Department for Environment Food & Rural Affairs (Defra)

Bis(2-ethylhexyl) phthalate (DEHP) in ion-selective electrodes applied in point of care analysis of ionic substances present in human body fluids and/or in dialysate fluids (UK-2021-04)

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Date: 7th February 2022

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Anthesis Consulting Group

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Executive summary

Background and Objectives

The European Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (2011/65/EU, RoHS 2[i]) permits exemptions to be sought. New and renewal exemptions are granted or extended at the discretion of the Commission and until 31st December 2020, have been automatically transposed into UK law as "The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012" (The RoHS Regulations)[ii]. With the United Kingdom's withdrawal from the European Union on 31st January 2020 and the end of the transition period on 31st December 2020 the UK regulation has been updated to reflect the rules for placing such equipment on the market in Great Britain and in Northern Ireland[iii iv].

The exemptions that had already been transposed into UK law remain, but several exemption applications were still under review by the European Commission. Consequently, any new exemptions adopted by the European Union post 1st January 2021 that were submitted to the European Commission before 1st January 2021, require an independent review by Defra before the Secretary of State decides whether to apply that exemption to The RoHS Regulations. Amending regulations repatriate powers to the Secretary of State to consider exemption applications made for the GB market. They set out transitional arrangements for applications that were made to the European Commission, before the end of the "transitional period".

Anthesis (UK) Limited (Anthesis) have been contracted by Defra through award of contract No. 59661 to review the exemption adopted by the European Union on 11th August 2021 for Bis(2-ethylhexyl) phthalate (DEHP) in ion-selective electrodes applied in point of care analysis of ionic substances present in human body fluids and/or in dialysate fluids to be included in Annex IV, entry 45 of The Restriction of Hazardous Substances Directive (RoHS 2). This exemption is being considered under the "transitional provisions" mentioned above. The Anthesis review has primarily focused on the European Commission's report considering *inter alia* alignment with UK REACH[v]; risk characterisation of the requested use; feasibility of alternatives paying specific attention to their availability in the GB market; and consideration of the socio-economic implications from a GB perspective.

Key Findings

The exemption request adopted in the European Union under RoHS 2 for the use of bis(2-ethylhexyl) phthalate (DEHP) in ion-selective electrodes applied in point of care analysis of ionic substances present in human body fluids and/or in dialysate fluids (Annex IV, entry 45) should be adopted in Great Britain under The

RoHS Regulations. Whilst the substitution is theoretically feasible, the reliability of substitutes currently cannot be sufficiently ensured and the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits. There is no conflict with UK REACH, thus the exemption will not weaken the environmental protection.

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1. Introduction

1.1 Adopted EU Delegating Act

On the 11th August 2021, a new entry to Annex IV of the RoHS 2 Directive was adopted by the European Union which was expected to be published in the European Official Journal in October 2021 (however, at the time of writing this report has not yet been published), Directive 2011/65/EU has been updated as follows:

Entry:	Annex IV, 45
Exemption:	*Exemption for the use of bis(2-ethylhexyl) phthalate (DEHP) in ion-selective electrodes for analysing human body fluids and/or dialysate fluids.*
Duration: 7 years	
Member State adoption & publication:	31st March 2021
Member State application of provisions:	21st July 2021

The exemption was granted, because the reliability of substitutes is currently not sufficiently ensured and the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits[vi].

1.2 Project scope and methodology

The Anthesis review has primarily focused on the European Commission's report[vii] considering its alignment with UK REACH[v] and the requirements laid out in The RoHS Regulations. The application submitted by COCIR (European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry, the Applicant) has also been consulted (available from the Öko-Institut website[viii]). The Anthesis review is supplemented with further research, to confirm the applicability of the exemption request to Great Britain. It should be noted that Anthesis only has access to information in the public domain, it has not been able to assess any confidential information referred to in any of the above sources.

This report first summarises the exemption request and the decision reached by the European Commission, Council and Parliament (Section 2). Section 3 reviews the exemption request within the context of Great Britain, considering:

- The risk characterisation of the requested use,
- The feasibility of alternatives, paying specific attention to availability in the GB market, and;
- Consideration of the socio-economic implications, from a GB perspective.

The Anthesis recommendation is given in Section 4.

2. Background to the Exemption

The application for the exemption for the use of bis(2-ethylhexyl) phthalate (DEHP) in ion-selective electrodes for analysing human body fluids (the original wording did not refer to dialysate fluids)

was received on 17th July 2018. The Commission launched a study to carry out the required technical and scientific assessment, that included an eight-week public consultation. One contribution was received[ix]. The assessment was undertaken by the Öko-Institut e.V. (Öko-Institut) and Fraunhofer IZM which was published in April 2020. The exemption application was an agenda item at the 21st October 2019 Member States' Expert Group meetings[x], where one Member States expert highlighted that the exposure of vulnerable patients to phthalates must be taken into account; and another expert stated that the amount of DEHP concerned by the exemption requests seems very low in comparison with the DEHP used in other non-electrical applications. The application was also discussed on the 23rd February 2021 Member States' Expert Group meeting[xi], where no questions or comments were raised. After notifying the European Council and Parliament, the Commission adopted it as entry 45 in Annex IV of the RoHS 2 Directive and referred it to the WTO Committee on Technical Barriers to Trade (TBT) on 29th June 2021. The publication of the exemption request, in the Official Journal, is expected imminently due to the 22nd of July 2021 deadline in (EU) 2015/863 (the exemption will apply retroactively from this date) and the much-reduced commenting window by the WTO TBT of 15 days.[xii]

2.1 Exemption applied for

The applicant, COCIR, applied for a new exemption for the use of DEHP within in-vitro diagnostic equipment (Category 8) that measure specific substances in body fluids on the 17th of July 2018.

