Questionnaire 1 (Clarification) Exemptions 8(b) and 8(b)-I of RoHS Annex III

Current wording of the exemptions:

8(b) Cadmium and its compounds in electrical contacts

8(b)-I Cadmium and its compounds in electrical contacts used in:

- *Circuit breakers,*
- *Thermal sensing controls,*
- *Thermal motor protectors (excluding hermetic thermal motor protectors)*
- *AC switches rated at:*

6 A and more at 250 V AC and more, or
12 A and more at 125 V AC and more,

- *DC switches rated at 20 A and more at 18 V DC and more, and*
- *Switches for use at voltage supply frequency ≥ 200 Hz*

Requested validity period: Maximum (5 and 7 years respectively)

1. Acronyms and Definitions

AED	automated external defibrillator
Cd	cadmium
CT	computerized tomography
MRI	magnetic resonance imaging
PET	positron emission tomography
SPECT	single-photon emission computerised tomography

2. Background

Bio Innovation Service, UNITAR and Fraunhofer IZM have been appointed[1] by the European Commission through for the evaluation of applications for the review of requests for new exemptions and the renewal of exemptions currently listed in Annexes III and IV of the RoHS Directive 2011/65/EU.

COCIR submitted a request for the renewal of the above-mentioned exemption, which has been subject to a first review. As a result we identified that some information is missing. Against this

[1] It is implemented through the specific contract 070201/2020/832829/ENV.B.3 under the Framework contract ENV.B.3/FRA/2019/0017

background the questions below are intended to clarify some aspects concerning the request at hand.

We ask you to kindly answer the below questions until 25 January 2021 latest.
Communication by the workgroup has been send out to request for an extended deadline till Feb 12, 2021.

Remark

You request the renewal of exemption 8(b) for all EEE in category 8 and 9 while the exemption remains valid for in-vitro diagnostic devices until 2023 and until 2024 for industrial monitoring and control instruments. In line with the Commission approach, we would like to point out that, should the exemption be renewed for these subcategories of EEE, the new exemption validity periods would start with the official renewal date of the exemption, which forseeably would be before 2023 and 2024 respectively.

Questions

As some of the following questions are primarily directed to certain organisations within the Umbrella Project where responses are directly from those addressed the following identifications are applicable:

MQ : Marquardt response
COCIR : COCIR response
ST : Sensata Technologies response

Umbrella Project: General response

1. You report reductions of cadmium uses at Sensata and Marquardt between 2010 and 2020. Please kindly let us know how much cadmium was avoided in the period between **2015** (last review by Gensch et al. (2016 e)) and 2020 by Marquardt, Sensata and other users of cadmium in contacts.
   In 2014, 1.8% of power tool switches sold by MQ had AgCdO contacts, containing 4.7kg CdO. In comparison in 2020, 0.8% of power tool switches sold by MQ had AgCdO contacts, containing 2.9kg CdO. As a consequence, MQ avoided 1.8kg CdO in 2020 compared to 2014. Assuming we had a linear decrease in AgCdO usage, this results in a cumulated saving of about 6.3kg AgCdO between 2015 and 2020.
   Note: These are global numbers. Due to global distribution channels on our and our customer's side, it is not possible to calculate how much of this relates to only the EU market.
   Note: Coming from 6.5% and 16.4kg in the year 2007, we can see that the biggest Cd saving in MQ power tool switches was achieved already before 2014.
   Eliminating the remaining few percent without affecting product safety takes significant time to overcome the technical challenges.
   ST : The estimated amount of Cd was 920kg in 2014 and reducing to 140kg in 2020 as stated in the exemption renewal application form. So the biggest reduction amount was found to be feasible over the past 5 years. For ST this is a worldwide estimate, as it is not possible to trace through the supply chain what will be the actual amount ending up in Europe.

2. You request the renewal of exemption 8(b)-I with a modified scope as illustrated in the below table.

Current Wording	Proposed new wording:
Cadmium and its compounds in electrical contacts used in: • circuit breakers,	8(b)-I Cadmium and its compounds in electrical contacts used in: • circuit breakers rated at — 10 A and more at 250 V AC and more, or — 15 A and more at 125 V AC and more,
• thermal sensing controls,	• thermal sensing controls rated at — 10 A and more at 250 V AC and more, or — 15 A and more at 125 V AC and more,
• thermal motor protectors (excluding hermetic thermal motor protectors)	• thermal motor protectors (excluding hermetic thermal motor protectors)
• AC switches rated at: — 6 A and more at 250 V AC and more, or — 12 A and more at 125 V AC and more,	• AC switches rated at: — 10 A and more at 250 V AC and more, or — 15 A and more at 125 V AC and more,
• DC switches rated at 20 A and more at 18 V DC and more, and	• DC switches rated at 25 A and more at 18 V DC and more, and
• Switches for use at voltage supply frequency ≥ 200 Hz.	• Switches rated at 300 V and more for use at voltage supply frequency ≥ 200 Hz

