



Department  
for Environment  
Food & Rural Affairs

# Industrial monitoring and control instruments: exemption for cadmium anodes in Hersch cells

15 March 2024

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# Introduction

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (the RoHS regulations) restricts the use of 10 hazardous substances in electrical and electronic equipment (EEE), with a view to contributing to the protection of human health and the environment, including the sound recovery and disposal of waste.

Industry can apply for exemptions to allow the supply of products using one or more of the restricted substances above the threshold limits set down in the RoHS regulations where specified criteria are met. Applications for exemptions are made to the Secretary of State under regulation 6 of the Hazardous Substances and Packaging (Legislative Functions and Amendment) (EU Exit) Regulations 2020 (the 2020 regulations). Any exemption that is granted can be used across industry, not just by the business that applied for the exemption. Exemptions are granted where it is determined that the necessary criteria have been met following a detailed evaluation conducted in accordance with regulation 5 of the 2020 regulations.

Following the UK's withdrawal from the EU, the function of granting, renewing and revoking exemptions were, in relation to Great Britain, transferred to the Secretary of State by the 2020 regulations, using powers in section 8 of the European Union (Withdrawal) Act 2018 (the Withdrawal Act).

Part of the evaluation process is an 8-week consultation to collect contributions from stakeholders.

A request for renewal for an exemption was submitted for cadmium anodes in Hersch cells for oxygen sensors used in industrial monitoring and control instruments, where sensitivity below 10ppm is required. These oxygen sensors are used in applications where maintaining the product integrity requires the prevention of oxygen permeation, therefore the measurement of extremely low levels of oxygen is necessary. Examples are pharmaceutical products, food packaging and solar panels that require a high oxygen barrier. The cadmium specified in the exemption request is used as the anode of the coulometric sensor.

The requested duration of the exemption is for 7 years (the maximum period under the 2020 Regulations) and according to the application it would be expected to lead to the introduction of 0.224 kg of cadmium to the UK market annually. The applicant states that elimination or substitution of cadmium whilst maintaining the current technical performance is scientifically or technically impracticable.

The exemption covers monitoring and control instruments in industry under category 9 (industrial) of electrical and electronic equipment (EEE), as covered in the 2012 RoHS regulations.

The applicant proposed the following change in the wording of the current exemption entry: Cadmium anodes in electrochemical Hersch cells for oxygen sensors for measurement of permeation.

The original wording is: Cadmium anodes in Hersch cells for oxygen sensors used in industrial monitoring and control instruments, where sensitivity below 10ppm is required.

Under Regulation 5, an exemption may only be granted where the following conditions are satisfied:

1. The exemption does not weaken the environmental or health protection afforded by UK REACH; and
2. The elimination or substitution of the material or component, via design changes or use of materials or components which do not include any restricted substances, is scientifically or technically impracticable.
3. The reliability of substitute materials or components is not ensured; or
4. The total negative environmental, health and consumer safety impacts caused by substitution of another material or component is likely to outweigh the total environmental, health and consumer safety benefits of that substitution.

## Purpose of this consultation

The purpose of this consultation is to seek views on the request for the renewal of an exemption to the substance restrictions in the RoHS regulations, to collect additional data and information, and to inform stakeholders about the application.

## Geographical extent

We are consulting on proposals applicable to England, Wales and Scotland only. The Secretary of State's transferred function only applies in relation to England, Scotland and Wales.

Northern Ireland is out of scope of this consultation. This is because the [EU RoHS Directive](#) is covered under the Windsor Framework agreement with the EU. As such, the EU RoHS Directive continues to apply in Northern Ireland and Northern Ireland continues to be bound by exemption decisions made by the EU.

## Audience

This is a public consultation, and we welcome all views, particularly views from the electrical and electronic equipment manufacturing and supply industry for medical devices, and relevant trade bodies, medical organisations who use the equipment in question, research institutions and universities, NGOs and public administrations.

## Responding to this consultation

Please respond to this consultation in one of the following ways:

Online using the [Citizen Space consultation hub at Defra](#).

For ease of analysis, responses via the Citizen Space platform would be preferred, but alternative options are provided below if required.

By email to: [rohs@defra.gov.uk](mailto:rohs@defra.gov.uk) or [consultation.coordinator@defra.gov.uk](mailto:consultation.coordinator@defra.gov.uk)

Please note, any responses sent by post must arrive at the above address by the closing date of the consultation (10 May 2024) to be counted. Unfortunately, any responses received after this date will not be analysed. To ensure your response is included in the analysis, please consider responding online via Citizen Space.

Further exchange with stakeholders will be held after the consultation has ended for those issues where further need for information or (technical) discussion has been identified.