The applicant indicated that DEHP is used as a membrane solvent for the ion selective electrode (ISE) that are used in point of care (PoC) analysers, to measure concentrations of sodium and potassium ions, pH, and partial pressure of CO2 (pCO2) in whole blood and other fluids. The applicant later clarified this meant serum, plasma, urine, cerebral spinal fluid, and pleural fluid, as well as dialysate fluid to aid in blood cleaning during dialysis.

As COCIR explained "Point of Care (PoC) analysers are medical devices used in situations where results of body fluid analysis are required in the shortest time possible, in order to enable quick therapeutic intervention", examples include emergency departments, intensive care units, neonatal units and in operating theatres.

The ISE sensors are supplied to hospitals as components of disposable cartridges that contain the sensors required for the measurements, "the chemicals used for the analysis and carry out measurement, washing and waste disposal, aqueous quality controls and electronics". These cartridges are only compatible with the specific type/model of analysers used by hospitals. "The system utilizes mathematical formulas (algorithms) that are specifically designed for each sensor (membrane formulation). Therefore, it is the total integrated system (instrument, reagents, sensor formulation, algorithms) that is the complete system device which yields clinically acceptable performance and result."[xiii] That means, without the exemption, the analysers already on market cannot operate as they will not be compatible with any new cartridges that are produced without DEHP.

The following figure illustrates the role of DEHP in the analyser and includes information on the equipment's features.

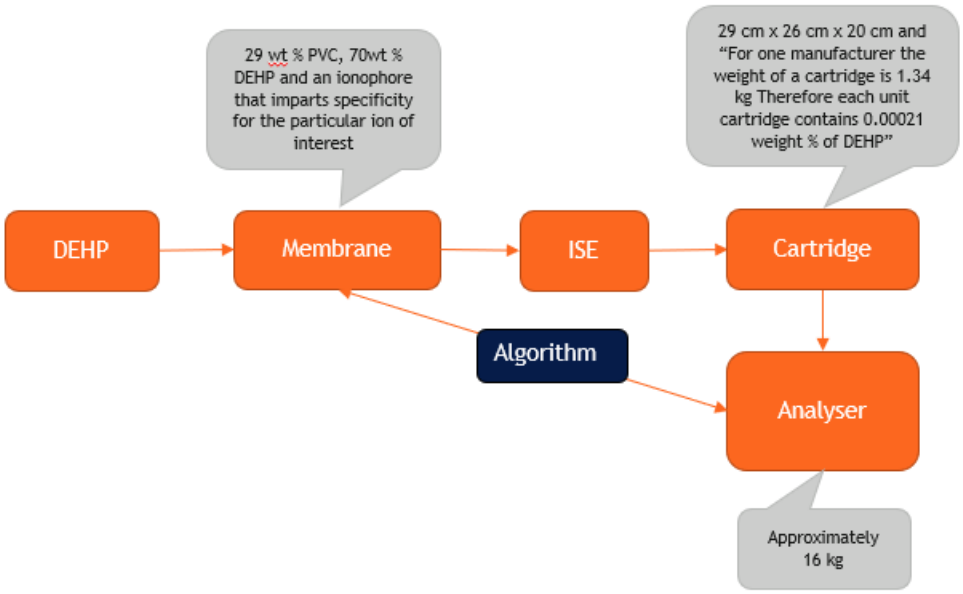

Figure 1: *Schematic to illustrate the role of DEHP in the PoC analysers.*

The following link illustrates a typical analyser, which the applicant included it in its clarification document[xiv]: RAPIDPoint® 500e Blood Gas System (siemens-healthineers.com)

According to the interpretation of the Öko-Institut, "these cartridges containing DEHP are consumables of the PoC analysers, which are nevertheless to be considered as electrical and electronic equipment (EEE)". They are disposed once the chemicals have been consumed, after a fixed period of time (e.g. 28 days) or after a specific number of samples have been analysed (e.g. 750).

According to the applicant, the key functions of the cartridge are the following:

- "Must be able to analyse whole blood directly,
- Must not affect stability of membrane or electrodes during use or in storage,
- Cartridges must be compatible with analysers already on the market and in use within EU hospitals,
- Give analysis results within as short time as possible, ideally within one minute
- Change-over time to replace the used cartridges should be as short as possible, ideally less than 30 minutes."

DEHP, as a plasticiser must have the following technical characteristics:

- "Be liquid over a wide range of temperatures,
- Be compatible with, and solvate the other membrane components,
- Not induce phase separation,

- Not exhibit crystallization,
- Be lipophilic so it does not leach from the membrane during the use“

2.2 Additional information considered

2.2.1 REACH Authorisation, Restriction and SCIP Database

In accordance with the criteria laid out in Article 5 (1)(a) of RoHS 2, the ability to grant an exemption by adapting Annexes III and IV should not “*weaken the environmental and health protection afforded by Regulation (EC) No 1907/2006*” (REACH). Therefore, the following section will look at any potential conflicts with (EU) REACH.

DEHP is registered in the EU in the 10,000- 100,000 tonnes per annum volume[1]. The registered uses shall be consistent with Annex XIV and Annex XVII.

At the time of the adoption and publication of Directive (EU) 2015/863, REACH Annex XIV included DEHP due to its reproductive effects. There is an exemption for DEHP: Uses in the immediate packaging of medicinal products covered under Regulation (EC) No 726/2004, Directive 2001/82/EC, and/or Directive 2001/83/EC. Commission Regulation (EU) 2020/171 amended the Annex XIV entry and allows that even after the sunset date, the use of DEHP is allowed until 1st March 2023 in the production of spare parts for the repair in certain cases. The applicant considers the cartridges consumables rather than spare parts for repair, upgrade or capacity expansion; therefore, this is not applicable.

