Committee for Risk Assessment (RAC)

Committee for Socio-economic Analysis (SEAC)

Opinion

on an Annex XV dossier proposing restrictions on

FOUR PHTHALATES (DEHP, BBP, DBP, DIBP)

RES-O-0000001412-86-140/F

ECHA/SEAC/[reference code to be added after the adoption of the SEAC opinion]

Adopted

10 March 2017

10 March 2017

RES-O-0000001412-86-140/F

16 March 2017

ECHA/SEAC/[reference code to be added after the adoption of the SEAC opinion]

Opinion of the Committee for Risk Assessment

and

Opinion of the Committee for Socio-economic Analysis

on an Annex XV dossier proposing restrictions of the manufacture, placing on the market or use of a substance within the EU

Having regard to Regulation (EC) No 1907/2006 of the European Parliament and of the Council 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (the REACH Regulation), and in particular the definition of a restriction in Article 3(31) and Title VIII thereof, the Committee for Risk Assessment (RAC) has adopted an opinion in accordance with Article 70 of the REACH Regulation and the Committee for Socio-economic Analysis (SEAC) has adopted an opinion in accordance with Article 71 of the REACH Regulation on the proposal for restriction of

Chemical name:	**Bis(2-ethylhexyl) phthalate (DEHP)**
EC No.:	**204-211-0**
CAS No.:	**117-81-7**

Chemical name:	**Benzyl butyl phthalate (BBP)**
EC No.:	**201-622-7**
CAS No.:	**85-68-7**

Chemical name:	**Dibutyl phthalate (DBP)**
EC No.:	**201-557-4**
CAS No.:	**84-74-2**

Chemical name:	**Diisobutyl phthalate (DIBP)**
EC No.:	**201-553-2**
CAS No.:	**84-69-5**

This document presents the opinion adopted by RAC. The Background Document, as a supportive document to both RAC and SEAC opinions and their justification, gives the details of the Dossier Submitter's proposal, amended for further information obtained during the public consultation and other relevant information resulting from the opinion making process.

PROCESS FOR ADOPTION OF THE OPINIONS

Denmark and ECHA have submitted a proposal for a restriction together with the justification and background information documented in an Annex XV dossier. The Annex XV report conforming to the requirements of Annex XV of the REACH Regulation was made publicly available at http://echa.europa.eu/web/guest/restrictions-under-consideration on ***15 June 2016***. Interested parties were invited to submit comments and contributions by ***15 December 2016***.

ADOPTION OF THE OPINION

ADOPTION OF THE OPINION OF RAC:

Rapporteur, appointed by RAC: *Marja PRONK*

Co-rapporteur, appointed by RAC: *Betty HAKKERT*

The opinion of RAC as to whether the suggested restrictions are appropriate in reducing the risk to human health and/or the environment was adopted in accordance with Article 70 of the REACH Regulation on ***10 March 2017***.

The opinion takes into account the comments of interested parties provided in accordance with Article 69(6) of the REACH Regulation.

The opinion of RAC was adopted ***by consensus.***

ADOPTION OF THE OPINION OF SEAC

Rapporteur, appointed by SEAC: *Jean-Marc BRIGNON*

Co-rapporteur, appointed by SEAC: *Leandros NICOLAIDES*

The draft opinion of SEAC

The draft opinion of SEAC on the proposed restriction and on its related socio-economic impact has been agreed in accordance with Article 71(1) of the REACH Regulation on ***16 March 2017.***

The draft opinion takes into account the comments from the interested parties provided in accordance with Article 69(6)(a) of the REACH Regulation.

The draft opinion takes into account the socio-economic analysis, or information which can contribute to one, received from the interested parties provided in accordance with Article 69(6)(b) of the REACH Regulation.

The draft opinion was published at http://echa.europa.eu/web/guest/restrictions-under-consideration on ***22 March 2017.*** Interested parties were invited to submit comments on the draft opinion by ***22 May 2017.***

The opinion of SEAC

The opinion of SEAC on the proposed restriction and on its related socio-economic impact was adopted in accordance with Article 71(1) and (2) of the REACH Regulation on ***[date of adoption of the opinion]***. **[**The deadline for the opinion of SEAC was in accordance with Article 71(3) of the REACH Regulation extended by ***[number of days]*** by the ECHA decision ***[number and date]*****]**[1].

[The opinion takes into account the comments of interested parties provided in accordance with Article[s 69(6) and][5] 71(1) of the REACH Regulation.**] [**No comments were received from interested parties during the public consultation in accordance with Article[s 69(6) and][3] 71(1)**]**[6].

The opinion of SEAC was adopted ***by*** **[*consensus*.][*a simple majority*]** of all members having the right to vote. [The minority position[s], including their grounds, are made available in a separate document which has been published at the same time as the opinion**.]**[6].

[1] Delete the unnecessary part(s)

Contents

A. OPINION OF RAC AND SEAC

The restriction proposed by the Dossier Submitter in the Annex XV report is:

Bis(2-ethylhexyl) phthalate (DEHP) EC number: 204-211-0 CAS number: 117-81-7 Benzyl butyl phthalate (BBP) EC number: 201-622-7 CAS number: 85-68-7 Dibutyl phthalate (DBP) EC number: 201-557-4 CAS number: 84-74-2 Diisobutyl phthalate (DIBP) EC number: 201-553-2 CAS number: 84-69-5	1. Articles containing DEHP, DBP, DIBP, and BBP in a concentration, individually or in combination, greater than or equal to 0.1% by weight of the plasticised material shall not be placed on the market. 2. Paragraph 1 shall apply three years from the entry into force of the restriction. Paragraphs 1 and 2 shall not apply to: a. articles only for outdoor use where the phthalate-containing material is not in prolonged contact with human skin or any contact with human mucous membranes "Prolonged contact with human skin" should in this context be understood as covering a daily overall contact with skin of more than 10 minutes continuously or 30 minutes discontinuously. “Only for outdoor use” should in this context be understood as articles which are not used or stored in the interior of dwellings where humans are present under normal and reasonably foreseeable conditions. b. articles only for use in industrial or agricultural workplaces. This derogation does not apply to articles where the phthalate-containing material is in prolonged contact with human skin by workers. c. measuring devices for laboratory use d. articles placed on the market in the European Union prior to the date in paragraph 2. Paragraph 1 and 2 shall not apply to articles covered under existing legislation: i. Food contact materials covered by Regulation (EC) No 1935/2004 and Regulation (EU) No 10/2011 on plastic materials. ii. Immediate packaging of medicinal products covered by Regulation (EC) No 726/2004, Directive 2001/82/EC or Directive 2001/83/EC, or to medical devices covered by Directive 90/385/EEC, Directive 93/42/EEC or Directive 98/79/EC. iii. Toys and childcare articles containing DEHP, DBP and BBP covered by existing restriction entry 51 in Annex XVII of REACH ‘Childcare article’ is defined as in the existing restriction entry 51 in Annex XVII.

Note on wires & cables:

The scope of the proposed restriction included wires & cables as these articles can cause dermal exposure or release phthalates to indoor air and thus, contribute to cumulative exposure and risk of the four phthalates. However, the relevant Commission services (DG GROW and DG ENV) requested following the submission of the dossier that the ECHA’s Committees (RAC and SEAC), when adopting their opinions, exclude electric and electronic equipment (EEE), as defined in Article 3(1) of RoHS, from the scope of the proposal to restrict these four phthalates under REACH. As the changes to RoHS enter into effect in mid-2019, the Dossier Submitter incorporated the consequent phasing-out of the use of the four

phthalates in wires & cables under the baseline scenarios. Therefore, the presented analysis of the effectiveness of the proposed restriction is not affected by the exclusion of wires & cables from the scope of the restriction.

A.1. THE OPINION OF RAC

RAC has formulated its opinion on the proposed restriction based on an evaluation of information related to the identified risk and to the identified options to reduce the risk as documented in the Annex XV report and submitted by interested parties as well as other available information as recorded in the Background Document. RAC considers that the proposed restriction on ***Bis(2-ethylhexyl) phthalate (DEHP), Benzyl butyl phthalate (BBP), Dibutyl phthalate (DBP) and Diisobutyl phthalate (DIBP)*** is the most appropriate Union wide measure to address the identified risk in terms of the effectiveness, in reducing the risk, practicality and monitorability as demonstrated in the justification supporting this opinion, provided that the scope and conditions are modified, as proposed by RAC.

The conditions of the restriction proposed by RAC are:

Bis(2-ethylhexyl) phthalate (DEHP) EC number: 204-211-0 CAS number: 117-81-7 Benzyl butyl phthalate (BBP) EC number: 201-622-7 CAS number: 85-68-7 Dibutyl phthalate (DBP) EC number: 201-557-4 CAS number: 84-74-2 Diisobutyl phthalate (DIBP) EC number: 201-553-2 CAS number: 84-69-5	1. The following articles or any parts thereof containing DEHP, DBP, DIBP, and BBP in a concentration, individually or in any combination, greater than or equal to 0.1% by weight of each plasticised material shall not be placed on the market: a. any articles whose phthalate containing material may be mouthed or is in prolonged contact with human skin or any contact with human mucous membranes, and b. any phthalate containing articles that are used (including stored) in an interior space where people are present under normal and reasonably foreseeable conditions and potentially exposed via inhalation. This does not apply to articles that are used only in industrial or agricultural workplaces by workers. 2. Paragraph 1 shall not apply to: a. measuring devices for laboratory use or articles that form part of measuring devices for laboratory use[2], b. toys and childcare articles subject to entry 51 of this Annex, c. articles for which it can be demonstrated that they have been placed on the market for the first time in the European Union prior to the date in paragraph 5. 3. Paragraphs 1 and 2 shall not apply to articles in the scope of: a. Food contact materials covered by Regulation (EC) No 1935/2004 and Regulation (EU) No 10/2011 on plastic materials. b. Immediate packaging of medicinal products covered by Regulation (EC) No 726/2004, Directive 2001/82/EC or Directive 2001/83/EC. c. Medical devices covered by Directive 90/385/EEC, Directive 93/42/EEC or Directive 98/79/EC or components for such devices. d. Articles covered under Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS Directive). 4. The following definitions apply to this entry: a. "Prolonged contact with human skin" shall mean a daily overall contact with skin of more than 10 minutes continuously or 30 minutes

[2] See ECHA Q&A#1179 for definition of measuring devices.

	discontinuously, under normal and reasonably foreseeable conditions of use. b. "Interior space" shall mean any space where people are present under normal and reasonably foreseeable conditions and potentially exposed via inhalation. Those may include buildings (residential: e.g., apartments, houses, mobile homes; or commercial areas: e.g., hospitals, restaurants, offices) or vehicles for transportation of people (e.g., railway cars, automobiles, airplanes). c. "Industrial or agricultural workplaces" shall mean any commercial activities performed by workers in a workplace in the following sectors: - agriculture, forestry and fishing [NACE A] - mining and quarrying [NACE B] - manufacturing [NACE C] - electricity, gas, steam and air conditioning supply [NACE D] - water supply; sewerage; waste management and remediation activities [NACE E] - construction [NACE F] d. "Childcare article" shall mean any product intended to facilitate sleep, relaxation, hygiene, the feeding of children or sucking on the part of children. 5. The restriction shall apply three years from its entry into force.
Amendment of entry 51 of Annex XVII of REACH	An amendment of the restriction entry to include DIBP in its scope.