Please let us know the voltage and current ranges of electrical contacts applied in EEE of RoHS catégories 1 to 10 for

For each of the following applications, in consideration for the drive to reduce the scope of the exemption, the workgroup has endeavored to define a lower limit that is commonly applicable to such a generic implementation of this exemption across the market.

a. Circuit breakers
There is a wide variety of EEE across a range of electrical ratings that would be described as Circuit Breakers under the different RoHS categories. These range from miniature devices switching voltages as low as 125V AC to large, air circuit breakers or gas-filled circuit breakers in power transmission applications at 600V or above. These devices can be operating at a range of currents measured in milliamps, up to many thousands of amps.

b. Thermal sensing controls
There is a wide variety of EEE across a range of electrical ratings that are described as Thermal Sensing Controls under the different RoHS categories. Conventional thermostats and bimetallic overload devices would be typical examples. Some of these will have a direct switching capability requiring contacts capable of connecting

and disconnecting a load. Some will be control circuit devices with only signal outputs. The switched output may be below or above 125V AC but would normally be rated across a range which would incorporate 125V AC or higher.

c. Thermal motor protectors
There is a wide variety of EEE across a range of electrical ratings that are described as Thermal Motor Protectors under the different RoHS categories. Most, if not all of these will have a direct switching capability requiring contacts capable of connecting and disconnecting a load at 125V AC or above, potentially under high-fault conditions.

d. AC switches
Many switches are designed to be used with both DC and AC, but they will have different voltage and current ratings. At higher voltage and current ratings, switches tend to diverge between types as a consequence of the differing making and breaking characteristics between AC and DC voltages. Switches for corded power tools (for example) are normally rated from a few mA up to 22A and within a range spanning 100 to 250V AC. AC switches in industrial applications will typically cover ranges from 10A up to many thousands of Amps. The AC voltage may be transformed, but most switches are designed to operate on the supply voltage which is typically 220/230V AC (phase to neutral) or 380/400/600/630V (phase to phase) depending on the locality.

e. DC switches
There is a wide variety of EEE across a range of electrical ratings that are described as DC switches under the different RoHS categories. These range from a few volts and milliamps up to many 100's of thousands of volts and amps. Switches for cordless power tools, as an example, are rated from a few mA up to 25A with voltage ranges between 3.6V and 36V. However, due to new battery technology and configurations, there is an additional new trend for high power cordless applications at 60V DC and 120V DC.

f. Switches for voltage supply frequencies of 200 Hz and more

The use of such application is more exotic than those listed above, being used in power tool applications at 72V up to 300V, current ratings up to 22A.

3. Could you please provide application examples for

a. circuit breakers rated at 10 A and more at 250 V AC and more, and 15 A and more at 125 V AC and more?
There is a wide range of applications in which a Circuit Breaker provides protection by sensing the current and disconnecting the supply under a fault condition. The circuit breaker will use thermal, magnetic or electronic elements to monitor the current. In the event of an overload condition or a short circuit the monitoring element triggers the opening of the contact set. This is normally done at very high-speed using mechanical energy stored within the circuit breaker mechanism. Because this triggering is in response to a fault condition, at the point of

disconnection the current will always be rising, often to many times the rating of the device, which places stress on the contact set of the circuit breaker at this point.

b. circuit breakers rated below 10 A and below 250 V AC?
Please see the response in question 3a.

c. thermal sensing controls rated at 10 A and more at 250 V AC and more, and 15 A and more at 125 V AC and more?
There is a wide range of applications in which a Thermal Sensing Control is offering control or protection by sensing the temperature and controlling the power means. Differentiation is not based on the type of application but on the electrical ratings of the applications. Typical applications (for example) include heating boilers, electrical convector heaters, ventilator fans, coffeemakers, compressors among others. However, if more detailed information is required, we can arrange a meeting with a Thermal Sensing Controls Field Application Engineering team.

d. thermal sensing controls rated below 10 A at less than 250 V AC, and below 15 A at less than 125 V AC?
Please see the response in question 3c.

e. AC switches rated between 6 A and 10 A at 250 V AC and more?
Typical applications rated 6A to 10A at 250 V AC (for example) include power tools such as Drills, Hammer Drills, Drivers, Saws, Small Angle Grinders, although applications are not limited to just power tools.
Above 10 A 250 V AC typical power tool applications are Large Angle Grinders, Demolition Hammers, Chop Saws (but applications of switches with this rating are not limited to just power tools).

