that there more than **[CONF.]** product lines that apply to this exemption would be impacted (cf. Annex I to this report for an overview of the relevant product groups). During 2021, **[CONF.]** units of these products were placed on the EEA market. These data were taken from 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 8(b), is estimated at approximately [CONF.] EUR/year**.[19]

Therefore, the non-renewal of the Annex III exemption 8(b) 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 (cf. Annex I to this report for details on product groups) 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.

[19] The calculation is based on the rounded value of the average and maximum price of the products that are going to be likely affected by the non-renewal of the exemption.

Depending on the part complexity, different compliance costs are also to be expected. The companies emphasized that switching to RoHS compliant products without using the exemption would require a disruptive amount of work and investments. The companies have provided different ranges of products that would have to be redesigned in case of a non-renewal. T&M manufacturers reported that the exemption is used in a range of 34% to 51% of all equipment families marketed by Category 9 OEMs. This would have to occur with limited availability of resources and specialized engineers, a high proportion of custom parts, extensive testing, and re-qualification requirements before products could be marketed. Increased capacity or numbers of certified test facilities would also be required to verify in parallel a larger than normal range of products – many of which are already taxed beyond capabilities to accommodate unrelated changes to the EU IVDR/MDR and created by Brexit.

The companies added that in contrast to the consumer goods industry, which concentrates on frequent redesign, their engineers are committed to new product development and new technological innovation with the products having significantly longer design cycles and lifetimes. The need for rigorous re-qualification testing on all products to ensure that newly designed products meet reliability and safety requirements has also been stressed by the companies.

Given the fact that new products drive long-term company growth, the time spent sustaining existing products directly impacts the company's growth, resulting in a large opportunity cost. Further, significant testing must be done to ensure that alterations will not affect the quality and performance of the final product since T&M equipment is particularly sensitive to component, material, and manufacturing changes. According to the companies, redesigning T&M products for RoHS compliance is a lengthy process that typically takes 3 months for a given product. Especially under Annex III, exemption 8(b) whose products are used in safety controlled parts such as switches that may require Safety re-certification by third party Nationally Recongized Test Laboratories which is costly and time consuming. Therefore, **considering the number of products affected by this restriction, the expected amount of investments to comply with the restriction would be more than [CONF.] EUR**. Additional costs due to loss of efficiencies and additional R&D spending at companies' suppliers are to be expected.

Given the variety of applications these components enable and how widely they are utilized, the re-qualification and re-certification process will differ greatly from one sector to another. Companies will at the very least need to transition a low impact part by producing new parts, updating all affected bills of materials, managing the inventory transition from old to new in the affected product lines, and training all staff on the revised construction so the legacy components are no longer used.

As a consequence of these technical and practical challenges, the TMC manufacturers anticipate loss of 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 cadmium 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 8(b) would not be renewed,[20] it is estimated that the TMC member companies 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.)[21] **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 represents 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 cadmium, especially, competitors based outside the EEA. Because the 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 the 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 Annex III, exemption 8(b) would result in much 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 cadmium 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 that 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 8(b) incorporated into T&M equipment are COTS parts. Consequently, T&M manufacturers are heavily reliant on their suppliers to identify alternatives.

[20] 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).

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

For the other parts, it is estimated that between at least four years are needed to evaluate the suitability of potential alternatives given the wide variety of uses. Overall, it is anticipated that four to six years are needed for re-designing (i.e., implementing the substitution, or concentration reduction of cadmium) in a full product.[22] This timeline applies only if a usable substitution candidate can be identified. Moreover, this is highly dependent on the complexity of change and impact on the final product.

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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 a re-design require 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 8(b) would be especially burdensome (if feasible) since it is used in complex product sub assemblies. Changing out these sub assemblies will require complex instrument re-design and a full suite of product validation substantially increasing the cost and timeline of implementation, especially as there may be software implications.

Therefore, **the TMC member companies have indicated that the implementation of substitution or concentration reduction of lead would cost approximately [CONF.] EUR** (rounded),[23] 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.

[22] Average of the estimated timelines provided by TMC manufacturers.

[23] ECB 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.

Impacts on the market – Quality and costs

If Annex III, exemption 8(b) 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 electronical equipment may experience a decreased availability of test and measurement industrial equipment.

For the majority of products that utilize Annex III, exemption 8(b) it is not possible to remove the exempt components without risk to product safety, quality, reliability or performance. 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 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.