A.2. THE OPINION OF SEAC

See the opinion of SEAC.

B. JUSTIFICATION FOR THE OPINION OF RAC AND SEAC

B.1. IDENTIFIED HAZARD, EXPOSURE/EMISSIONS AND RISK

B.1.1. Description of and justification for targeting of the information on hazard(s) and exposure/emissions (scope)

B.1.1.1. Summary of proposal:

The four phthalates are all classified as toxic to reproduction in category 1B. The Dossier Submitter presents the four phthalates as a group of substances on the basis of their common physicochemical properties, common anti-androgenic mode of action, and similar use.

The spectrum of effects in the male rat associated with exposure to the four phthalates is known as the *phthalate syndrome*. The cause for the syndrome is suppression of foetal androgen action. The four phthalates inhibit foetal testosterone production, reduce male anogenital distance, decrease gene expression related to steroid biosynthesis, increase permanent nipple retention in male offspring, increase male mammary gland changes, increase incidence of genital malformations (hypospadias and cryptorchidism), delay puberty onset, reduce semen quality and cause testicular changes including decreased testes and epididymides weight, tubular atrophy and Leydig cell hyperplasia in rats. The Dossier Submitter summarises the current scientific evidence in male animals and epidemiological studies, which shows that these effects are relevant for male humans.

B.1.1.2. RAC conclusion(s):

RAC considers the proposed targeting (scope) justified.

B.1.1.3. Key elements underpinning the RAC conclusion:

The scope of the restriction proposal is limited to the four phthalates on Annex XIV whose sunset date has passed, and for which the Dossier Submitter (in light of Article 69(2) of the REACH Regulation) concludes that their use in articles is not adequately controlled. The proposed restriction therefore aims to restrict the placing on the market of articles containing the four phthalates, thereby focussing on those articles that present risks to human health, via the critical routes of exposure:

i. oral (due to mouthing) and dermal or mucous membrane in an indoor or outdoor environment, as well as
ii. oral (due to ingestion of dust) or inhalation route in an indoor environment.

The targeting on human health as of primary concern is justified by the fact that all four phthalates adversely affect the male reproductive organs and sexual differentiation during foetal development, due to their common anti-androgenic effects, and that based on these effects all four are classified as reproductive toxicants category 1B. The grouping of the four phthalates is in line with the previous restriction dossier/RAC opinion on these phthalates[3],

[3] ECHA (2012). RAC/SEAC Opinion on an Annex XV dossier proposing restrictions on four phthalates. https://echa.europa.eu/previous-consultations-on-restriction-proposals/-/substance-rev/1904/term

where RAC concluded that the grouping is justified. RAC supports the primary focus on the effects known as phthalate syndrome, but also recognises there are (qualitative) indications for other effects that could possibly be equally or more sensitive (e.g., effects on the immune system).

The four phthalates are commonly used plasticisers (mainly in flexible PVC) and they can be found in a wide variety of articles. Hence there is great potential of combined exposure via various routes to these phthalates, both in a cumulative way (exposure to several phthalates with the same mode of action) and in an aggregated way (per phthalate exposure to a broad range of articles via various sources such as direct contact and indoor emissions).

B.1.2. Description of the risk(s) addressed by the proposed restriction

B.1.2.1. Information on hazard(s)

B.1.2.1.1. Summary of proposal:

The Dossier Submitter proposes DNELs based on NOAELs (or LOAELs) for anti-androgenic effects seen in experimental studies. The DNELs are consistent with those previously agreed by RAC with the exception of DIBP. For DIBP only a few reproductive toxicity studies are published and the substance has not been tested at doses below 100 mg/kg bw/day. To appropriately reflect the anti-androgenic potency of DIBP, the Dossier Submitter derives a new DNEL based on read-across from its isomer DBP.

Table 1. Overview of DNEL derivation

	NOAEL (mg/kg bw/day)	LOAEL (mg/kg bw/day)	Endpoint and study reference	AFs [#]	Correction for absorption [§]	DNEL internal dose (mg/kg bw/day)
DEHP	4.8	14	Small male reproductive organs (testes/epididymes/ seminal vesicles) and minimal testis atrophy in Wolfe and Layton (2003)	4*2.5*10 = 100	0.7	0.034
DBP	–	2	Reduced spermatocyte development at postnatal day 21, and mammary gland changes (vacuolar degeneration and alveolar atrophy) in adult male offspring in Lee et al. (2004)	4*2.5*10*3 = 300	1	0.0067
DIBP	-	2.5	Read-across from DBP	4*2.5*10*3 = 300	1	0.0083
BBP	50	100	Reduced anogenital distance in Aso et al. (2005), Tyl et al. (2004) and Nagao et al. (2000). Reduced reproductive organ weights and altered sperm counts and motility in Ahmad et al. (2014)	4*2.5*10 = 100	1	0.50

[#] Assessment factors: an allometric scaling factor of 4 for rats; a factor of 2.5 for remaining interspecies

differences; a factor of 10 for intraspecies differences; a factor of 3 as extrapolation from LOAEL to NAEL if no NOAEL is available
§ Oral absorption fraction=0.7 in rats for DEHP and 1 for the other compounds

The Dossier Submitter concludes that the uncertainties in the hazard assessment point towards an underestimation of the risks. Some of the sources of uncertainties are:

- The DNELs for DEHP and BBP may be lower than currently derived.
- A number of experimental and epidemiological studies have suggested possible effects on the immune system, the metabolic system and neurological development. Some of these studies indicate that reproductive toxicity may not be the most sensitive endpoint and that the selected DNELs may not be sufficiently protective against these other effects.
- The Member State Committee (MSC) has confirmed that these four phthalates are endocrine disruptors related to human health[4] and the Commission is considering to identify them as substances of equivalent concern (SVHC) under Article 57(f) of REACH. This raises additional uncertainties regarding the appropriateness of the derived DNELs.

B.1.2.1.2. RAC conclusion(s):

RAC generally agrees with the Dossier Submitter's proposal to build the current restriction proposal on robust (and for the main part previously agreed) DNELs based on the anti-androgenic effects of the four phthalates. However, RAC notes there are indications that the DNELs for DEHP and BBP may contribute to underestimation of the risk for these effects and may need reconsideration. RAC further notes that the proposed DNELs may not be sufficiently protective for other effects of the phthalates (e.g. endocrine disruption, immunotoxicity) that possibly are more sensitive. Yet, RAC acknowledges that at the moment these other effects cannot be dealt with in a quantitative way in risk assessment, due to the lack of robust dose response data. In view of that, RAC sees the approach[5] taken by the Dossier Submitter as a pragmatic way forward, since risks are already identified for the traditional, apical endpoints (i.e., the proposed DNELs are already sufficient to justify the restriction proposal).

B.1.2.1.3. Key elements underpinning the RAC conclusion(s):

The toxicity of three of the four phthalates (DEHP, DBP and BBP) has extensively been reviewed in the recent past, i.e., in the EU by the European Chemicals Bureau (within the framework of the Existing Substances Regulation (EEC) 793/93, resulting in EU-Risk Assessment Reports (RARs)) and by the European Food Safety Authority (EFSA). The European Chemicals Agency (ECHA) identified all four phthalates as Substances of Very High

[4] ECHA (2014) https://echa.europa.eu/view-article/-/journal_content/title/the-member-state-committee-unanimously-agreed-to-identify-the-phthalate-dehp-as-an-svhc-because-of-its-endocrine-disrupting-properties-in-the-environm
[5] The approach includes addressing the uncertainties related to the DNELs, the impact of the endocrine disrupter status and the potential for effects on other, possibly more sensitive endpoints in the uncertainty analysis and, as far as possible, in the socio economic analysis (SEA).

Concern (SVHC), based on their classification as reproductive toxicants category 1B. This resulted in the four phthalates being included in Annex XIV of REACH.

The EU-RARs form the main information source in the Background Document, supplemented with information from registration dossiers, as well as recent literature not addressed in these sources.

RAC notes that the hazard assessment of the current restriction dossier builds very much on the previous restriction dossier/RAC opinion on the four phthalates[2] and on the RAC documents setting reference DNELs for DEHP, DBP and BBP in light of the authorisation process[6]. The main focus is therefore on reproductive toxicity, in particular anti-androgenic effects. The choices made for grouping the four phthalates (because of their structural and metabolic similarities, similar anti-androgenic mode of action and spectrum of adverse effects, similar category 1B classification for reproductive toxicity, and similar use and exposure pattern) and the use of dose addition in the combined risk assessment of these phthalates are identical and still supported by RAC. RAC notes that for phthalates, dose addition has been recently used or recommended by other regulatory bodies (e.g. CHAP, 2014; Health Canada, 2015a).

Toxicokinetics - absorption

In line with previous opinions by RAC[2,5], the Dossier Submitter used the following absorption fractions for calculating internal doses/DNELs:

Table 2. Absorption fractions for calculation of internal doses

	Absorption fraction, oral	**Absorption fraction, dermal**	**Absorption fraction, inhalation**
DEHP	70% rats, all ages 100% adult humans 100% infants/children	5% human, all ages	75% adults 100% infants/children
DBP and DIBP	100% (exp animals and humans)	10% human, all ages	100% human, all ages
BBP	100% (exp animals and humans)	5% human, all ages	100% human, all ages

Toxicity for reproduction – anti-androgenic effects

The DNELs proposed by the Dossier Submitter for DEHP, DBP, DIBP and BBP are based on NOAELs (or LOAELs) for developmental effects on male reproduction related to an anti-androgenic mode of action. Except for DIBP, the points of departure (PoD) chosen, the assessment factors used[7] and the DNELs proposed are identical to those previously agreed by RAC following an extensive evaluation of the available information related to the hazard

[6] ECHA (2013a/b/c). Authorisation, establishing reference DNELs for DEHP/DBP/BBP. https://echa.europa.eu/applying-for-authorisation/evaluating-applications

[7] Since the last restriction dossier and RAC evaluations on the phthalates, some more information on possible species differences in sensitivity for the effects of phthalates has become available, as also pointed out during public consultation. After careful evaluation of the available information (see section B.4.2.7 of the Background Document) the Dossier Submitter considered the evidence still insufficient to deviate from the default interspecies assessment factor. RAC supports the assessment and conclusion and notes that it is in line with recent risk assessments on phthalates by other regulatory bodies (e.g. CHAP, 2014; SCENIHR, 2016), who addressed the issue of possible interspecies differences in sensitivity, but judged it too early to deviate from the default assessment factor of 10 for interspecies differences.

profile of the substances. For DIBP a new DNEL was proposed by the Dossier Submitter, to better reflect its anti-androgenic potency.