## Duration

This consultation will be open for 8 weeks from 15 March 2024 until 10 May 2024.

## Confidentiality and data protection information

A summary of responses to this consultation will be published on the Government website at: [www.gov.uk/defra](http://www.gov.uk/defra). An annex to the consultation summary will list all organisations that responded, but will not include personal names, addresses or other contact details. Defra may publish the content of your response to this consultation to make it available to the public without your personal name and private contact details (for example, your home address or email address).

If you would like anything in your response to be treated as confidential, please say so clearly in writing when you submit your response to the consultation and explain why you

require these details to be kept confidential. The reason for this is that information in response to this consultation may be subject to release to the public or other parties in accordance with access to information laws. These are primarily the Environmental Information Regulations 2004 (EIRs), the Freedom of Information Act 2000 (FOIA) and the Data Protection Act 2018 (DPA).

We have obligations, mainly under the EIRs, FOIA and DPA, to disclose information to particular recipients or to the public in certain circumstances. In view of this, your explanation of your reasons for requesting confidentiality for all or part of your response would help us balance these obligations for disclosure against any obligation of confidentiality. If we receive a request for the information that you have provided in your response to this consultation, we will take full account of your reasons for requesting confidentiality of your response, but we cannot guarantee that confidentiality can be maintained in all circumstances.

If you select 'No' in response to the question asking if you would like anything in your response to be kept confidential, we will be able to release the content of your response to the public, but we won't make your personal name and private contact details publicly available.

There may be occasions when Defra will share the information you provide in response to the consultation, including any personal data with external analysts. This is for the purposes of consultation response analysis and provision of a report of the summary of responses only. This consultation is being conducted in line with the Cabinet Office [Consultation Principles](#).

Please find our latest privacy notice uploaded as a related document alongside our consultation document.

If you have any comments or complaints about the consultation process, please address them to [consultation.coordinator@defra.gov.uk](mailto:consultation.coordinator@defra.gov.uk) using the heading below:

Consultation on amendments to the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations – Hersch Cells.

## After the consultation

A summary of the non-confidential responses to this consultation and the government response will be published and placed on government websites at [www.gov.uk/defra](http://www.gov.uk/defra)

The summary will include a list of respondents and organisations that responded, but not personal names, addresses or other contact details. However, information provided in response to this consultation document, including personal information, will be shared with the Devolved Administrations and may be subject to publication or release to other parties or to disclosure in accordance with the access to information regimes, for example Freedom of Information Act 2000 (FOIA) and the Data Protection Act 2018.

# About you

A wide range of businesses, organisations and individuals are involved with or take an interest in the supply of electrical equipment. The questions below are intended to put your responses in perspective with those of other respondents.

## Q1. Would you like your response to be confidential?

Yes or No.

- If you answered 'Yes', please provide your reason.

## Q2. What is your name?

## Q3. What is your email address?

This is optional, but if you enter your email address you will be able to return to edit your consultation response in Citizen Space at any time until you submit it. You will also receive an acknowledgement email when you submit a completed response.

## Q4. Which best describes you?

Please provide the name of the organisation or business you represent and the approximate size or number of staff (where applicable). (Please tick one option. If multiple categories apply, please choose the one which best describes the organisation you are representing in your response).

- Business representative organisation or trade body
- Producer of electrical and electronic equipment
- Business end-user of electrical or electronic equipment
- Public end-user of electrical or electronic equipment (for example, NHS, educational institution)
- Distributor (including Online Marketplaces)
- Local government
- Community group
- Non-governmental organisation
- Charity or social enterprise
- Consultancy
- Academic or research
- Individual
- Other
- If you answered 'Other', please provide details:



# Background

The EU RoHS Directive limits the use of specified hazardous substances in the manufacture of certain electrical and electronic products. The UK played a key role in developing the original European legislation, and the RoHS Regulations transposed the EU RoHS Directive into UK law. The RoHS Regulations limits the use of 10 substances and maximum concentration values tolerated by weight in homogeneous materials as follows:

- lead (0.1%)
- mercury (0.1%)
- cadmium (0.01%)
- hexavalent chromium (0.1%) Polybrominated biphenyls (PBB) (0.1%)
- polybrominated diphenyl ethers (PBDE) (0.1%)
- bis(2-ethylhexyl) phthalate (DEHP) (0.1 %)
- butyl benzyl phthalate (BBP) (0.1%)
- dibutyl phthalate (DBP) (0.1%)
- diisobutyl phthalate (DIBP) (0.1%)

The scope of the RoHS Regulations is wide ranging, covering most types of electrical and electronic equipment intended for household or commercial use. A limited list of products is exempt, such as large-scale fixed installations, large-scale industrial tools, military equipment, items designed specifically for research and development, most forms of transport and active implant devices.