Applications for Authorisation were received for DEHP used in other EEE. None of the Authorisation applications submitted consider the use of DEHP in medical devices, due to the exemption afforded by Article 60 (of REACH). Article 60(2) specifically exempts the need for Authorisation of use within medical devices, when the intrinsic properties of the substance identified has hazards that only affect human health. Furthermore, Article 62(6) states that applications do not need to include risks to human health arising from medical devices. This is because the Medical Devices Regulation (EU) 2017/745, repealing Directives 90/385/EEC and 93/42/EEC and effective from 26th May 2020 and the in vitro Medical Devices Regulation (EU) 2017/746 repealing Directive 98/79/EC with effect from 26 May 2022, specifically identifies phthalates and assesses the risk of those uses.

In late 2014, though, DEHP was identified as a substance of very high concern (SVHC) for its equivalent level of concern, based on its potential for endocrine disruption properties for the environment. In 2017, its entry was updated with the inclusion of endocrine disrupting for human health. The Annex XIV entry for DEHP has yet to be amended, but the draft regulation was adopted on the 23rd November 2021 and will enter into force on the 20th day after its publication in the Official Journal. Once the derogation for the use of DEHP in medical devices expires on 27th May 2025, further applications for Authorisation for DEHP might be expected, as Articles 60(2) and 62(6) will not provide full exemption for DEHP to be used in medical devices. In our opinion,

[1] https://echa.europa.eu/registration-dossier/-/registered-dossier/15358

even at that point, there will be no conflict between this exemption request and EU REACH, as the substances are already incorporated into the articles when imported to the EU. The scope of Authorisation is the use of substances on their own or in mixtures, or when incorporating them into articles within the EU. As the applicant states: "ion selective electrode membranes containing DEHP are manufactured outside of the EU and so only articles are imported into the EU and DEHP is not used as a chemical substance in the EU."

Articles are typically regulated via restrictions (Annex XVII) and although DEHP is included in entry 51 of Annex XVII, it neither applies to EEE within the scope of RoHS 2 nor medical devices regulated by 90/385/EEC, 93/42/EEC and 98/79/EC[xv]. Entry 51 was updated to its present form in December 2018 via the Commission Regulation (EU) 2018/2005. Based on its toxic to reproduction category 1B classification, entry 30 also applies to DEHP, however, entry 30 restricts supply to the public, whilst this application in only sold to professional users (i.e., health facilities).

COCIR also mentioned a registry of intentions under REACH regarding materials with prolonged skin contact. The Öko-Institut confirmed, however, that the registry of intentions, to which COCIR refers, forms part of the amendment of entry 51 of Annex XVII and does not apply to the exemption request. Furthermore, the cartridges in question are also sealed, thus no prolonged skin contact can occur.

The revised Waste Framework Directive mandated the European Chemicals Agency (ECHA) in 2018 to establish a database of articles that contain SVHCs in greater than 0.1% concentration. This database, called SCIP (**S**ubstances of **C**oncern **I**n articles as such or in complex objects (**P**roducts), aims to provide transparency, primarily for waste operators, to ensure safe recycling. The information is also accessible to consumers. The notification obligation for article suppliers entered into force on 5th January 2021, so it was not effective when the Öko-Institut prepared their assessment.

Any European medical device producer or importer must submit a SCIP-notification for the articles they place on the market, if they contain more than 0.1% of an SVHC. Therefore, ISE importers might need to submit a notification depending on the concentration of DEHP in the smallest part of the complex object that meets the article definition. However, from this respect, the exemption (in our opinion) does not weaken the environmental and health protection in the EU, as the SCIP notification requirement is not a restriction.

2.2.2 Medical Device Regulations

The European regulatory framework ensures the safety and efficacy of medical devices and facilitates patients' access to devices in the European market. Medical devices within the EU are currently regulated by 1 Regulation and 3 Directives:

- Regulation (EU) 2017/745 on medical devices (MDR);
- Council Directive 90/385/EEC on Active Implantable Medical Devices (AIMDD) (1990);
- Council Directive 93/42/EEC on Medical Devices (MDD) (1993); and
- Directive 98/79/EC of the European Parliament and of the Council on in vitro Diagnostic Medical Devices (IVDMD).

Regulation (EU) 2017/746 of the European Parliament and of the Council of 5th April 2017 on in vitro diagnostic medical devices and repealing Directive 98/79/EC and Commission Decision 2010/227/EU will apply from 26th May 2022. The two new Regulations will progressively replace the existing directives after a transition period.

Regulation (EU) 2017/746 requires that medical devices shall be designed and manufactured in such a way as to reduce as far as possible the risks posed by substances that may be released from the device. Devices from which such a release might cause a prolonged exposure, may only contain substances that are CMR category 1A or 1B, endocrine disruptors or other SVHCs identified under REACH, where justified.

Furthermore, the Commission mandated a scientific committee to prepare a guideline specifically on phthalates, including a benefit-risk assessment of the presence of phthalates (including DEHP), considering the intended use of the device and available alternatives. This guideline may be consulted for the above-mentioned justifications[xvi].

2.2.3 Technical feasibility and availability of substitutes

The applicant states that there is currently no practical alternative to the use of DEHP in the ISE membrane that would enable the accuracy, correct data and efficiency that is provided with the use of DEHP. Due to the nature of the use in in-vitro devices, i.e., in critical care and emergency situations and the scale of use of these devices, the applicant states that none of the current options enable the rapid results that DEHP enables.