DEHP

For DEHP, a NOAEL of 4.8 mg/kg bw/day found in a three-generation study with dietary exposure of rats (Wolfe and Layton, 2003) was selected as PoD. In this study, testicular toxicity (small testes/epididymes/seminal vesicles and minimal testis atrophy) was observed in offspring exposed to 14 mg DEHP/kg bw/day and above as the most sensitive effect attributable to an anti-androgenic mode of action. The Dossier Submitter however acknowledged that there is some uncertainty associated with the NOAEL selected/DNEL proposed. On the basis of recent evaluations and comparisons between closely related phthalates the PoD for DEHP could be lower, e.g. based on findings of cryptorchidism in a few animals at 5 mg/kg bw/day in a study by Andrade et al. (2006) and the presence of mild dysgenesis of external genitalia at 3 mg/kg bw /day in a study by Christiansen et al. (2010). In a study by Howdeshell et al. (2008) DEHP was further shown to decrease foetal testosterone production with comparable potency as the closely related phthalate DBP, for which a 5-fold lower internal DNEL was derived. Furthermore, it was noted that parameters that appeared to be most sensitive for DBP (effects on the mammary gland and delayed germ cell development, LOAEL 2 mg/kg bw/day) have not been examined in studies with DEHP.

In the view of RAC, the uncertainties raised by the Dossier Submitter provide grounds for reconsideration of the PoD for DEHP, as it could potentially be lower than the current PoD. Noting that recently SCENIHR reconfirmed the use of the NOAEL of 4.8 mg/kg bw/day as PoD for its DEHP risk assessment (SCENIHR, 2016), and that the proposed DNEL is already sufficient to justify the restriction proposal, RAC supports the pragmatic way forward to include the uncertainties related to the PoD in the uncertainty analysis.

DBP

The selected key study for DBP revealed as the most sensitive effect delayed germ cell development in prepubertal rats and mammary gland changes (vacuolar degeneration and alveolar atrophy) in adult male rats exposed perinatally (from gestation day 15 to post-natal day 21) to ≥ 20 mg DBP/kg feed (corresponding to a LOAEL of 2 mg/kg bw/day; Lee et al., 2004). The Dossier Submitter selected this LOAEL as PoD. RAC notes that this PoD and the DNEL derived are as previously agreed for DBP, and supports the proposal.

DIBP

Previously, the LOAEL of 125 mg/kg bw/day from the study of Saillenfait et al. (2008) was selected as PoD for DNEL derivation. In this study, histopathological effects in testes (degeneration of seminiferous tubules) and oligo-/azospermia in epididymes were observed in male rats perinatally (from gestation day 12 to 21) exposed by gavage to dosages ranging from 125 to 625 mg DIBP/kg bw/day. The Dossier Submitter however noted that the database on DIBP is rather poor, with only very few reproductive toxicity studies published, and that DIBP has not been tested at doses below 100 mg/kg bw/day. In view of this and of recent evaluations and comparisons between closely related phthalates, the Dossier Submitter followed a different approach for DIBP.

In a recent analysis, Health Canada (2015b,c) grouped DIBP and DBP in the same category of medium chain length phthalates, given their structural similarity (DIBP being a branched isomer of DBP having the same molecular weight and physicochemical properties). The mono ester metabolite of DBP is the closest structural analogue to the mono ester metabolite of DIBP, both compounds affecting similar mechanistic targets leading to similar adverse developmental effects. According to the Dossier Submitter this makes DBP the most relevant phthalate for read across to DIBP. When looking at potency they concluded (based on studies reviewed by Health Canada (2015b,c)) that DIBP appears equipotent to DBP when comparing effects on foetal testosterone production and gene expression, and of somewhat lower potency (roughly estimated at 25% lower based on the study by Saillenfait et al. (2008)) when comparing other reproductive developmental effects, such as anogenital distance (AGD), nipple retention, reproductive organ weight, reproductive tract malformations and puperty onset. Hence, a LOAEL of 2.5 mg/kg bw/day (25% higher than the LOAEL of 2 mg/kg bw/day for DBP) was set as the PoD for DIBP, resulting in a DNEL of 0.0083 mg/kg bw/day.

Given the similarities between DBP and DIBP in structure and potency as regards anti-androgenic effects, RAC agrees with the Dossier Submitter that the previous PoD of 125 mg/kg bw/day for DIBP does not appropriately reflect this potency, and therefore needs reconsideration. From the study by Saillenfait et al. (2008) it appears that a 25% higher dose of DIBP (625 mg/kg bw/day) is needed to cause the same developmental effects as 500 mg/kg bw/day of DBP. Other studies point to equipotency. RAC considers the extrapolation of the potency findings from the high dose to the low dose area, as done by the Dossier Submitter, justifiable. Although surrounded with some degree of uncertainty, RAC can support the new PoD of 2.5 mg/kg bw/day for DIBP[8].

BBP

When previously evaluated, reduced AGD in male rats was found to be the most sensitive endpoint for BBP. It was observed at LOAELs of 500, 250 and 100 mg/kg bw/day in two-generation studies by Nagao et al. (2000), Tyl et al. (2004) and Aso et al. (2005), respectively, with an overall NOAEL of 50 mg/kg bw/day from the Tyl et al. study. In a recent study by Ahmed et al. (2014) reduced reproductive organ weights and altered sperm counts and motility were observed at 100 mg/kg bw/day in adult male rats exposed in utero, with a NOAEL of 20 mg/kg bw/day. Combining the results of the previous studies with those of the Ahmed et al. study, the Dossier Submitter selected an overall NOAEL of 50 mg/kg bw/day as PoD for BBP, the same as previously selected. They however acknowledged that further studies on BBP including endocrine sensitive endpoints might reveal effects at lower doses than 50 mg/kg bw/day, given that certain endpoints have not been examined for BBP and that the potency of BBP to reduce foetal testosterone production was shown to be comparable to DEHP and DBP in a study by Howdeshell et al. (2008).

In view of the facts that parameters that appeared to be most sensitive for DBP (effects on the mammary gland and delayed germ cell development) and DEHP (dysgenesis of external genitalia) have not been tested for BBP, and that BBP appears of comparable potency to DBP and DEHP in reducing foetal testosterone production, there are in RAC's view substantial grounds for reconsideration of the PoD for BBP, as it could potentially be considerably lower than the current PoD. However, since the proposed DNEL is already sufficient to justify the

[8] Please note that in section B.9.3 of the Background Document the Dossier Submitter analysed the effect on the RCRs when DIBP is considered equipotent to DBP (see also section B.1.2.4 of this document).

restriction proposal, RAC supports the pragmatic way forward to include the uncertainties related to the PoD in the uncertainty analysis.

Human data

The anti-androgenic related effects that are suspected to be relevant in humans in relation to the four phthalates are congenital malformations of the male reproductive organs, reduced semen quality, reduced male reproductive hormone levels, and changes in pubertal timing including changes in male breast development. It has been hypothesised that these disorders may comprise a *testicular dysgenesis syndrome* with a common origin in foetal life. Testicular cancer may also be part of this syndrome, and it has been speculated whether prenatal exposure to phthalates may play a role in the increasing incidence levels of this and other hormone dependent cancers like breast cancer.

Unfortunately, the available epidemiology studies are associated with such uncertainties that the studies do not allow to conclude on a direct causal relationship between the effects investigated (congenital malformation of the male genitalia, semen quality, pubertal timing and testicular cancer) and phthalate exposure. Besides, anti-androgenic effects are not unique to the phthalates; numerous other chemicals show these effects as well. It is therefore difficult if not impossible to give a robust or quantitative indication of the contribution of the phthalates to the infertility problems and increases in hormone dependent cancers observed in humans, solely on the basis of epidemiological data.

Toxicity other than toxicity for reproduction

DEHP, DBP, DIBP and BBP are not classified for any other human health endpoint (including carcinogenicity) than for reproductive toxicity. So far, reproductive toxicity has been seen as the most sensitive endpoint for the four phthalates under consideration. Some recent studies included in the Background Document however indicate that this might not be the case. Effects investigated in these studies include effects on the immune system, on metabolism and on neurological development.

Immunotoxicity

In a recent review by Braun et al. (2013), epidemiological data are presented showing associations between exposure to DEHP, BBP and DBP and allergic diseases including asthma and eczema. In other studies it was found that children from homes with high concentrations of phthalates in dust had high incidences of allergy, asthma, rhinitis or eczema (Bornehag et al., 2004; Hsu et al., 2012; Kolarik et al., 2008), and that higher maternal BBP exposure in pregnancy was associated with early-onset eczema in children (Just et al., 2012). A further literature search and information submitted during public consultation revealed more reviews into associations between exposure to phthalates and human immunological outcomes (Robinson and Miller, 2015; Kimber and Dearman, 2010; Bornehag and Nanberg, 2010; Jaakkola and Knight, 2008). These reviews also show clear associations between PVC materials or phthalate exposure and increased immunological symptoms (asthma, other respiratory symptoms, rhinitis and eczema).

The epidemiological data are supported by several experimental studies in mice and rats. These experimental studies generally show that DEHP administered via the intraperitoneal or subcutaneous route of exposure induced adjuvant effects in mice. Similar conclusions can be

reached for subcutaneous administration of the monoester metabolite of DEHP (MEHP) as well as DBP and other phthalates or phthalate metabolites.

Dermal studies are suggestive of adjuvant effects of DBP, but not of DEHP, BBP and DINP, in mice following topical application. In a dermal study with mice, DBP (0.4, 4 and 40 mg DBP /kg bw/day) showed effects on total IgE, Th cytokines histopathology and ear swelling from 4 mg/kg bw/day onwards (Li et al., 2014), indicating that DBP may promote and aggravate atopic dermatitis. Six other dermal studies using only one single dose either confirmed these results (three studies with DBP) or did not show any effect (DEHP, BBP, DIHP, DINP).

Inhalation studies also provide evidence for adjuvant effects in mice. In a long-term inhalation study (20 min/day, 5 days/week, 14 weeks) with DEHP aerosols of 0.022-13 mg/m^3, adjuvant effects were induced at the highest dose of 13 mg/m^3 (Larsen et al., 2007). In a study by the same group, MEHP, the monoester metabolite of DEHP, had an adjuvant effect at 0.03 and 0.4 mg/m^3 in female mice following exposure during 14 weeks (20 min/day, 5 days/week for 2 weeks and thereafter weekly) (Hansen et al., 2007).

Most evidence for an adjuvant effect of phthalates in mice and rats is found in oral studies with DEHP administration (Guo et al., 2012; You et al., 2014; Han et al., 2014; Sadakane et al., 2014; Shin et al., 2014; Yang et al., 2008; Tonk et al., 2012). In these studies DEHP displayed adjuvant effects on airway hyperresponsiveness, atopic dermatitis or liver response. The only oral study with DBP (Zuo et al., 2014) suggests DBP may exert an adjuvant effect in mice, but there was no dose response (effects seen at 0.45 mg/kg bw/day but not at 45 mg/kg bw/day due to spleen injury). For DEHP, the lowest effect level was found in the study of Guo et al. (2012), where dose-dependent increases in serum IgE and in severity of airway pathology were observed after 52 days of treatment in adult mice from 30 µg/kg bw/day onwards. Also in weanling mice serum IgE and IgG1 were increased from 30 µg/kg bw/day onwards (Han et al., 2014).