As explained above, businesses can apply for exemptions that allow the manufacture and supply of products that exceed these threshold limits where it can be proven that alternative less hazardous substances are not available or not reliable or the total environmental, health and safety impacts of the substitution would outweigh the benefits thereof. Following the UK withdrawal from the EU, the Secretary of State now has the power to determine applications for exemptions for products supplied to or in Great Britain. Businesses can apply to the Secretary of State for new exemptions and renewal of existing exemptions. A list of existing exemptions can be found in [Table 1, Schedule A2, of the Hazardous Substances and Packaging \(Legislative Functions and Amendment\) \(EU Exit\) Regulations 2020](#).

Under Regulation 5, an exemption may only be granted where the following conditions are satisfied:

1. The exemption does not weaken the environmental or health protection afforded by UK REACH; and
2. The elimination or substitution of the material or component, via design changes or use of materials or components which do not include any restricted substances, is scientifically or technically impracticable.
3. The reliability of substitute materials or components is not ensured; or

4. The total negative environmental, health and consumer safety impacts caused by substitution of another material or component is likely to outweigh the total environmental, health and consumer safety benefits of that substitution.

## The exemption request

Entry 94 in Table 1, Schedule A2 of the 2020 regulations is for cadmium anodes in Hersch cells for oxygen sensors used in industrial monitoring and control instruments, where sensitivity below 10ppm is required. The exemption for category 9 (monitoring and control instruments in industry) applications is due to expire by 15 July 2023; the applicant, AMETEK MOCON has requested a renewal for 7 years.

Granting the renewal of this exemption would lead to the continued introduction of 0.224 kg of cadmium to the UK market annually. The applicant states that no suitable substitutes that have been verified to meet the technical performance required have been identified.

## Proposed change to exemption wording

The applicant proposed the following change in the wording of the exemption entry: Cadmium anodes in electrochemical Hersch cells for oxygen sensors for measurement of permeation.

Whilst this wording could be considered to be less specific as it removes the sensitivity level, it is more specific to the applicant's exemption requirements by stating it measures permeation. This may narrow the potential applications for which the exemption can be used. Therefore, it is important to understand whether there are other exemption uses that may not be covered within the specific purpose that the applicant proposes to use.

## Details on the exemption application

The Hersch cell is uniquely able to provide the extremely high-sensitivity (oxygen range detection: 80ppt to 70ppm) and long-term stability that are required in industrial monitoring and control instruments (category 9ind) such as pharmaceutical products, food packaging and solar panels that require a high oxygen barrier. Hersch cells work based on a patented technology whereby the sample gas is introduced into an electrolytic solution (potassium hydroxide – KOH) and the coulometric oxygen sensor measures the generated electrical current that is proportionate with the amount of oxygen it was exposed to in the gas. Cadmium is used for the anode. The design of the Hersch cells ensures the measurement of all (absolute amount of) oxygen in the sample gas as it does not include a membrane barrier or other restriction between the sensor and the sample gas (direct measurement). Due to the absolute nature of the measurement, no calibration is required, which in turn ensures the extremely low concentration levels. Ensuring the near 100% availability of oxygen for the sensor requires specific design considerations, for example the anode has to

be available in a plaque form. Further advantages of using cadmium that makes it difficult to substitute:

- the voltage discharge level is the flattest of the electrochemical sensors which gives the Coulox sensor its accuracy and consistent measurements throughout its life
- cadmium is very specific to oxygen and has very few interfering gases and this sensitivity does not degrade over long periods of time (years);
- the solubility of cadmium in the electrolyte (KOH) is very low, therefore does not migrate (like other metals) to the sensing electrode, precipitate or block the sensing electrode sights. This gives the Hersch cadmium cell extraordinary long stable sensitivity life (years). Other metals do not have comparable life-time, sensitivity or stability

## **Alternatives and substitutes testing**

According to the exemption applicant, alternative anode metals (such as lead, zinc and lithium) have been researched, however, none of these are able to provide the same level of sensitivity and stability. Alternative technologies also exist, these include: Tuneable Laser Diodes, Zirconia, Thermal Conductivity Detectors (TCD), Pulsed Discharge Helium Ionization Detector (PDHID), and Optical Fluorescence, but none of these provide the same level of sensitivity as none of them are absolute in nature. The applicant has tested two different galvanic cell combinations and two different fuel cells designs, none of these were able to provide equal level of efficiency and sensitivity. Testing of a further 6 to 12 other materials is ongoing, so far with no positive results. The applicant stated that the development of a new sensor typically takes up to 10 years, even an improvement involving changing one component of the Cd Coulox sensor took three years. At the moment the applicant has no immediate prospects of identifying a suitable alternative.