When introducing the alternatives tested in prior R&D activities, the applicant discussed different levels of substitution, as illustrated in Figure 2.

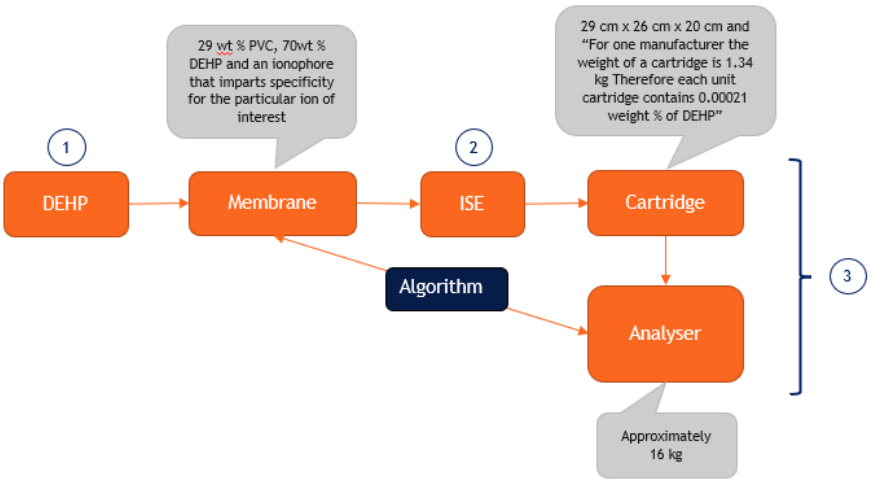

***Figure 2**: Illustration of the different levels of substitution: 1: alternative plasticiser, 2: alternative analysis method, 3: alternative analysis technique*

1) The first level is the substitution of DEHP in the membrane with **alternative plasticisers**. Several manufacturers of IVD ion selective electrodes (ISE) have attempted to replace DEHP with alternative substance showing similar properties. For example, in one experiment, sensors using nitrophenyloctylether (NPOE), dioctyl sebacate (DOS), dioctyl adipate (DOA), diundecyl phthalate (DUP), ditridecyl phthalate (DTP) resulted in unacceptable drift, which made it impossible to provide reproducible

and accurate results. (Drift is a natural phenomenon caused by physical changes and it affects the sensor's accuracy.) "This test has shown that DEHP exhibits the best balance between initial drift after one hour and reproducibility" [xiii]. This has allowed the technology to meet the needs of the critical care environment in particular a short period of time to obtain results and a short time before first measurement with a new cartridge.

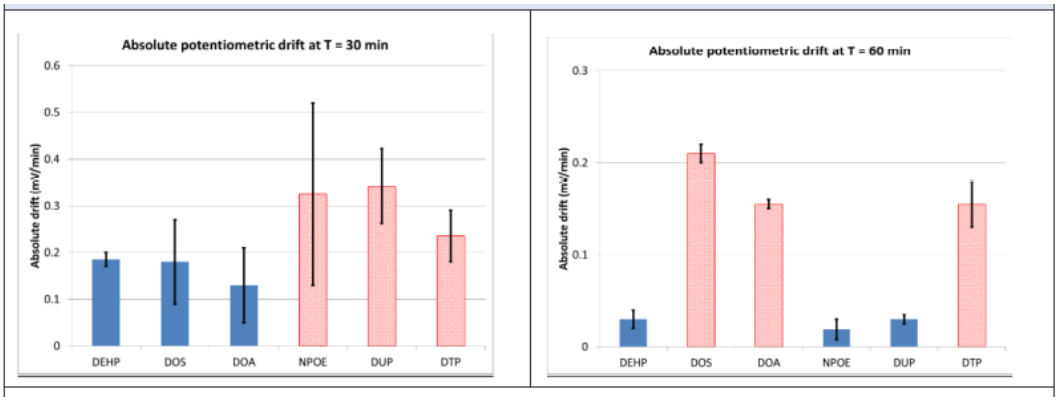

Figure 3: *Initial drift (mV/min) measured at T = 30 minutes and drift at T = 60 minutes after exposure to aqueous solutions for each of the tested plasticizers*

2) The applicant introduces several **alternative analysis methods** to measure the same analytes such as ion chromatography, flame photometry, atomic adsorption spectroscopy and glass pH electrodes for pH. Most of these are, however, laboratory-based methods (i.e., the sample would need to be sent to hospital's laboratory and testing would take several hours instead of minutes), often need a skilled operator, more sample material (e.g., pH electrode needs to be immersed), and take significantly more time. The applicant also notes that "that Ion chromatography, Flame Photometry and Atomic Adsorption Chromatography all yield the total concentration of the analyte. The physiological and clinical relevant result is only the ion activity, which is the portion which is ionized and free in the sample." Due to the critical limitations, none of these were found to be acceptable.
3) COCIR also suggested an **alternative analysis technique**, the so-called "lab-on-a-chip". According to COCIR, "this is the main focus of IVD equipment manufacturers. This technique is likely to use ion selective electrodes but these, the chemical pumps and analysis electronics are miniaturised so that only very small samples are required and analysis can be fairly rapid."

In terms of the time required to develop and implement the above alternatives, the applicant estimates about 7-8 years for development and 2 years for regulatory (re-)approval for replacing DEHP and reformulating the membrane but using the current design. The modified ISE modules, however, would not work with the current analysers.