Based on the data above, the Dossier Submitter concluded that there are indications that phthalate exposure could lead to immunological disorders (allergy, asthma and eczema), possibly at levels lower than reproductive toxicity. However, they also concluded that in order to take effects on the immune system into consideration for quantitative risk assessment, there is a need for further robust data. Similarly, SCENIHR (2016) acknowledged that for DEHP/phthalates there are data showing the potential to interact with the immune system and data suggesting a correlation with obstructive respiratory symptoms and asthma. Nevertheless, in its risk assessment of DEHP, SCENIHR reconfirmed the use of a PoD based on reproductive toxicity, as more recent studies were considered not sufficiently robust to justify the derivation of a new one (SCENIHR, 2016). RAC notes that the available epidemiological data indeed indicate a potential for effects on the immune system by phthalates, although it is acknowledged that for epidemiological studies it is difficult or even impossible to prove a causal relationship between the effect, the mode of action and the exposure. The experimental studies with direct oral exposure to DEHP and DBP, the inhalation studies with DEHP and its monoester metabolite MEHP, and the dermal studies with DBP all confirm an adjuvant effect in rodents. These studies also indicate that possibly the DNELs proposed for reproductive toxicity may not be sufficiently protective against these immunological effects as effects appear to begin from 30 µg/kg bw/day, i.e. at a lower dose than the current PoD for DNEL setting. The question is however whether the currently available data (e.g. on type of effects and other phthalates than DEHP studied, on dose response) are relevant and robust enough for PoD and DNEL setting. RAC therefore supports

the approach of the Dossier Submitter to address the effects on the immune system in the uncertainty analysis and in the socio-economic analysis (SEA).

Effects on metabolism

Associations between prenatal phthalate exposure and obesity or diabetes in adulthood have been investigated in epidemiological studies, and in vitro and animal studies have provided mechanistic knowledge indicating obesogenic effects of phthalates, e.g., by promoting differentiation of and accumulation of lipid in lipid cells (reviewed by Kim and Park, 2014). The foetal period is considered critical to phthalate exposure, but few studies have been able to clarify the role of prenatal exposure to phthalates in the obesity epidemic.

The Dossier Submitter considered the available data to provide as yet only weak evidence for an effect of phthalates on metabolism. Although RAC considers that such an effect cannot be excluded, it is acknowledged that the data are insufficient as to PoD and DNEL derivation. RAC therefore supports the Dossier Submitter's approach to include the possibility for these effects in the uncertainty analysis and the SEA.

Neurodevelopment

Altered neurodevelopment has been associated with high phthalate exposures in children, as reviewed by Miodovnik et al. (2014). Numerous behavioural disorders including autism spectrum disorders, ADHD, learning disabilities, and altered play behaviour have been associated with higher phthalate exposure in humans (reviewed by Braun et al., 2013). Animal studies examining behavioural effects of phthalate exposure have shown some effects that may be related to altered sex differentiation, whereas other behavioural effects are not clearly linked with disruption of sex hormones. Different modes of action for phthalate effects on neurodevelopment have been proposed, including interference with the thyroid hormone system, altered calcium signalling, relation to activation of peroxisome proliferator activated receptors (PPARs) in brain and altered lipid metabolism (Miodovnik et al., 2014).

The Dossier Submitter considered the available data to provide as yet only weak evidence for an effect of phthalates on neurodevelopment and behaviour. However, RAC notes that the available epidemiological and experimental data do indicate that such effects cannot be excluded. It is acknowledged though that the available studies do not provide robust dose response data that are important for PoD and DNEL setting. RAC therefore supports the Dossier Submitter's approach to take the possible effects on neurodevelopment and behaviour into account in the uncertainty analysis and in the SEA.

Endocrine disruption and threshold for phthalates

In December 2014, MSC has unanimously concluded that DEHP and the other phthalates included in the current restriction proposal have endocrine disrupting properties that can be linked to adverse effects to human health. DEHP was further concluded to be an endocrine disruptor for the environment. A majority in MSC was of the view that the concern related to endocrine disruption constitutes an equivalent level of concern to CMRs, whereas a minority considered this concern to be already covered by the existing identification as SVHC due to toxicity to reproduction[3]. It is only very recent (16 February 2017) that the REACH Committee

voted in favour of identifying them as substances of equivalent concern under Article 57(f) of REACH[9].

According to current policy, substances having endocrine disrupting properties do not have a threshold, except when it can be demonstrated that a threshold exists. The existence of a threshold has not yet been assessed and documented for the four phthalates under consideration. Although there would be consequences for the PoDs and DNELs if there is no threshold, RAC is of the opinion that in this specific case the proposed PoDs and DNELs, which are based on traditional, apical endpoints, are already sufficient to substantiate the restriction. Therefore, an assessment to determine whether or not a threshold exists appears not to be necessary for the current restriction proposal. RAC proposes to take the possible consequences for the PoDs and DNELs into account in the uncertainty analysis. Further, the SEA should, where possible, address the endocrine-related effects.

B.1.2.2. Information on emissions and exposures

B.1.2.2.1. Summary of proposal:

The Dossier Submitter estimates that in 2014 more than 170 000 tonnes of the four phthalates were contained in the articles in scope placed on the EU market and leading to exposure to the general population and vulnerable groups. These tonnages are forecast to decline by close to 30% by 2020 as a result of pressures related to the authorisation requirements and the entry into force of the amendments of the RoHS Directive. More than half of this decline is anticipated to be recovered by the end of the study period in the absence of a restriction and other regulatory measures. This growth of more than 15% between 2020 and 2039 is projected due to increase in tonnages of the four phthalates contained in imports. This is seen as the result of growth in article import volumes which outpaces substitution of the four phthalates on many international markets where DEHP in particular is anticipated to dominate for the foreseeable future. As shown in Table 3, the tonnages contained in imported articles are anticipated to represent almost all of the tonnages of the four phthalates in articles placed on the EU market in the scope of this restriction proposal.

Table 3. Tonnes of DEHP, DBP, DIBP and BBP contained in articles in scope placed on the EU28 market – baseline projections

DEHP, DBP, DIBP and BBP content	**2014**	**2020**	**2039**
Tonnes used in EU28 article manufacturing	62 612	13 828	9 663
% change from previous period		*-78%*	*-30%*
Tonnes contained in Exported articles	15 722	5 952	3 025
% change from previous period		*-62%*	*-49%*
Tonnes contained in Imported articles	124 245	112 965	136 474

9 http://ec.europa.eu/transparency/regcomitology/index.cfm?do=Search.getPDF&ds_id=49989&version=1&AttLang=en&db_number=1&docType=SUMMARY_RECORD
http://ec.europa.eu/transparency/regcomitology/index.cfm?do=Search.getPDF&ds_id=44354&version=4&AttLang=en&db_number=1&docType=DRAFT_MEASURE

% change from previous period		*-9%*	*21%*
Tonnes contained in articles placed on EU28 market*	171 135	120 841	143 112
% change from previous period		*-29%*	*18%*
Share of tonnes imported of total placed on EU28 market	72.6%	93.5%	95.4%

* Tonnes contained in articles placed on EU28 market = Tonnes used in EU28 article manufacturing - Tonnes contained in Exported articles + Tonnes contained in Imported articles

The Dossier Submitter presents information on the different routes and sources of exposure of the general population to the four phthalates. Oral exposure occurs from ingestion of food and dust, and from mouthing of articles. Exposure also occurs from inhalation of air and dust and from dermal contact with articles and dust. The main sources of exposure are considered food, indoor environment and direct contact with articles. The exposure to DEHP in women and infants appears to be driven by food consumption but exposure from indoor environment and direct contact with articles are still relevant sources of exposure. The exposure pattern is reversed for DBP, BBP and DIBP: direct contact with articles and exposure via the indoor environment are the dominant sources of exposure.

The Dossier Submitter's exposure assessment is based on DEMOCOPHES urinary biomonitoring samples taken in 2011-12. The modelling estimates presented by the Dossier Submitter are generally consistent with the biomonitoring results for children and mothers, but appear to underestimate risks slightly in Member States with high exposure levels.

B.1.2.2.2. RAC conclusion(s):

RAC agrees with the Dossier Submitter to rely for exposure assessment in particular on the DEMOCOPHES project, given that it is recent, consists of a large sample size, and is more representative for EU28 than all other biomonitoring studies available. The results of the additional exposure modelling correspond reasonably well with the biomonitoring data, except for DEHP where biomonitoring studies indicate that food is the main source of DEHP exposure whereas this is not so apparent from the modelling. For the other three phthalates the contribution from exposure to articles seems most important.

B.1.2.2.3. Key elements underpinning the RAC conclusion(s):

Articles containing DEHP, DBP, DIBP, and BBP continue to be placed on the market in the EU albeit at decreasing rate. This decrease however has been and will in future be even more compensated by an increase in import, particularly from Asia. DEHP, DBP, DIBP, and BBP are commonly used plasticisers, mainly in flexible PVC (approximately 95% of total use). They can be found in a wide variety of articles (including electrical cables, hoses, flooring, wall coverings, coated textiles, luggage, sports equipment, toys, roofing membranes, pool liners, footwear as well as medical devices such as tubing and blood bags), at a typical concentration of about 30% of the soft PVC content.

The exposure assessment by the Dossier Submitter especially relied on biomonitoring. Whilst biomonitoring data integrates all exposures, biomonitoring studies give limited information on the sources of exposure. Therefore exposure modelling was also performed by the Dossier Submitter, to better characterise the contributing sources of exposure.

Biomonitoring

In the Background Document an overview is presented of published intake estimates of phthalates based on urinary biomonitoring data from Europe. Most of these studies were already reported in the previous restriction dossier. The current assessment by the Dossier Submitter relied in particular on the urinary biomonitoring data generated by the EU-wide DEMOCOPHES project (largely unpublished). This project was still ongoing when the previous restriction dossier was evaluated by RAC. In the DEMOCOPHES project, morning urine samples were collected from mother-child pairs in 16 EU Member States and Switzerland from September 2011 until February 2012. Children were 6-11 years old and the median age of the mothers was 39 years. In order to estimate the daily intake (µg/kg bw/day) from the spot samples gathered in the DEMOCOPHES project, the Dossier Submitter used the creatinine correction method for extrapolation of the spot sample excretion data to full day excretion. The median and 95th percentile intake estimates from DEMOCOPHES using creatinine corrected urinary metabolite concentrations are reported in Table 4.