Impacts on suppliers

The participating companies maintain a large supply chain: a vast amount of actors supply components, materials, and performs contract manufacturing operations. 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 **Annex III, exemption 8(b)** would not be renewed, **there would be a decrease in demand for the services of each actor in the supply chain**. 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 contract manufacturers whose core business is to provide such items to the electronics market. Reduced product volumes from equipment producers would also affect profitability (reduced volumes vs. fixed costs) of contract manufacturers. Moreover, in case of non-renewal, a substantial impact on 5G and 6G deployment and EV and chip producers, due to the non-availability of test equipment exclusively needed for these sectors, is to be anticipated.**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 8(b) 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 8(b) 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 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.** This would negatively impact the competitiveness of EEA market players compared to those that have access to a wider portfolio of test and measurement instruments in other areas of the world.

Furthermore, non-EEA competitors would not be subject to restriction and would be able to supply and place on the international market a wider range of products, without bearing any redesign costs. Thus, 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.

On the one hand, expiring exemptions, particularly relating to the use of cadmium (Cd), will prevent the rest of the world from doing business with EEA. **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.**

Impacts on the market – Innovation and R&D

The revocation of Annex III, exemption 8(b) is expected to have wider impacts on innovation in Europe. One of the major uses of the Category 9 products is in essential 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 8(b), will therefore have a **direct negative impact on the research and innovation output within the EEA.**

A possible non-renewal will, as noted before, influence the EEA market's competitiveness and significantly affect the sales of the companies. The significant reduction in sales as a result of a possible non-renewal of **Annex III, exemption 8(b)** will have an inevitable negative impact on R&D investments. Therefore, based on the assumption that the percentage of revenue spent remains the same, the loss of sales to the EEA market will result in a decrease in R&D spending. Moreover, the manufacturers have further noted that the current geopolitical situation, supply chain disruptions and the inflated cost of materials have already resulted in a cut in R&D investments. The non-renewal of the exemption would solely exacerbate the lack of and decrease in R&D funding.

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 additional T&M equipment products. Non-renewal of Annex III, exemption 8(b) would **adversely affect the resources available for new product design and innovation, as the limited R&D resources available would be spent on responding to a non-renewal instead**.

It is anticipated that chip producers would be particularly impacted due to the non-availability of test equipment exclusively needed for these sectors. the electronics industry has increasingly emphasized the importance of increasing investment and lowering supply chain dependence on manufacturing in other regions (i.e., the recently proposed EU Chips Act). Within this context, **a non-renewal of cadmium exemption would be a significant step back for innovation in the semiconductor industry.**

Impacts on the market – Trade

When assessing this aspect, it is important to consider the trade balance of the EU. **A non-renewal of this exemption in the EEA would disadvantage European companies in their trade with the rest of the world.**

A non-renewal of **Annex III, exemption 8(b)** would effectively prohibit the electrical components and microelectronics industry from doing business in the EEA. It would also have a significant impact on EU-based businesses that also rely on cadmium-based materials to make precision micro machining technically feasible. A non-renewal would hamper the EU's relative importance as an exporter and trading partner for the goods and industries mentioned above.

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**.

4.4 Social impacts: unemployment

The restriction of cadmium will not have a direct impact on the headcount of the manufacturer companies. 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 8(b)** and if that transition is capable of retaining the same precise product specifications and reliability performance.

However, the TMC member companies declared that a non-renewal would very likely lead to unemployment within the companies. 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, approximately **[CONF.]** high-skilled workers in the companies 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)[24] and the paper of Dubourg (2016)[25] 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.[26]

[24] ECHA (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

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

[26] 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).

- 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.[27]
- 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.

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	1328.5	0.096128799	0.5	0.048064399
From 1 to 2 months	2585.5	0.187083936	1.5	0.280625904
From 3 to 5 months	2175.0	0.157380608	4.5	0.708212735
From 6 to 11 months	1953.3	0.14133864	8.5	1.201378437
From 12 to 17 months	1637.8	0.118509407	14.5	1.718386397
From 18 to 23 months	640.3	0.046331404	20.5	0.949793777
From 24 to 47 months	1651.0	0.119464544	35.5	4.240991317
48 months or over	1848.6	0.133762663	48	6.420607815
Total	13820.0	1		**15.56806078**

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** (rounded).

We 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).**

We can affirm with a high likelihood that the total social impact of a restriction of cadmium and its compounds in electrical contacts *along the whole supply chain* would be much larger than [CONF.] EUR, once all other economic operators having business linked to test and measurement industrial equipment products are considered.