For the development of the lab-on-chip technology, the applicant estimated about 8-10 years. In a response to the first clarification questionnaire, COCIR clarified that the work on this alternative began before 2015, it "is in feasibility phase and will take 8 to 10 years before complete

replacement will be possible". During the stakeholder consultation Radiometer stated the following: "To Radiometer's knowledge the 'lab-on-chip' technology will not be available for the foreseeable future."

COCIR explained that the exemption is needed for analysers placed on the market post 2021, but before the alternative is available (expected in about 8-10 years) and to assure reverse-compatibility for analysers already at hospitals and only compatible with DEHP ISE. Considering that hospitals and clinics in the EU already using devices that require DEHP-membranes on its ISEs would need to obtain consumables until the analysers reach end of life, the applicant estimated that: "cartridge consumables will be needed in the EU at least until 2030 and so this exemption will be needed for these until this date."

During the stakeholder consultation, Radiometer Medical ApS submitted a contribution that claimed they have an ongoing project for substituting DEHP in ISE. Their plan at that time was to substitute DEHP before 21st July 2021, however at the time of submission, they were not able to point to a suitable substitute. Anthesis has reached out to Radiometer to confirm whether they have accomplished the successful substitution, they confirmed that they were not able to complete their substitution plan yet.

Based on exemption 41 of Annex IV for lead in blood gas analysis cartridges, the Öko-Institut established that there are at least four manufacturers placing equipment in the EU market (Roche, Siemens, Instrumentation Laboratories and Radiometer), and thus concluded that three of the at least four manufacturers of blood analysis devices have not achieved substitution and would need the exemption. The forth company is Radiometer who stated in their contribution to the stakeholder consultation that they plan to substitute before July 2021. During the clarification phase, the applicant stated that they were unaware whether other manufacturers were using DEHP in analytes.

Based on their research, the Öko-Institut concluded, that "even though a broad range of RoHS compliant plasticisers exist and have been tested, the compatibility with the intended use of the sensors in PoC situations, makes time and precision of results a critical feature that needs to be ensured for the ISE application described by the applicant".

In their assessment, Öko-Institut had also reached out Professor Mark Meyerhoff from the University of Michigan regarding the technical feasibility to substitute DEHP in polymer membrane ISEs. Based on his input, Öko-Institut concluded that the substitution of DEHP "is in principle a feasible process". As a technical consultant on the electrochemical sensor technology with more than 30 years of experience, Professor Meyerhoff confirmed that in his opinion "it is possible that all ISE sensors within other whole blood analysers can indeed be prepared without the need to employ DEHP in the sensing membranes" [vi]

When asked to respond to this, COCIR provided the following comment: "There are complex interactions between the sensor membrane formulations, internal electrolyte formulations, system calibration reagent surfactants, calibration reagent preservatives and compatibility with internal system materials used to house the sensors. The membrane formulations are specifically optimized to function within the system and all components that contact the sensors. All these aspects need to be addressed to yield a stable, reproducible, and useful system. In our exemption request we also noted that the system utilizes mathematical formulas (algorithms) that are specifically designed for each sensor (membrane formulation). Therefore, it is the total integrated system (instrument, reagents, sensor formulation, algorithms) that is the complete system device which yields clinically acceptable performance and results." [xiii]

"Overall system stability and availability is very important to enable quick treatment of patients. In our exemption request we showed data that alternative plasticizers do not enable a stable system and will result in delayed treatment of patients. This delay can negatively impact patient outcomes. We also showed data that alternative plasticizers yield sensors with more variability. This can cause low quality clinical results leading to improper treatment of patients. The conclusion of our data was the following: "DEHP exhibits the best balance of initial drift after one hour and reproducibility and is therefore the preferred plasticizer. This has allowed the technology to meet the needs of the critical care environment in particular a short period of time to obtain results and a short time before first measurement with a new cartridge." [xiii]

Based on Radiometer's contribution to the stakeholders' consultation, the Öko-Institut concluded that substitution is possible in the timeframe before the restriction is entering into force, but "finding a compatible substitute may be more time-consuming for some manufacturers as it is a trial-and-error process." Thus some manufacturers will still need the exemption to complete their substitution plan. Furthermore, as mentioned above, Radiometer confirmed recently that they were not able to implement an alternative as they suggested during the European public consultation.

2.2.4 Environmental considerations

In terms of environmental risks, the applicant states that without the exemption, the in-vitro diagnostic analysers would need to be disposed of prematurely, increasing electrical equipment waste. In the answers to the clarification questionnaire [xiv], COCIR provided estimates of the possible amounts of waste generated through a forced substitution. This was estimated to be > 1,000 tonnes per annum, relating to the substitution of blood analysis devices already operating on the market and considering all associated consumables, based on the following assumptions:

- 30,000 analysers already on the EU market x 16 kg ≈ 500 t
- 12 cartridges per analyser per year x 1.34 kg ≈ 500 t

COCIR also stated that the manufacture of new alternatives would have negative environmental impacts, i.e., in resources used before the analysers reach their full potential. Furthermore, the applicant also indicated, that "Replacing these 500t by new devices would also lead to additional RoHS substances entering the EU market (e.g., lead in steel up to 0.35%, lead in aluminium with up to 1.5%, lead in copper with up to 4%)[2]. Assuming that 20% steel, 10% aluminium and 5% copper are being used, with a lead content of 0.35% in steel, 1.5% in aluminium and 4% in copper, the total weight of additional lead put on the market would be 2,100 kg (compared to a saving of 2.2 kg DEHP)". It should be noted that this would be realised irrespective of the exemption, when new equipment will be installed, however, in case the exemption is rejected, this impact would be accelerated. This data is summarised in Table 1.