RAC notes that for the calculations no data on body weight, creatinine levels and urinary metabolites per individual participant were made available to the Dossier Submitter. Therefore, the Dossier Submitter used a fixed value for the 24-hour creatinine excretion (from literature), and for body weight the country-specific median values. Although this leads to some loss of accuracy in the exposure estimates, RAC agrees with the Dossier Submitter to rely in particular on the DEMOCOPHES project, given that it is recent (and the most recent available of this scale), consists of a relatively large sample size, and is more representative for EU28 than all other studies available. RAC also supports the choice for the 95th percentile as an estimate of the reasonable worst case exposure, as this is common practice in consumer risk assessment. It is further noted that whereas the total sample size in the study is indeed relatively large, for each country and for Europe as a whole the number is not that large, thereby increasing the chance that highly exposed individuals or subpopulations are not represented in the sample. Peak exposures are particularly relevant in the case of phthalates as even a short elevated exposure level within the critical windows of exposure may be sufficient to cause adverse effects on the developing foetus. Furthermore, very small children as sub-population are not included in the study. These arguments are all in favour of using the 95th percentile value rather than e.g. the 90th percentile value in risk assessment.

The Dossier Submitter presented the intake estimates from DEMOCOPHES per individual country. The overall intake estimates over all participating countries were also given, as indication of a representative estimate for the whole EU28 (based on Den Hond et al. (2015)). For DBP and DIBP data from 12 countries are available, and for DEHP and BBP from 17 countries. Combining these data, a “European” intake estimate can be generated. The median, 95th percentile and maximum intake estimates are presented in Table 5.

Table 4. Intake estimates (µg/kg bw/day) from DEMOCOPHES

				intake			
				DEHP	DBP	BBP	DiBP
Country	N	Population		µg/kg/d	µg/kg/d	µg/kg/d	µg/kg/d
BE	125	Mother	P50	1.49	0.84	0.18	1.04
			P95	4.92	2.64	0.65	5.02
	125	Child	P50	2.11	0.98	0.23	1.43
			P95	12.06	2.90	0.92	8.60
CH	117	Mother	P50	1.15	0.46	0.10	0.50
			P95	5.83	1.82	0.43	1.61
	119	Child	P50	2.11	0.64	0.12	0.64
			P95	7.45	1.91	0.81	2.08
CY	59	Mother	P50	1.03	0.46	0.06	1.51
			P95	14.99	1.33	0.30	3.62
	60	Child	P50	1.42	0.57	0.09	1.54
			P95	7.77	1.51	0.41	3.60
CZ	117	Mother	P50	2.53	1.83	0.13	NA
			P95	8.05	4.98	1.30	NA
	120	Child	P50	4.41	3.10	0.19	NA
			P95	14.03	8.90	1.49	NA
DE	116	Mother	P50	1.39	0.86	0.12	0.68
			P95	3.82	2.28	0.54	1.89
	120	Child	P50	2.45	1.19	0.15	1.09
			P95	7.26	3.66	1.01	3.06
DK	143	Mother	P50	1.61	0.66	0.13	1.22
			P95	5.37	1.28	0.52	3.30
	142	Child	P50	2.84	0.93	0.21	1.73
			P95	7.75	2.03	1.00	4.92
ES	118	Mother	P50	3.17	1.00	0.24	1.25
			P95	8.70	2.25	0.96	2.67
	119	Child	P50	4.74	1.30	0.37	1.62
			P95	12.05	6.03	1.39	7.07
HU	115	Mother	P50	2.21	1.03	0.11	0.00
			P95	8.49	3.21	0.53	0.00
	117	Child	P50	3.47	1.49	0.17	0.00
			P95	12.86	4.57	0.78	0.00
IE	120	Mother	P50	2.05	0.56	0.08	0.71
			P95	6.58	1.58	0.54	3.00
	120	Child	P50	3.32	0.68	0.12	1.09
			P95	10.27	1.75	0.57	3.91
LU	58	Mother	P50	1.08	0.60	0.10	0.65
			P95	4.98	1.42	0.41	2.29
	60	Child	P50	1.63	0.77	0.12	1.09
			P95	3.84	1.69	0.58	5.98
PL	119	Mother	P50	2.89	1.37	0.11	1.51
			P95	12.39	5.59	0.71	5.94
	115	Child	P50	4.57	2.14	0.24	2.93
			P95	17.31	7.58	1.63	10.07
PT	117	Mother	P50	2.47	0.65	0.15	0.86
			P95	11.59	1.51	0.47	2.52
	116	Child	P50	2.82	0.81	0.20	1.05
			P95	8.91	2.25	1.05	3.41
RO	117	Mother	P50	3.13	0.72	0.07	1.01
			P95	34.60	1.70	0.32	2.79
	119	Child	P50	4.23	1.11	0.10	1.41
			P95	29.85	3.97	0.54	5.10
SE	96	Mother	P50	1.73	1.79	0.34	NA
			P95	5.84	4.96	2.25	NA
	97	Child	P50	3.21	2.27	0.60	NA
			P95	11.16	6.46	2.60	NA
SI	120	Mother	P50	NA	0.56	0.12	NA
			P95	NA	2.71	0.50	NA
	120	Child	P50	NA	0.84	0.16	NA
			P95	NA	2.70	0.75	NA
SK	125	Mother	P50	2.53	1.87	0.11	NA
			P95	7.11	5.32	0.44	NA
	127	Child	P50	4.90	2.70	0.18	NA
			P95	14.10	7.46	0.90	NA
UK	21	Mother	P50	1.00	0.42	0.06	0.47
			P95	2.69	0.95	0.14	2.20
	21	Child	P50	2.53	0.73	0.11	0.77
			P95	5.41	1.94	0.62	2.33

NA = not available

Table 5. Overall intake estimates (µg/kg bw/day) from DEMOCOPHES (calculated for "Europe"), based on Den Hond et al. (2015)

		Intake (µg/kg bw/day)		
	N	**Median**	**P95**	**maximum**
EU (DEMOCOPHES)				
Children				
DEHP	1816	3.3	12	256
DBP	1355	1.0	4	25
BBP	1816	0.2	1.2	17
DIBP	1355	1.4	5.0	49
Mothers				
DEHP	1800	2.1	8.3	123
DBP	1347	0.7	2.1	65
BBP	1800	0.1	0.7	14
DIBP	1347	0.9	3.2	12

There is another recent biomonitoring study that RAC finds worth considering, given that it is also a study in mother-child pairs in an EU Member State (Greece) that was not part of the DEMOCOPHES project. This study by Myridakis et al. (2015) investigated (a.o.) phthalate levels in spot urine samples from 239 Greek mother-child pairs. The (pregnant) mothers were sampled between May 2007 and May 2008, their children (mean age 2.3) between March 2009 and June 2011. The daily intake was calculated using the volume correction method.

The results are presented in Table 6 and can be used in combination with those of DEMOCOPHES.

Table 6. Intake estimates (µg/kg bw/day) from Myridakis et al. (2015) for Greece and in combination with DEMOCOPHES (calculated for "Europe")

		Intake (µg/kg bw/day)		
	N	**Median**	**P95**	**maximum**
GREECE (Myridakis et al. 2015)				
Children				
DEHP	239	4.0	21.6	69.6
DBP	239	1.0	6.6	50.8
BBP	239	0.2	1.3	9
DIBP	239	1.4	8.2	36
Mothers				
DEHP	239	4.4	25.6	1015
DBP	239	1.9	11.4	4840
BBP	239	0.3	1.8	9.9
DIBP	239	2.1	11.0	30.6
EU (DEMOCOPHES and Myridakis) *				
Mothers				
DEHP	2039	2.37	10.33	1015
DBP	1586	0.88	3.50	4840
BBP	2039	0.12	0.83	14
DIBP	1586	1.08	4.38	30.6

* Combined by weighted averaging. Mothers only, as children were of different age groups.

One source of uncertainty in the estimates is the use of (morning) spot samples, given the variation in quantities of phthalate metabolites excreted in urine in response to the variation in intakes of these compounds over a 24 hour period. Observations by Preau et al. (2010) have shown that for DEHP metabolites in urine within day variability was greater than between day variability, as was within person variability compared to between person variability. There was however also an important interpersonal variability in DEHP exposure. Another source of uncertainty is the use of the creatinine correction method for extrapolation, possibly resulting in 2x lower values than the volume-based method.

It can be concluded that the exposure of children is higher than that of mothers. This finding is consistent with the findings in most of the other biomonitoring studies presented in the Background Document, including Hartmann et al. (2015).

Very small children were not included in the DEMOCOPHES and Myridakis study, nor in any of the other reported biomonitoring studies. The youngest age group investigated appears to be infants of 15-21 months old, in the fairly recent study by Fromme et al. (2013). The number of infants monitored in this German study (with sampling between October 2009 and January 2010) was however rather limited (n=25). The intake estimates from this study are therefore given for illustrative purposes only (Table 7). It seems that intake estimates are higher in infants than in children.

Table 7. Intake estimates (µg/kg bw/day) from Fromme et al. (2013)

		"Average" intake * (µg/kg bw/day)			"High" intake * (µg/kg bw/day)		
	N	**Median**	**P95**	**Maximum**	**Median**	**P95**	**Maximum**
Infants (15-21 months)							
DEHP	25	2.6	6.3	11.4	4.9	20.6	26.9
DBP	25	1.6	3.6	5.9	2.2	6.2	9.2
BBP	25	0.3	1.3	2.1	0.7	2.5	2.7
DIBP	25	2.2	5.3	6.1	3.9	11.1	13.9

''Average'' intake derived from median values and ''high'' intake from 95th percentiles of seven sampling days of each child

The Dossier Submitter looked at the time trend, and compared the calculated intake estimates from DEMOCOPHES with Danish and German data from 2001-2011, which were used in the previous restriction dossier. For DEHP, DBP and BBP a decline between 30 and 80% was shown, confirming the trend that was already on-going when RAC evaluated the previous restriction dossier. This declining trend will in all likelihood have continued in the years after 2011, as indeed demonstrated for 2011-2015 for Germany by Koch et al. (2016), in a (very homogeneous) subpopulation of students. It is noted that the extent of decline in Germany (and Denmark) is not necessarily representative for the whole of Europe and its non-homogeneous subpopulations. Nevertheless, the declining trend has been taken into consideration in the calculation of the future risks (see section B.3.2.3 of the opinion).

Several studies on biomonitoring combined the studies with an investigation on the source of the phthalate exposure. This was performed by including analysis of the diet for phthalate content, or by changing the diet (fasting or low-phthalate diet). Overall, it can be concluded that for DEHP the exposure results for the large part from food, whereas for DBP, BBP and DIBP other sources are driving the exposure. It was assumed by the Dossier Submitter that for DEHP 75% is attributable to food, whereas for DBP, DIBP and BBP this is 25%. Based on the data available, RAC considers this reasonable assumptions, although it is recognised that for DEHP the percentage is on the low side.

Modelling of exposure via indoor environment, food and contact with articles

In order to characterise the relative contributions of the different exposure sources, the Dossier Submitter modelled the exposure to the four phthalates via the indoor environment, via ingestion of food and via contact with articles. Two scenarios were made, a typical (average median) scenario and a reasonable worst case (average 95th percentile) scenario, with the aim to give an indication of the exposure for the average consumer and for the highly exposed consumer.

In addition to deterministic modelling, probabilistic modelling (using Monte Carlo simulations) was performed for contact with articles (assuming the worst case for one parameter is not correlated with a worst case for another parameter) and for combined phthalate exposure (assuming a high exposure for one phthalate is not correlated with a high exposure for another phthalate).