This consultation aims to collect opinions on the current state of play regarding alternatives and substitutes, at a substance and a device level, and to further understand the alternatives and any limitations that the alternatives currently available might have for end users.

## **Socio-economic impacts**

This consultation is also looking to further understand how the granting or revocation of this exemption request may impact on business, from manufacturing through to end user applications, as well as wider society and social impacts (for example, human health impacts). We welcome opinions and supporting evidence for any viewpoints associated with the socio-economic impacts of this exemption.

## Consultation specific questions

**Q5. Do you agree or disagree that the exemption under RoHS for cadmium anodes in Hersch cells for oxygen sensors used in industrial monitoring and control instruments, where sensitivity below 10ppm is required should be renewed?**

Agree

Disagree

Don't know

*Please provide evidence to support your answer, explaining why you either support the applicant's request or object to it. To support your views, please provide detailed technical argumentation or evidence in line with the criteria in regulation 5 of the 2020 regulations. to support your statement.*

**Q6. Do you agree or disagree with the proposed length (7 years) of the exemption renewal?**

Agree

Disagree

Don't know

*Please provide evidence to support your answer, explaining why you either support the applicant's request or object to it. To support your views, please provide detailed technical argumentation or evidence in line with the criteria in regulation 5 of the 2020 regulations. to support your statement.*

**Q7. Do you agree or disagree that the wording of the exemption should be changed, noting that if the wording is changed, the scope of the exemption would potentially be narrower?**

**Existing wording:** Cadmium anodes in Hersch cells for oxygen sensors used in industrial monitoring and control instruments, where sensitivity below 10ppm is required.

**Proposed wording:** Cadmium anodes in electrochemical Hersch cells for oxygen sensors for measurement of permeation.

Agree

Disagree

Don't know

*Please provide evidence to support your answer. Please suggest an alternative wording and explain your proposal if you do not agree with the proposed exemption wording.*

**Q8. Do you know of alternative substances to cadmium that can be used in the production of the anodes in Hersch cells for oxygen sensors, where sensitivity below 10ppm is required?**

Yes, I do know of alternative materials which do not rely on RoHS-restricted substances.

No, I do not know of alternative materials which do not rely on RoHS-restricted substances.

*Please provide evidence to support your answer and if possible, links to supporting information on alternative materials and any limitations of those alternatives.*

**Q9. Do you know of alternative devices (with comparable features and performance), which do not rely on RoHS-restricted substances? For example, different design of sensors, or entirely different technology that does not use cadmium or other RoHS restricted substances.**

Yes, I do know of alternative devices with comparable features.

Yes, I do know of alternative devices, but these do not have comparable features.

No, I do not know of alternative devices.

*Please provide an explanation to support your answer and if possible, links to supporting information. Please provide any thoughts on why the alternatives are or are not suitable for use by your organisation.*

**Q10. Are you aware of any research initiatives (past, present or planned) which are looking into possible alternatives for some or all of the application range of cadmium in the anodes in Hersch cells for oxygen sensors, where sensitivity below 10ppm is required?**

Yes, I do know of research initiatives which will help in the eventual production of RoHS compliant devices.

No, I do not know of research initiatives which will help in the eventual production of RoHS compliant devices.

*Please provide evidence to support your answer and if possible, links to supporting information. If you answered yes, please provide an estimate of the time required until the technology will be available for use in the market.*

**Q11. Can you estimate how many cadmium-containing oxygen sensors (Hersch cells or other equipment covered by this exemption) your organisation produces or purchases per year, or it is planning to produce or purchase over the next 7 years?**

*Please provide quantitative data to support your view.*

**Q12. Please summarise your view on the potential impacts on the environment, if this exemption was or was not granted.**

*Please provide quantitative data to support your view.*

**Q13. As part of the evaluation, socio-economic impacts shall also be assessed. Please estimate possible impacts on employment in total, in Great Britain and outside Great Britain, should the exemption be granted or not granted. Please tick to indicate the main sectors in which possible impacts are expected:**

- manufacturers
- importers, distributors or professional sellers
- end-users
- other (please state)

*Please provide any quantitative data available to support your view.*

**Q14. Please estimate additional costs and benefits associated with a forced substitution should the exemption not be granted, and how this is divided between various sectors:**

- manufacturers
- supply chain (for example, distribution)
- distributors or retailers (selling devices)
- end-users
- other (please state)

*Please provide any quantitative data available to support your view.*

**Q15. Please summarise your view on the potential impacts on human health, if this exemption was granted or not granted.**

*Please provide quantitative data to support your view.*

**Q16. Please provide any further information and/or data that you think is of importance to substantiate your views.**