[2] Using lead in ion selective electrode is covered under a separate application for exemption

Table 1: Estimation of the total weight of lead entering the market through replacement of the PoC analysers currently in stock.

Total Weight of EEE which need to be replaced [kg]	**500.000**
% Steel	20,00%
% Aluminum	10,00%
% Copper	5,00%
% Lead content in Steel	0,35%
% Lead content in Aluminum	1,50%
% Lead content in Copper	4,00%
Total Weight of Lead entering the market by products replacing the installed base [kg]	**2.100**

The Öko-Institut raised the possibility of selling surplus consumables outside of the EU, but COCIR indicated it is not possible "as there are other distribution centres which support the rest of the world. Manufacturing production and distribution centres are pre stocked based on forecast demand, so all material is accounted for. In addition, there is a limited shelf life so all stock would go to waste." Due to the limited shelf-life (9 months), it is also not possible to stock up on cartridges for hospitals for the entire lifetime of their analysers. However, it is assumed that at least some of the 500 tonnes of consumables could be still used, even in a forced substitution scenario.

Regarding the potential 500t wasted analysers, it is important to note, that not granting the exemption would only mean premature obsolescence (emphasis added by Anthesis), i.e., no additional waste would be generated, but rather that the waste of such devices shall be generated before they reach their full potential. "The average life-time of ISE PoC Analyzer is 9.7 years, with >50% of the install base older than 10 years." [xiii]

Radiometer stated in their contribution to the public consultation that up to 2019 they placed approximately 7,800 analysers on the market. They estimated the weight of analysers at risk to be potentially wasted be 73 tons.

The applicant highlights that in contrast, not granting the exemption would help to avoid entering 2.2 kg DEHP to the European market. (This will decrease when alternatives enter the market). The Öko-Institut also added, that in contrast to the 2.2kg, DEHP is currently registered in 10,000-100,000 tonnes in the EU.

Finally, as ISE is considered biohazard, thus sent to incineration as medical waste, not granting an exemption is not expected to lead to environmental benefits in the form of reducing emissions and health risks in EEE waste management facilities.

2.2.5 Socio-economic impacts

Human health impact:

As the devices are used in critical care diagnostic equipment, if there is no suitable alternative readily available, a significant impact on human health is expected. If not granted, the applicant states that it is likely that there would be serious negative impacts on human health, due to the inability to rapidly assess ion levels using the DEHP-ISE analysers. If results are inaccurate or

delayed, this could lead to incorrect diagnosis, or further illness/death; however, the applicant states that the actual quantitative impact in terms of human health would be difficult to measure.

Based on the approximately 30,000 instruments currently in the EU, it is estimated that between 90 and 120 million patients could be affected if the exemption is not granted. These estimates account for the number of cartridges and samples taken per year that are reported and calculated by the manufacturers. However, it can be assumed that there would be a requirement for manufacturers to inform hospitals and that they would take appropriate action in due time to minimise this impact. Even so, there would be an indirect impact on services due to the unplanned investment of purchasing new equipment. COCIR states that the additional investment that would be required by hospitals to replace equipment would affect patient care in hospitals due to reduced resource during training, and due to the redistribution of funds. Is also not clear whether alternatives are available already.

Economic impact:

The applicant, COCIR, states that there will be an increase in fixed costs for new devices due to the need for substitution, as research for alternatives needs funding and new production equipment will be needed to build the substitute analysers.

The applicant estimated that hospitals would be faced with costs greater than €250 million (£208,896,250[xvii]) to replace all the existing equipment on the EU market. COCIR also refers to the decision-making process and associated time and economic burdens, as described in Gensch et al. (2019)[xviii]. The unanticipated investment for a single hospital is estimated to cost over €300,000 (£250,675), with an additional cost of integration of new instruments with existing information systems (estimated at €20,000 (£16,711)). Furthermore, training for new equipment should be considered as loss of work, a hospital in Germany estimated that this could result in 1,200 hours of unproductive work time [xviii]. According to Gensch et al. (2019), the blood analysers in German hospitals are the same model and vendor to ensure standardisation and harmonised training.

The consultant's report stated that "This unplanned investment may affect the general ability to provide patients with other services in light of limited budget, but it cannot be followed that medical facilities would not replace equipment as quickly as possible." As previously stated, it also cannot be assumed that all analysers and all consumables would be wasted, therefore, the €250 million (£208,896,250) should be considered as a high estimate.

Radiometer estimated the total replacement cost including training to amount to approximately €130 million (£108,626,050).

Finally, it is important to note, that "This exemption is justified on the basis that substitution is not technically practical and does not rely on socio-economic issues to justify the maximum validity period".

Employment:

The consultant's report states that "COCIR refers to negative impacts along a range of industries e.g., manufacturing, supply chain, service, R&D, marketing, quality, regulatory, information technology, associated distributors, medical services and hospitals." The Öko-institut assumes in case there will be at least one company that reaches compliance (e.g., Radiometer) "some negative effects on employment might be offset by the industry sector which has reached compliance".