As the exposure differs depending on age, behaviour, stage of development and articles used, three age groups were selected: infants in the age of 6-12 months (with a body weight of 9.2 kg), children in the age of 6-11 years (31.8 kg body weight) and women (60 kg bw). Infants

of 6-12 months old were chosen because they are expected to mouth many articles not only toys, and because they will stop being breast fed and start to eat solid food. Children at 6-11 years were chosen to represent school children, and because they are of the same age as the children in the DEMOCOPHES biomonitoring study.

By correcting for absorption, the exposure estimates were converted into internal dose estimates (µg/kg bw/day), to allow summation via different routes of exposure.

Indoor environment (indoor air and dust)

In the Background Document, the exposure to the four phthalates from the indoor environment is estimated based on recent measurements of concentrations in house dust in Europe (literature data from 2009-2013) and measurements of indoor air concentrations (using simulation, calculation and literature data, for DEHP only). Exposure to house dust describes the ingestion of dust, assuming conservative dust intakes of 50 mg for adults and 6-11 year old children and 100 mg for 6-12 months old infants. The simulation for indoor air is based on data from analysed articles, mainly with large surfaces such as PVC flooring, wall paper, mattresses and shower curtains. Table 8 presents the internal exposure estimates to phthalates from dust ingestion, and for DEHP also from air/particles in air.

Table 8. Internal exposure to phthalates (in µg/kg bw/day) from indoor environment

	Infants		Children		Women	
	Typical case	**Reasonable worst case**	**Typical case**	**Reasonable worst case**	**Typical case**	**Reasonable worst case**
DEHP (dust)	3.94	20.42	0.57	3.68	0.31	1.65
DEHP (dust + air)	4.22	21.85	0.93	5.51	0.48	2.52
DBP	0.28	1.47	0.04	0.27	0.02	0.12
DIBP	0.27	1.41	0.04	0.25	0.02	0.11
BBP	0.08	0.42	0.01	0.08	0.01	0.03

Typical case scenario (median, average); Reasonable worst case scenario (95th percentile, average). The average 95th percentile value gives the average variation in 95th percentile values over the studies, not the 95th percentile of all individual data from the studies combined. It is to be noted though that 95th percentile values were only reported for two studies for DEHP, and for one study for DBP, DIBP and BBP.

The exposure estimates for indoor environment via dust have taken into account data from more than one study and more than one (Northern) European country. The estimates are presented as the (weighted) average median and average 95th percentile of a number of median and 95th percentile values found in the various studies.

RAC agrees to a large extent with the exposure assessment performed for phthalates in dust and indoor air but notes the following:

- No data on house dust for Southern and Eastern European countries are included. It is not known how different the situation in these countries is as compared to Northern European countries, although the Kolarik et al. (2008) study showed higher levels of DEHP, and especially DBP and BPP, in Bulgaria.

- Distributions found in studies before 2008 (as reported in the previous restriction dossier) were used by the Dossier Submitter to estimate the 95th percentile for

those studies where no 95th percentile was provided. Methodologically this is not considered appropriate.

- The Dossier Submitter used simulations for the concentration in air, only for DEHP, as for DIBP, DBP and BBP simulations revealed negligible concentrations in air. Some recent studies (Blanchard et al., 2014; Dallongeville et al., 2016; Luongo and Östman, 2016) show however that not only DEHP is present in indoor air, but that DIBP and DBP are present in approximately comparable concentrations.

- Body weights used are not consistent between modelling scenarios.

- The estimates for dust have been generated using the default values for dust intake from the ECHA Guidance R.15. Data from recent publications however indicate that these values are rather conservative, and that dust intakes of 30 mg for adults and children and 60 mg for infants (central tendency; US EPA 2011) are more realistic.

By how much the above may impact the exposure estimates is difficult to say, but the impressions is that estimates may be underestimates rather than overestimates.

Food

According to the Dossier Submitter, the following sources may result in phthalate exposure via food:

- food contact materials (FCMs; both compliant and non-compliant), such as food packaging and articles (e.g. machinery, conveyor belts, gloves etc.) that are used during the processing of food;

- non-FCM articles that may come into contact with food, e.g., table mats and oilcloth for tables;

- the environment: environmental release of phthalates occurs from phthalate manufacturing plants (DEHP and DBP only, as of February 2015), from downstream use of phthalates (DEHP and DBP only, as of February 2015) and from the article service life (including the waste stage). This may lead to contamination of plant and animal based food sources.

There is no legislation limiting phthalate content in food per se but since 2008, DEHP, DBP and BBP are authorised to be used in FCMs as long as their Specific Migration Limits (SML) of resp. 1.5, 0.3 and 30 mg/kg food are met. Market surveillance data however indicate that the SML for especially DEHP and DBP is often exceeded (see section B.8.4.5.3 of the Background Document). DIBP is not authorised for use in FCMs.

The Background Document presents estimates for the exposure via food based on data reported in literature, i.e. the ones cited in the previous restriction report supplemented with more recent publications from Europe (Sioen et al., 2012; Fromme et al., 2013). The Dossier Submitter based the exposure assessment on the latter two studies (Sioen et al. for children and adults, Fromme et al. for infants), as only these studies include analyses of food conducted after the entry into force of the legislation of phthalates in FCMs. In Sioen et al. (2012) the dietary intake of phthalates was calculated using Belgian food consumption data for preschool children (2.5 to 6.5 years old) and adults (≥15 years old) in combination with

data on phthalate concentrations in over 550 food products sold on the Belgian market between 2009 and 2011. Fromme et al. (2013) calculated the phthalate exposure from food for children in the age of 15-21 months. Exposure calculations were based on measurements of duplicate diet samples from 25 German infants collected over 7 consecutive days in the period from October 2009 until January 2010. In the absence of intake data on BBP for infants in these two studies, the Dossier Submitter used the BBP intake as estimated for infants in a 2007 study by Fromme et al. and lowered this by 70%, in view of the finding that BBP intake for adults in the Sioen et al. 2012 study was only 30% of that in the Fromme et al. 2007 study.

Table 9. Intake estimates for food (µg/kg bw/day)

	Infants**		Children*		Women*	
	Median daily intake	95-p daily intake	Median daily intake	95-p daily intake	Median daily intake	95-p daily intake
DEHP	4.66	7.09	3.50	5.38	1.49	2.86
DBP	0.70	1.24	0.20	0.30	0.08	0.16
DIBP	1.03	9.02	0.42	0.64	0.14	0.28
BBP	0.15	0.24	0.12	0.21	0.05	0.12

*Sioen et al. (2012)
**Fromme et al. (2013), except BBP where 30% of the estimate in Fromme et al. (2007) is used

RAC notes there are only a few recent studies in three EU countries available[10], in which different methodologies were used. This raises uncertainty as to the representativeness of the intake estimates. As to the estimate for BBP intake for infants presented in Table 9, RAC considers the uncorrected BBP intake for infants from Fromme et al. (2007) (median 0.5 and 95th percentile 0.8 µg/kg bw/day) more appropriate, as for infants at least the median daily intake values for the other three phthalates were very similar in the Fromme et al. (2007) and (2013) studies.

When looking at the time trend by comparing the new data with the data from the COT UK Total Diet Study (2011) that was used in the RAC opinion on the previous restriction dossier[2] and in which the measurements were from before the FCM regulation, there does not seem to be much change for DEHP. For DBP, BBP and DIBP there seems to be somewhat of a decline, with the exception of DIBP in infants where there seems to be an increase. But it is difficult to say, based on such a small number of studies, which moreover have a different study design.

The uncertainties in the food estimates as to which part can be attributed to FCM use, and which to environmental pollution are difficult to solve, as is the case for the relative contribution of articles in- and excluded in the scope to the environmental pollution. In a Belgian study (Van Holderbeke et al., 2014) special attention was given to DEHP, DBP, DIBP and BBP in bread, since high concentrations (especially DEHP) were found in this food product. The reason turned out to be both contaminated ingredients (i.e. flour), as well as the migration from baking equipment and contact materials during production. Since the flour itself is already processed, the environmental contribution of the flour contamination is not

[10] A third recent study was pointed out during public consultation, i.e. a French total diet study in children under three years of age and carried out on food specimen collected in 2011-2012 (ANSES, 2016). This study showed lower median and P90 (upper bound) intake values for the four phthalates for French infants of all sub-agegroups (1-4 months, 5-6 months, 7-12 months, 13-36 months) than the median and P95 values reported by Fromme et al. (2013) for 15-21 months old German children.

clear. Also investigations on phthalates in apples, bread, salami and cheese revealed the important role of processing, and not so much packaging, on the phthalate contents in food. Yet, this might be dependent on the specific food product, including the way of packaging, as well as of the locations, and the way of processing.

The estimates from food comprise solid foods, liquid foods (e.g., soup and sauces) and beverages (e.g., milk, coffee, drinking water). The Dossier Submitter expects the contribution from drinking water to exposure via food to be negligible due to the low water solubility of the four phthalates. In possible cases of contamination, the contribution of drinking water may be more significant. The EU RAR for DEHP reported a case of contaminated groundwater in the Netherlands (20 to 45 µg /l of DEHP) from a publication in 1987. No recent information is available on groundwater or drinking water contaminated with such high levels of phthalates.

Articles

General

Compared to the previous restriction dossier, in which the exposure from contact with articles was based on only a few selected articles for which migration data were available, the Dossier Submitter took a different approach in the present dossier. The exposure to the four phthalates from contact with articles was now calculated using the average of all migration rates referenced in the literature, in combination with assumptions on the proportion of articles containing DEHP (74%), DBP (8%), DIBP (8%) and BBP (10%), and assumptions on exposure time and contact area.

The main information source on migration rates (in unit per area) were published and unpublished surveys from the Danish EPA. In these surveys and a few other reports, a broad variety of plastic articles containing phthalates have been analysed for migration of phthalates (mostly DEHP, sometimes also DBP and DIBP) to artificial sweat or saliva, under static or dynamic conditions. The average and 95th percentile of all positive findings on migration for DEHP, DBP and DIBP were used[11] in the Background Document to calculate the typical and reasonable worst case exposure to these phthalates, respectively, using first tier models for oral (infants only) and dermal exposure estimation. In the absence of measured migration rates for BBP in the available reports, the Dossier Submitter used the mean and maximum migration rate for BBP as reported in the dissertation by Wormuth (2006).

The internal exposure estimates for dermal and oral exposure to phthalates in articles are given in Table 10. The 3rd column for each phthalate in this table presents the results of the Monte Carlo simulation of the reasonable worst case scenario, by carrying out 10 000 iterations of random combinations of parameters that are considered not correlated (exposure time, dermal contact area and migration rate, and for oral exposure also body weight), taking into account their variation.