f. AC switches rated between 12 A and 15 A at 125 V AC and more?
Typical applications rated 12A to 15A at 125 V AC (for example) include power tools such as Drills, Hammer Drills, Drivers, Saws, Small Angle Grinders, although applications are not limited to just power tools.
Above 15 A 125 V AC typical power tool applications are Large Angle Grinders, Demolition Hammers, Chop Saws (but applications of switches with this rating are not limited to just power tools).

g. DC switches rated between 20 A and 25 A and more at 18 V DC and more?
Typical applications (for example) include cordless power tools such as Drills, Drivers, Impact Tools, Saws, Hammers and Grinders, although applications are not limited to just cordless power tools.
Specifically relating to medical devices, the following is a case study provided by a COCIR member: DC switches rated at 10A and more at 150VDC/ 400VAC in defibrillator and AED (class 3 medical devices) requiring a single, Dual Pole, Single Throw (DPST) Miniature Power Relay to transfer therapeutic shock energy to a patient. The cadmium containing relay has been tested extensively at millisecond pulse durations, at current and voltage levels far exceeding published “continuous” specifications. in order to provide an appropriate therapeutic dose of electrical energy to a patient. The biphasic energy waveform delivered through the closed

relay contacts has a very specific profile and duration in order to provide a successful therapeutic outcome.
In addition, the device implements a daily self-test by measuring the circuit impedance (milliohms) through closed relay contacts in order to guarantee a safe and efficacious therapeutic patient outcome during use.
This application type may be considered exotic in that the published "continuous" power rating of the relay is deliberately violated for very short, pulsed application of therapeutic energy through the closed contacts. Both the application of therapeutic energy and the diagnostic impedance measurement are implemented using a "cold switching" method, where no load is present at the contacts during switching. A cold-switching use case may have significant differences in impedance drift over time than a hot-switching use case. Cadmium in well known in the industry for low contact resistance.

h. Switches for use at voltage supply frequencies ≥ 200 Hz rated at less than 300 V?
These are non-standard applications of very specialized types of grinders, sold in lower volume by a small number of manufacturers of electrical equipment.

Please also let us know whether these uses are common ones or more exotic and non-standard applications.

4. Both Markquardt and Sensata had announced to have their product portfolios changed to cadmium-free contacts until 2020/2021 in the last review in 2015/2016 by Gensch et al. (2016 e). At that time, Sensata had indicated only 15 % (11 products) remaining for conversion until 2020/2021, Marquardt had achieved 98.5 % of cadmium-free contacts for power tools already, and had announced to be 99.9 % cadmium-free in 2020.

   a. What happened to these plans? Which activities had Sensata, Marquardt and members of the umbrella project undertaken to achieve cadmium-free contacts?
   MQ: The initiated activities have been permanently continued, but delayed by internal reorganizations and relocations, time consuming test programs including test failures, late responses from customers and finally by the Corona crisis. Also the corresponding standards IEC/EN/UL61058 (for appliance switches) and IEC/EN/UL62841 (for tools) have changed, which further increased the work load for the transition process. The MQ AgCdO replacement team has been reorganized 6 months ago and is holding weekly meetings to discuss and promote progress. Based on our current progress and prognosis, we believe we will reach the 99.9% target in 2022, resulting in 0.6kg CdO usage (target for 2020 was 0.9kg), while the vast majority of this will be used for spare parts.

   ST : safety reliability is a concern and in some cases causing delay in the planning. The implementation is defined by getting possible alternatives of suppliers, internal testing (quality/safety), customer release testing and agency testing for updating product (safety) certifications.

b. Why is there no progress for thermal motor protectors since 2015? There were long dicussions among stakeholders in the last review already as to the actual necessity of this part of the exemption.
ST : There are advances made also for the thermal motor protectors, however more or less the same issues apply here for electrical contacts. The workgroup has taken this into consideration by scoping down based on electrical ratings, more or less generic in line with what is feasible overall.

5. You apply for the seven year renewal of exemption 8(b) in its current wording. Why can exemption 8(b)-I (possibly in its current wording) not be applied to EEE of categories 8 and 9 instead of requesting the renewal of exemption 8(b) for even seven more years in its current wording? These categories have been in the scope of the RoHS Directive since 2011, and there had already been progress with the substitution of cadmium five years ago in 2015 when the exemption was reviewed last time, which is reflected in the current wording of exemption 8(b)-I. We are aware that this might require electrical and geometrical redesign of the component, which producers are exptected to do as effort to achieve RoHS compliance without the need of exemptions.
If scientifically and technically actually impracticable, the exemption scope could be extended to include fixed electrical contacts in the types of oxygen and capnography sensors.