2.3 Conclusion

Article 5(1)(a) of RoHS 2 provides that an exemption can be justified if at least one of the following criteria is fulfilled:

i. Elimination or substitution via design changes, or materials and components which do not require any of the materials or substances listed in Annex II, is scientifically or technically impracticable.

ii. The reliability of substitutes is not ensured.

iii. The total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

The independent assessment concluded that exemption can be granted based on the third criteria of article 5(1)(a) above in case the health and environmental impacts of using DEHP in this specific application is compared to the "general scenario of substitution", i.e., when the substance cannot be used anymore. Typically, this criteria can be fulfilled by comparing the impact of the RoHS substance with the impact of the substitute, however, in this case no reliable substitute has been identified. Öko-Institut considered the first two criteria not to be fulfilled, as a reliable substitute was expected to be available by the time the restriction enters into force based on Radiometer's contribution. However, this assumes that Radiometer's substitution plan will succeed, and Anthesis confirmed that this is not the case. Furthermore, this substitute would not be compatible with the analysers already on the market and used by hospitals. Therefore, not granting the exemption would inevitably lead to "a decrease in health services to patients, either directly where analysis devices are not available to provide the services currently available at facilities or through funding being allocated from other services towards purchase of new analysis devices". Considering the significant impact on hospitals and the early scrapping of equipment, Öko-Insitut recommended the maximum of 7 years for the duration of the exemption.

The Delegated Act follows this recommendation, with the following reasoning: "the reliability of substitutes is currently not sufficiently ensured and the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof." [vi] In the interest of legal certainty and for avoiding disruption, the Commission decided that the Directive should enter into force as a matter of urgency and should apply with retroactive effect from 21st July 2021 when the restriction of the substances entered into force.

3. Assessment to the Criteria laid out in Part 2, regulation 5

Regulation 5 of The RoHS Regulations permits an exemption to be granted if the following are satisfied:

- The exemption does not weaken the environmental or health protection afforded by UK REACH; and
- 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.
- The reliability of substitute materials or components is not ensured; or
- 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 following assessment reviews each of these elements.

3.1 Links to UK REACH

On 1st January 2021 UK REACH entered into force and substances manufactured or imported >1 tonne per annum (tpa) in Great Britain require registration, before being placed on the market.

To minimise disruption to businesses and supply chains at the end of the transition period, existing GB downstream users who were, at any time in the 2-year period before 1st January 2021, already a downstream user under EU REACH could submit a Downstream User Import Notification (DUIN). The deadline for the notification was 27th October 2021. This effectively defers their registration responsibilities for up to six years depending on the tonnage band and hazard profile of the substance. Consequently, there is currently no publicly available database of all substances likely to be registered in Great Britain. The Government recently set out its intention to consult on extending the transitional deadlines for full registration[xix].. A list of substances for which information has been submitted to the Health and Safety Executive (HSE) under Article 127B(4)(a) of the UK REACH Regulation (initial transitional data) was published in September 2021 [xx]. This is not a verified list of registrations that were transferred into UK REACH from EU REACH under Article 127A (1) (transferred registrations), only a list of substances for which information has been submitted to the HSE under Article 127B(4)(a) of the UK REACH Regulation (initial transitional data).

DEHP is not listed, this means there is no information to suggest that any companies would manufacture or import DEHP in greater than 1 tonne per annum.

The Statutory Instruments for UK REACH also laid out transitional measures for the Authorisation and Restriction processes within UK REACH and these are discussed in the following section.

3.1.1. Annex 14 (Authorisation)

Substances included in Annex XIV of REACH were transposed to UK REACH, with effect from 1st January 2021. Currently, the substances included in UK REACH Annex 14 are the same as those in the EU equivalent Annex XIV and therefore, this includes DEHP due to its intrinsic hazard as toxic to reproduction.

The transitional arrangements provided for by UK REACH required GB-based holders of EU Authorisations, or GB downstream users relying on another's Authorisation, to confirm the

Authorisation, to the HSE by 1st March 2021. Where an Authorisation decision was still pending from the EU, then other transitional measures exist. The HSE has initiated its first public consultation for an Authorisation application concerning DEHP. It concerns the extension of the Authorisation originally granted to Rolls Royce in 2014[xxi], but this is out of the scope of this report as it is not used in medical devices.

As noted above, applications for Authorisations would not be anticipated for medical devices, as long as Annex 14 only includes DEHP for its reproductive toxicity and not as suspected endocrine disruptors for the environment.

The Candidate List (the list of substances of very high concern (SVHCs) is the precursor for including substances on Annex 14. The Candidate List was transposed on 1st January 2021 to UK REACH and includes those substances added to the List up to and including June 2020[xxii]: thus, DEHP is included for its endocrine disrupting properties for human health and for the environment. If the Annex 14 entries are amended in UK REACH in a similar way to EU REACH, then medical devices containing DEHP will be in scope of Authorisation. As stated earlier, in our opinion even at that point, there will be no conflict between the exemption and UK REACH, as the substances are already incorporated into the articles (cartridges) when imported, whilst the scope of Authorisation is to use substances own their own or in mixtures or incorporating them into articles within GB.

The UK REACH work programme for 2021/2022 states that the UK will present its first recommendation of priority substances to be included in Annex 14, but this does not include DEHP, as they focused on ECHA's 10th and 9th recommendations, whilst amending the Annex XIV entry for DEHP was included in the 8th recommendation[xxiii]. Therefore, at the time of writing the report, it is not known when the UK will move forward with updating Annex 14.

3.1.2. Annex 17 (Restriction)

REACH Annex XVII, as of 31st December 2020, was transposed to UK REACH and included all EU restrictions that had entered into force including any in their transitional period[xxiv]. Therefore, DEHP is included as entry 51 with the same conditions as the EU. The legislation allows for further restrictions to be imposed if relevant chemicals pose an unacceptable risk to human health or the environment. The UK Government announced its first plans for restrictions under UK REACH on 23rd March 2021[xxv], and has since created a Registry of restriction intentions[xxvi]. To date only 2 new restrictions are proposed, above and beyond those already transposed, and these do not concern either uses in scope of The RoHS regulations, or DEHP.