Other (low-skilled) workers would be impacted, even though the TMC member companies are not in a position today to quantify the unemployment effect.

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

Moreover, as a progressive result and due to the expected reduction in sales, job creation is also expected to be negatively affected. Manufacturers anticipated that eventually they would inevitably reduce new recruitment.

5. CONCLUSION

This SEA identifies the main potential negative consequences that the EU society at large would face in the framework of the potential non-renewal of **Annex III, exemption 8(b)** cadmium and its compounds in electrical contacts. 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 cadmium and its compounds in electrical contacts 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.

The total monetized impact of a non-renewal is estimated in the range of 1.6 billion EUR and 2.3 billion EUR, including: **[CONF.]** EUR of economic impact for test and measurement industrial product types manufacturers (EBIT losses); **[CONF.]** EUR of substitution costs; **[CONF.]** EUR of social impact deriving from unemployment. **This is a conservative estimate (lower bound), on the understanding this is not the sole injury likely to be suffered in the EU.**

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 cadmium.

In addition, and pursuant to Article 5 of the RoHS Directive a continuation of exemption 8(b) Annex III is warranted as **no suitable alternatives to the RoHS restricted substance are available for each individual application**.

6. ANNEX I

Product groupings and equipment types relevant to exemption 8(b)

Product Grouping	Equipment Types
Test and measurement upgrades and accessories	
Oscilloscopes, Analyzers & Meters	Oscilloscopes
	Spectrum Analyzers (Signal Analyzers)
	Network Analyzers
	Logic Analyzers
	Protocol Analyzers and Exercisers
	Bit Error Ratio Testers
	Noise Figure Analyzers and Noise Sources
	High-Speed Digitizers and Multichannel DAQ Solutions
	AC Power Analyzers
	DC Power Analyzers
	Materials Test Equipment
	Device Current Waveform Analyzers
	Parameter and Device Analyzers, Curve Tracers
	Digital Multimeters
	Phase Noise Measurement
	Power Meters and Power Sensors
	Counters
	LCR Meters and Impedance Measurement Products
	Picoammeters & Electrometers
Generators, Sources and Power	Signal Generators (Signal Sources)
	Waveform and Function Generators
	Arbitrary Waveform Generators
	Pulse Generator Products
	HEV/EV/Grid Emulators and Test Systems
	DC Power Supplies
	Source Measure Units
	DC Electronic Load
	AC Power Sources
Wireless	Wireless Network Emulators
	Channel Emulation Solutions
	Nemo Wireless Network Solutions
	5G OTA Chambers
	Wireless Analyzers
	IoT Regulatory Compliance Solutions
Modular Instruments	PXI Products
	AXIe Products
	Data Acquisition – DAQ
	USB Products
	VXI Products

Product Grouping	Equipment Types
	Reference Solutions
Network Test, Security & Network Visability	Protocol and Load Test
	Network Test Hardware
	Cloud Test
	Performance Monitoring
	5G NR Base Station Test
	Radio Access and Core Network Test
	Network Security
	Cyber Training Simulator
	Network Modeling
	Application and Threat Intelligence
	Network Packet Brokers
	Cloud Visibility
	Network Taps
	Bypass Switches
	Clock Synchronization
Application-Specific Test Systems and Components	
Photonic Test & Measurement Products	
Laser Interferometers and Calibration Systems	
In-circuit Test Systems	
Used Equipment	
Probe	
Semiconductor Characterization System	
Laboratory Products	Autoclave Sterilizers
	Baths and Circulators
	Biological Safety Cabinets
	Blood Culturing Devices
	Centrifuges
	Chillers
	Electrophoresis
	Environmental Chambers
	Freeze Dryers
	Furnaces
	Heat Controllers/Exchangers
	Ovens
	Refrigerators
	Freezers
	Mixers
	Water Purification
Chemical Analysis	Handheld XRF Analyzers
	Dosimetry Personnel Contamination Monitors
	(Laser) Spectroscopy
Material and structural analysis	Electron Microscopes
Clinical Diagnostics	Therapeutic drug monitoring
	Quality control

Product Grouping	Equipment Types
	Sepsis diagnosis
	Prenatal screening
Other	Liquid Chromatography
	Gas Chromatography
	Mass Spectrometry
	Molecular Spectroscopy
	Smart Docking Solutions
	Cell Analysis
	Vacuum Products

EPPA SA/NV
Place du Luxembourg 2
1050 Brussels, Belgium
+32 2 735 82 30
www.eppa.com
economics@eppa.com