Table 10. Internal exposure to phthalates (in µg/kg bw/day) from oral and dermal contact with articles

	DEHP			**DBP**			**DIBP**			**BBP**		
	TC	RWC	RWC MC	TC	RWC	RWC MC	TC	RWC	RWC MC	TC	RWC	RWC MC
Estimated exposure from mouthing of articles												
Infants	0.05	1.53	2.76	0.01	0.27	0.37	0.01	0.23	0.36	0.005	0.14	0.18

[11] Thereby assuming that the measured migration has all migrated during the first hour, regardless of the actual migration time in the experiment.

Estimated exposure from dermal contact with articles												
Infants	3.44	25.79	24.91	1.19	8.95	6.10	1.06	7.92	6.39	0.31	2.29	1.57
Children	2.39	17.91	17.26	0.83	6.22	4.39	0.73	5.50	4.49	0.21	1.59	1.13
Women	2.13	7.63	12.06	0.74	2.65	3.17	0.65	2.34	3.09	0.19	0.68	0.77
TOTAL												
Infants	3.49	27.32	27.67	1.20	9.22	6.48	1.06	8.16	6.74	0.31	2.43	1.75
Children	2.39	17.91	17.26	0.83	6.22	4.39	0.73	5.50	4.49	0.21	1.59	1.13
Women	2.12	7.63	12.06	0.74	2.65	3.17	0.65	2.34	3.09	0.19	0.68	0.77

TC = Typical case scenario
RWC = Reasonable worst case scenario. In this estimate, the reasonable worst case estimates for exposure time (oral and dermal) and contact area (dermal) were used, and the typical case estimate for migration rate.
RWC MC = Monte Carlo simulation of the reasonable worst case scenario

Some specific articles

In addition to the above, the Dossier Submitter considered the exposure from some specific articles that might lead to high oral or dermal exposures. In particular erasers, plastic sandals and sex toys were identified, and the exposure estimation for these articles was performed in a way identical to that in the previous restriction dossier. The results are presented in Table 11.

Table 11. Calculated internal exposure to DEHP, DIBP and DBP from specific consumer articles (µg/kg bw/day)

Article	DEHP			DBP			DIBP		
	Infants	Children	Women	Infants	Children	Women	Infants	Children	Women
Eraser *									
- typical		15.8							
- RWC		176.0							
Plastic sandals									
- typical	0.90	1.87	0.71	0	0	0	0	0	3.76
- RWC	3.63	0	1.44	0	3.91	5.50	3.56	0	2.61
Sex toys #									
- typical			0.001						
- RWC			0.92						

* The typical value is based on mouthing 1 cm^2 (3.79 g) of eraser for 1 hour. The reasonable worst case value is based on ingestion of 8 mg eraser per day.
# The typical value is based on the migration to artificial sweat and the reasonable worst case value is based on the migration to artificial sweat + oil based lubricant.

Toys and childcare articles

The Dossier Submitter further remarked that in contrast to DEHP, DBP and BBP, DIBP is not restricted in toys and childcare articles under entry 51 in Annex XVII of REACH. Its concentration in these kind of articles is however limited to 5% w/w under the Toy Safety Directive (as of March 2018 this limit will be reduced to 0.3% w/w).

According to market surveillance data, DIBP is used in 1-3% of toys and childcare articles with flexible PVC (often together with other phthalates), with an average concentration of 10-20% of PVC content. Although historical information is not available to confirm that DIBP is replacing DBP in toys, the substitution is feasible, given their structural and pricing

similarities. RAPEX notifications and results from a 2013 joint market surveillance action on toys intended for children under 3 years[12] have shown non-compliance with the Toy Safety Directive limit for DIBP on a number of occasions.

Using for DIBP the same assumptions as done by ECHA in their evaluation of DINP and DIDP in toys and childcare articles (ECHA 2013d,e), reasonable worst case internal exposure estimates for 6-12 months old infants from DIBP in toys and childcare articles would be 118 µg/kg bw/day (from mouthing) and 5 µg/kg bw/day (from dermal contact). Toys that are not in compliance with the Toys Directive and childcare articles could therefore contribute to a relatively high exposure to DIBP.

Discussion - articles

RAC notes that the modelled exposure from contact with articles depends on the assumptions made on the use of articles, the migration rates and the share between the four phthalates. This will lead to various uncertainties, as people behave and consume differently, influencing the articles used. The results of the surveys of content and migration showed large differences in measured migration rates. It is known that the migration rate depends on a multitude of factors, a.o. the analytical method used. Migration is for instance in general higher under dynamic conditions (using for instance the head over heel method, or shaking) than under static conditions, as is also apparent from the surveys. It is also apparent from the available data that there is no correlation between the content and the migration of phthalates. The mere presence in an article therefore does not automatically mean that under normal conditions of use there will be (high) migration, and thus (high) exposure upon direct contact.

The Dossier Submitter chose to use an overall migration rate for the phthalates in the exposure estimation, and combined this with assumptions on the share of the phthalates in articles. RAC can support these latter assumptions, as they are in relative close agreement with the baseline assumptions (that point to a slightly higher contribution from DEHP, and a slightly lower contribution from DBP, DIBP and BBP). As to the overall migration rate used, RAC notes that in calculating it the Dossier Submitter assumed that all of the migration of the phthalates will happen within the first hour, no matter what the actual migration time in the experiment is. There are studies showing that the migration of DINP is linear at least up to 4 hours (Oomen et al., 2004). Given that the studies presenting the highest migration rates had experimental migration times below 1 hour, the migration rate per hour in these studies is actually higher. So the overall migration rate may be underestimated rather than overestimated. The more so since more than half of all migration rates available were obtained under static conditions, whereas migration is generally much higher (and realistic) under dynamic conditions (in particular the head over heel method), and very much higher when in addition sunscreen or oil is applied. The latter situation may be rather typical for infants and children, but only very few migration rates under these conditions were available in the dataset.

All in all, RAC finds it an elegant and practical approach to assess an aggregate exposure estimate for substances that are present in such a broad range and number of consumer articles. The approach makes best use of the available data, with measurements in relevant media (artificial saliva and artificial sweat) and under both dynamic and static conditions, giving an impression of phthalate exposure from articles for a typical or high-end consumer (albeit that the migration rate may be underestimated). It is acknowledged though that there

[12] http://www.prosafe.org/images/Documents/JA2013/JA2013_Toys_Final_Technical_Report_24-02-2016.pdf

were only relatively few migration measurements for DBP and DIBP and none at all for BBP (rendering the estimated migration rates for these phthalates less robust), and that migration studies from specific articles like erasers, sandals and sex toys have shown that individual articles can contribute to a relatively high exposure. The latter is also true for DIBP in toys and childcare articles. On the other hand, RAC notes that a level of conservatism seems to have been built in in the exposure estimates, given that it was assumed that people are exposed to phthalate containing articles on a daily basis, that all articles indeed contain one of the four phthalates (whereas from the surveys it appears that in the majority of plastic articles analysed, the four phthalates were either not detectable or only present in insignificant (<1% w/w) amounts), and that for all articles the migration rate remains as high over time as during the first hour.

Taking into account that certainly not all individual plastic articles belonging to an article category will contain the four phthalates in significant amounts, it is unlikely that each and every person will be in direct contact to plastic articles that all have the highest content and highest migration rate (continuously) of phthalates every day. Thus, individuals may possibly have, every now and then, a high exposure from direct contact (under rather extreme conditions, such as 'eraser eating' for 6-11 year children), but that will not be the case on a population level.

RAC notes further that for the reasonable worst case scenario the Dossier Submitter took the reasonable worst case estimates only for exposure time and contact area, not for migration rate. It is acknowledged though that very seldom the reasonable worst case will apply for all parameters at the same time. RAC therefore appreciates the probabilistic assessment by the Dossier Submitter, in which not only the variation in exposure time and contact area was taken into consideration, but also the variation in migration rate. The resulting estimate from the Monte Carlo simulations is likely more representative for the reasonable worst case than the deterministic estimate.

Aggregated exposure from indoor environment, food and contact with articles

The aggregated exposure for the individual phthalates is presented in Table 12.

Table 12. Aggregated exposure from indoor environment, food and contact with articles for each phthalate (µg/kg bw/day)

	Infants			**Children**			**Women**		
	Typical	RWC	MC RWC	Typical	RWC	MC RWC	Typical	RWC	MC RWC
DEHP									
Indoor	4.22	21.85	21.85	0.93	5.51	5.51	0.48	2.52	2.52
Food	4.66	7.09	7.09	3.50	5.38	5.38	1.49	2.86	2.86
Articles	3.49	27.32	27.67	2.39	17.91	17.26	2.12	7.63	12.06
Total	12.37	56.26	56.61	6.82	28.80	28.15	4.09	13.01	17.45
Monte Carlo			42.98			22.38			14.17
DBP									
Indoor	0.28	1.47	1.47	0.04	0.27	0.27	0.02	0.12	0.12
Food	0.70	1.24	1.24	0.20	0.30	0.30	0.08	0.16	0.16
Articles	1.20	9.22	6.48	0.83	6.22	4.39	0.74	2.65	3.17
Total	2.18	11.93	9.19	1.07	6.79	4.96	0.84	2.92	3.45
Monte Carlo			6.63			4.63			3.27

DIBP									
Indoor	0.27	1.41	1.41	0.04	0.25	0.25	0.02	0.11	0.11
Food	1.03	9.02	9.02	0.42	0.64	0.64	0.14	0.28	0.28
Articles	1.06	8.16	6.74	0.73	5.50	4.49	0.65	2.34	3.09
Total	2.37	18.59	17.18	1.19	6.40	5.39	0.82	2.74	3.48
Monte Carlo			12.19			4.94			3.28
BBP									
Indoor	0.08	0.42	0.42	0.01	0.08	0.08	0.01	0.03	0.03
Food	0.15	0.24	0.24	0.12	0.21	0.21	0.05	0.12	0.12
Articles	0.31	2.43	1.75	0.21	1.59	1.13	0.19	0.68	0.77
Total	0.54	3.09	2.41	0.34	1.87	1.41	0.25	0.83	0.92
Monte Carlo			1.90			1.25			0.83

Typical = Typical case scenario
RWC = Reasonable worst case scenario
RWC MC = Monte Carlo simulation of the reasonable worst case scenario

For DEHP, modelling suggests that food (with negligible contribution from drinking water) is the dominant source for infants' and children's exposure in the typical case, while contact with articles dominates for women. In the reasonable worst case, contact with articles seems to be the main source for children and women, while both articles and indoor environment are important sources for infants. The exposure from dust is though expected to be overestimated, as the default intake of dust of 100 mg/day for infants is very high.

Results from biomonitoring studies indicate that food is the predominant source of DEHP exposure. This is not supported by the modelled data. This difference illustrates that exposure estimations in general are uncertain due to large number of varying parameters.

For DBP and BBP the main source seems to be contact with articles for all three age groups for both the typical and the reasonable worst case. The same applies for DIBP for children and women, whereas for infants food seems equally important as contact with articles. It must be noted though that the contribution of toys and childcare articles is not included in the estimate presented in Table 12.