3.1.3 SCIP Database

In November 2020 the Defra confirmed that it will not transpose the SCIP provisions[xxvii], but was considering how to identify and track chemicals of concern in articles to reduce barriers to reuse and recycling. At that time, Defra indicated that the UK's approach will probably be communicated in its Chemicals Strategy, that was planned to be published in 2022. The notifications of SVHCs in articles according to article 7(2) exists, but only applies above 1 tonne[xxviii]. The Agency for UK REACH Work Programme 2021/2022 does not mention SCIP[xxix]. This means, that the import of DEHP in cartridges into GB does not require a notification similar to the one to the SCIP database in the EU.

3.2 Scientific and technical practicability of substitution

At the time of submitting the request for exemption in the EU, at least three European manufacturers of blood analysis devices have not achieved substitution and needed the exemption. A fourth company, Radiometer stated in their contribution to the stakeholder consultation that they plan to substitute DEHP before July 2021. Anthesis has reached out to Radiometer to confirm whether they have accomplished the successful substitution, and they confirmed that this is not the case. During the clarification phase, the applicant stated that they were unaware whether other manufacturers were using DEHP in analytes.

Based on their assessment, including a discussion with technical consultant on the electrochemical sensor technology with more than 30 years of experience, Professor Meyerhoff from the University of Michigan, the Öko-Institut concluded that the substitution of DEHP "is in principle a feasible process", however, "finding a compatible substitute may be more time-consuming for some manufacturers as it is a trial-and-error process." The Delegated Act granted the exemption because "the reliability of substitutes is currently not sufficiently ensured and the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof."

Based on the information Anthesis received from Radiometer, it has been confirmed that, a suitable alternative has not been developed by the time this report is prepared. However, even if Radiometer succeeded, the analyser equipment the hospitals already own would not be compatible with this.

3.3 Environmental and socioeconomic considerations

At the time of the application, the GB would have been included in the EU figures describing the environmental impact of the exemption not being granted:

- 500 tonnes of analyser equipment and some of the associated 500 tonnes consumables to be prematurely wasted
- Approximately 2,100 kg of lead entering the market as part of the new equipment

The amount of DEHP entering the market in the ISE cartridges was estimated to be 2.2 kg per year, again, part of this would be placed on the GB market.

Anthesis have not identified any information related to the proportion of the 30,000 analysers that are placed on the GB market, thus it is not possible to estimate the concrete numbers should the exemption applied to the GB.

The same applies for the financial burden of hospitals, without knowing how many analysers are placed on the GB market, it is not possible to estimate the total cost hospitals will face to replace their equipment. Anthesis have reached out COCIR to understand the size of the GB market, but COCIR indicated this type of information is usually sensitive. Anthesis also enquired to COCIR for confirmation of the three companies have sales activities in the GB or providing an estimate for the analysers based on the GB market but have not received a response by the time of this report's completion. Anthesis also approached AXREM, who directed us to ABHI and BIVDA, but they have not responded by the time of submitting this report.

Based on the review of the medical devices registered with the UK Medicines & Healthcare products Regulatory Agency, there are at least two manufacturers placing SE kits on the market:

Randox Laboratories Limited and Siemens Healthcare Diagnostics Inc.[xxx] Based on the clarification document, [xiv] Siemens estimated that by 2020 >3500 central lab-type instruments will be in place in the EU by 2020, manufactured by Siemens. COCIR estimates typically 3 instruments are used on each site.

This means at least some of the hospitals in GB will be affected, as they use ISE equipment manufactured by or Siemens Healthcare Diagnostics. Anthesis has no information about the technology used by Randox Laboratories Limited.

Gensh et al. (2019) [xviii] estimated the unanticipated investment for a single hospital to cost over €300,000, with an additional cost of integration of new instruments with existing information systems (estimated at €20,000). Furthermore, training for new equipment should be considered as loss of work, a hospital in Germany estimated that this could result in 1,200 hours of unproductive work time [xviii]. According to Gensch et al. (2019), the blood analysers in German hospitals are the same model and vendor to ensure standardisation and harmonised training.

The impact of health services is expected to be significant, due to the inability to rapidly assess ion levels using the DEHP-ISE analysers in case the consumable cannot be used after the restriction enters into force and due to the indirect effects of redistributing funds to purchase new equipment (if alternative is available), loss of time due to training, etc.

Increased fixed costs are expected irrespective if this exemption is adopted in the GB, as manufacturers need to fund the research and development activity to identify and implement an alternative, and to produce new equipment using the alternative technology. According to COCIR[xiv], Siemens' diagnostics business earned approximately $1.5 bn in the EU in 2018, therefore approximately $0.45 bn can be attributed to POC assuming 30% contribution. Again, no information on how much of their business in the GB contributes to this.

The impact on employment and the health services can be reduced by alternatives entering the market, however, Anthesis has no information if any exist to date.

3.4 Exemption duration

The exemption period granted by the EU is for 7 years and will therefore expire on the 21st July 2028. Based on informal discussion between Anthesis and COCIR, even if the applicants have made progress with the substitution up to date, the maximum period is required for the hospitals to change the analysers, as the substitution will inevitably mean new technology, not compatible with their existing equipment.

4. Recommendation

A reliable alternative has not been identified and any new technology would not be compatible with the analysers owned currently by hospitals, leading to potentially significant financial impact on hospitals, along with negative impact on health services. It can be concluded that the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits, therefore, it is recommended to extend the exemption, Annex IV, entry 45 granted under RoHS 2 in EU-27 to

Great Britain. As the EIF of the restriction of DEHP is aligned with the EU, it is reasonable to adopt the exemption and with the same application date.

5. Appendix

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