COCIR: The wording of exemption 8(b)-I would not include the uses of category 8 and 9 as listed in the exemption renewal request, as the technical reasoning for using cadmium is different for these applications. The key properties for category 8 applications include very low drift, high reliability over multiple years while the device is continuously used, ability to operate at high temperatures, good adhesion and resistance to electro-migration.

Exemption 8(b)-I in its current wording would exclude uses of cadmium which are essential to the function of category 8 and 9 products and changing the exemption to replicate the scope of 8(b)-I would not reflect the technical function of these parts.

Since 2015 alternative solutions have been trailed but no alternative has been found which demonstrates the required technical performance to be a suitable alternative. Listing the types of applications to just oxygen and capnography sensors would not address all of the applications required for category 8 and 9 applications, as the applications listed in the renewal request encompassed more applications than this, as well as being a non-comprehensive list.

6. You put forward that many types of medical devices use high power circuits that require relays and contactors, both of which have switching contacts to switch power on and off, and you give some examples.

a. How would you describe «high power circuits» in terms of voltages and currents in this context?
COCIR: The specific voltages and currents are application specific and can range between 5-30 amps and 250VAC.

b. Please specify the «high power» for automated external defibrillators (AEDs), and for the thermal motor protectors used in CTs, MRIs, PETs and SPECTs.

COCIR : AED applications: 10-70A and 150VDC/400VAC, with some applications requiring between 2200 V and 0 V over several milliseconds (“cold-switching”) as detailed above.

CT applications: 2-10A and 250VAC

Ultrasound applications: 20A peak pulse current and 250VAC

7. You describe the use of a cadmium-based circuit breaker on the unit of a Computerised Tomography (CT) system that rotates with high speeds (0.35 sec/rot) generating around 30 G centrifugal force.
You state that size and weight of the circuit breaker are critical to resist this centrifugal force, and that failures of the circuit breaker would lead to concerns over electrical safety and reliability.

   Why do you assume that the resistance against centrifugal forces cannot be achieved with cadmium-free alternatives?

   COCIR: CT manufacturers are able to evaluate and use only the types of circuit breakers that are currently available on the market. Only a few very small and lightweight circuit breakers suitable in CT have been identified and all use cadmium. Once a cadmium alternative is developed which meets the technical criteria of the application, it will be reviewed to determine its safety and reliability. However, currently the number of circuit breakers used in CT annually is too few to persuade circuit breaker manufacturers to redesign and develop cadmium-free versions that CT manufacturers could test.

8. You mention that ”*Products made with substitute contacts may be more susceptible to failure in the dangerous welded-closed state more often than are AgCdO contacts.*”

   Do you have specific examples of such failures? When did they occur, with which substitutes, and in which applications, and what was learned from it as to consequences for design and other improvements of cadmium-free contacts?

   MQ: This is sensitive and confidential information, which is not suitable for publication. If necessary, MQ is willing to share this information with the consultant in confidential communication.

   ST : The difficulties of implementing alternative contact materials are indicated in the application form. Specific examples will contain sensitive and confidential information, which is not suitable for publication. ST is willing to share information on this topic with the

consultant through telecom. In direct communication we can support the consultant with information of interest for preparing the stakeholder consultation.

Please note that answers to these questions will be published as part of the evaluation of this request. If your answers contain confidential information, please provide a version that can be made public along with a confidential version, in which proprietary information is clearly marked.

It would be helpful if you could kindly provide the information in formats that allow copying text, figures and tables to be included into the review report.

3. References

Gensch et al. (2016 e): Assistance to the Commission on Technological, Socio-Economic and Cost -Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment - Study to assess renewal requests for 29 RoHS Annex III exemptions. RoHS 14. Unter Mitarbeit von Carl-Otto Gensch, Yifaat Baron, Markus Blepp, Katja Moch, Susanne Moritz, Oeko-Institut und Dr. Deubzer, Otmar, Fraunhofer Institut Zuverlässigkeit und Mikrointegration IZM (Adaptation to Scientific and Technical Progress of Annexes III and IV of Directive 2011/65/EU, RoHS XIV). Online verfügbar unter https://circabc.europa.eu/sd/a/eda9d68b-6ac9-4fb9-8667-5e561d8c957e/RoHS-Pack_9_Final_Full_report_Lamps_Alloys_Solders_June2016.pdf.