B.1.2.3. Characterisation of risk(s)

B.1.2.3.1. Summary of proposal:

Based on the 95th percentile of combined exposure to the four phthalates in 2011, the Dossier Submitter identified a risk in 14 out of 15 Member States (93%) where the monitoring took place. The modelling estimates presented by the Dossier Submitter are generally consistent with the biomonitoring results for children (boys) and mothers (boys in utero), but appear to underestimate risks slightly in Member States with high exposure levels. It is estimated that in 2014 about 5% of new born boys (130 000) in the EU28 were at risk through in utero exposure and about 15.5% boys (400 000) were at risk from direct exposure.

Based on these data, the Dossier Submitter concludes that the identified risk to the general population is not adequately controlled and needs to be addressed. This risk is in addition to

the recognised occupational risk from the use of DEHP in formulation and production of articles and any possible risk to the environment from exposure to DEHP[13].

B.1.2.3.2. RAC conclusion(s):

RAC notes that the 95th percentile of combined exposure to the four phthalates presents an EU-wide risk for both children and mothers. In view of the uncertainties identified in the hazard and exposure assessment, RAC notes that overall these uncertainties point to an underestimation rather than an overestimation of the risks. RAC thus supports the conclusions of the Dossier Submitter that there is a need to address the risks.

B.1.2.3.3. Key elements underpinning the RAC conclusion(s):

In the Background Document RCRs have been calculated for each individual phthalate by comparing the DNEL with the intake estimate based on the DEMOCOPHES biomonitoring data. Subsequently, the total risk was calculated summing the RCRs of the individual phthalates into a combined RCR. Tables 13 and 14 present the RCRs as estimated from the geometric mean (typical case) and 95th percentile (reasonable worst case) intakes, respectively. Addition of RCRs based on the 95th percentile intakes is considered a reasonable and not too worst case, given literature data indicating that coexposure to high levels of multiple phthalates is not uncommon (see section B.8.3.2.6 of the Background Document). From US biomonitoring data it can be seen that 7% of the individuals were exposed above the 95th percentile for two or more phthalates simultaneously, and 2% were exposed above the 95th percentile for three or more phthalates simultaneously (Qian et al., 2015).

Table 13. RCRs for exposure to the four phthalates as estimated from geometric mean (GM) urinary biomonitoring levels from DEMOCOPHES data from 2011-2012

		Mother						Child				
Country	N	DEHP	DBP	BBP	DIBP	SUM	N	DEHP	DBP	BBP	DIBP	SUM
SI	120	0.1	0.1	0.0	*NA*	0.2	120	0.1	0.1	0.0	*NA*	0.2
CH	117	0.0	0.1	0.0	0.1	0.2	119	0.1	0.1	0.0	0.1	0.2
CY	59	0.0	0.1	0.0	0.2	0.3	60	0.0	0.1	0.0	0.2	0.3
LU	58	0.0	0.1	0.0	0.1	0.2	60	0.0	0.1	0.0	0.1	0.3
UK	21	0.0	0.1	0.0	0.1	0.1	21	0.1	0.1	0.0	0.1	0.3
HU	115	0.1	0.2	0.0	*NA*	0.2	117	0.1	0.2	0.0	*NA*	0.3
IE	120	0.1	0.1	0.0	0.1	0.2	120	0.1	0.1	0.0	0.1	0.3
PT	117	0.1	0.1	0.0	0.1	0.3	116	0.1	0.1	0.0	0.1	0.4
DE	116	0.0	0.1	0.0	0.1	0.3	120	0.1	0.2	0.0	0.1	0.4
BE	125	0.0	0.1	0.0	0.1	0.3	125	0.1	0.2	0.0	0.2	0.4
DK	143	0.0	0.1	0.0	0.2	0.3	142	0.1	0.1	0.0	0.2	0.4
SE	96	0.1	0.3	0.0	*NA*	0.3	97	0.1	0.4	0.0	*NA*	0.5
RO	117	0.1	0.1	0.0	0.1	0.3	119	0.1	0.2	0.0	0.2	0.5
SK	125	0.1	0.3	0.0	*NA*	0.4	127	0.1	0.4	0.0	*NA*	0.6
ES	118	0.1	0.1	0.0	0.1	0.4	119	0.1	0.2	0.0	0.2	0.6
CZ	117	0.1	0.3	0.0	0.0	0.3	120	0.1	0.4	0.0	0.0	0.6
PL	119	0.1	0.2	0.0	0.2	0.5	115	0.1	0.4	0.0	0.4	0.9

NA = not available

[13] The Member State Committee (MSC) confirmed that DEHP is an endocrine disruptor in the environment and thus, there may also be risks to the environment from exposure to DEHP.

Table 14. RCRs for exposure to the four phthalates as estimated from 95th percentile urinary biomonitoring exposure levels from DEMOCOPHES data from 2011-2012

	Mother					Child					
Country	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**
SI	120	0.2	0.4	0.0	*NA*	0.6	120	0.2	0.4	0.0	*NA*	0.6
UK	21	0.1	0.1	0.0	0.3	0.5	21	0.2	0.3	0.0	0.3	0.7
CH	117	0.2	0.3	0.0	0.2	0.6	119	0.2	0.3	0.0	0.3	0.8
CY	59	0.4	0.2	0.0	0.4	1.1	60	0.2	0.2	0.0	0.4	0.9
PT	117	0.3	0.2	0.0	0.3	0.9	116	0.3	0.3	0.0	0.4	1.0
IE	120	0.2	0.2	0.0	0.4	0.8	120	0.3	0.3	0.0	0.5	1.0
HU	115	0.2	0.5	0.0	*NA*	0.7	117	0.4	0.7	0.0	*NA*	1.1
LU	60	0.1	0.2	0.0	0.3	0.6	60	0.1	0.3	0.0	0.7	1.1
DK	143	0.2	0.2	0.0	0.4	0.7	142	0.2	0.3	0.0	0.6	1.1
DE	116	0.1	0.3	0.0	0.2	0.7	120	0.2	0.5	0.0	0.4	1.1
SE	96	0.2	0.7	0.0	*NA*	0.9	97	0.3	1.0	0.0	*NA*	1.3
SK	125	0.2	0.8	0.0	*NA*	1.0	127	0.4	1.1	0.0	*NA*	1.5
CZ	117	0.2	0.7	0.0	*NA*	1.0	120	0.4	1.3	0.0	*NA*	1.7
BE	125	0.1	0.4	0.0	0.6	1.1	125	0.4	0.4	0.0	1.0	1.8
RO	117	1.0	0.3	0.0	0.3	1.6	119	0.9	0.6	0.0	0.6	2.1
ES	118	0.3	0.3	0.0	0.3	0.9	119	0.4	0.9	0.0	0.9	2.1
PL	119	0.4	0.8	0.0	0.7	1.9	115	0.5	1.1	0.0	1.2	2.9

NA = not available; RCRs ≥1 marked in yellow

As can be seen from these tables, the RCRs based on the geometric mean are below 1 for both children and mothers, although in several Member States the body burden for children is rather high (RCR >0.5), in particular in Poland. Based on the 95th percentile, a combined RCR equal to or above 1 was found for children in 13 out of 15[14] participating Member States (87%). For five out of these Member States the combined RCR is ≥1 also for mothers, with a sixth Member State (Cyprus) having a combined RCR above 1 in mothers but not in children. In some Member States also a risk from exposure to individual phthalates (in particular DBP and DIBP) was identified.

The Dossier Submitter made a projection of the risk estimate in 2014 (see Table 15), but considering the limited decline in volume expected to have occurred between 2011 and 2014, the total RCRs are very similar.

Table 15. RCRs for exposure to the four phthalates as estimated from 95th percentile urinary biomonitoring exposure levels from DEMOCOPHES data extrapolated from 2011/2012 to 2014

	Mother					Child					
Country	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**
SI	120	0.2	0.4	0.0	*NA*	0.5	120	0.2	0.4	0.0	*NA*	0.6
UK	21	0.1	0.1	0.0	0.2	0.4	21	0.2	0.3	0.0	0.3	0.7
CH	117	0.2	0.2	0.0	0.2	0.6	119	0.2	0.3	0.0	0.2	0.7
CY	59	0.4	0.2	0.0	0.4	1.0	60	0.2	0.2	0.0	0.4	0.8
PT	117	0.3	0.2	0.0	0.3	0.8	116	0.3	0.3	0.0	0.4	0.9
IE	120	0.2	0.2	0.0	0.3	0.7	120	0.3	0.2	0.0	0.4	1.0
LU	60	0.1	0.2	0.0	0.3	0.6	60	0.1	0.2	0.0	0.7	1.0
HU	115	0.2	0.4	0.0	NA	0.7	117	0.4	0.6	0.0	NA	1.0
DK	143	0.2	0.2	0.0	0.4	0.7	142	0.2	0.3	0.0	0.5	1.0
DE	116	0.1	0.3	0.0	0.2	0.6	120	0.2	0.5	0.0	0.3	1.0
SE	96	0.2	0.7	0.0	NA	0.8	97	0.3	0.9	0.0	NA	1.2
SK	125	0.2	0.7	0.0	NA	0.9	127	0.4	1.0	0.0	NA	1.4
CZ	117	0.2	0.7	0.0	NA	0.9	120	0.4	1.2	0.0	NA	1.6
BE	125	0.1	0.4	0.0	0.5	1.1	125	0.4	0.4	0.0	0.9	1.7
ES	118	0.3	0.3	0.0	0.3	0.9	119	0.4	0.8	0.0	0.8	1.9
RO	117	1.0	0.2	0.0	0.3	1.5	119	0.9	0.5	0.0	0.6	2.0
PL	119	0.4	0.8	0.0	0.7	1.8	115	0.5	1.0	0.0	1.1	2.6

NA = not available; RCRs ≥1 marked in yellow

[14] The Dossier Submitter excluded UK (because of too small sample size) and Switzerland (not part of the EU).

Leaving out the UK data (because of too small sample size), the Dossier Submitter subsequently estimated the population at risk as the percentage of mothers (boys exposed in utero) and children exceeding an RCR value of 1 for the individual 15 EU Member States. The overall percentage of the population at risk from these 15 Member States was used to extrapolate to the remaining 13 Member States. It was estimated that in 2014 in the EU28 about 5.1% of new born boys (130 000) were at risk through in utero exposure and about 15.5% boys (400 000) were at risk from direct exposure. In 2011, the percentages were 6% and 18%, respectively.

In the Background Document also RCRs for the "European" intake estimates are presented, based on the overall DEMOCOPHES data and extrapolated to 2014 (see Table 16). These RCRs show for the reasonable worst case an EU-wide risk for children and almost for mothers.

Table 16. RCRs for exposure to the four phthalates as estimated from median and 95th percentile urinary biomonitoring exposure levels from DEMOCOPHES (calculated for "Europe"; based on Den Hond et al., 2015); data from study report and extrapolated to 2014

	RCRs based on biomonitoring			
	2011		2014	
	Median	**P95**	**Median**	**P95**
EU (DEMOCOPHES)				
Children (6-11 yr)				
DEHP	0.1	0.4	0.1	0.4
DBP	0.1	0.6	0.1	0.5
BBP	0.0	0.0	0.0	0.0
DIBP	0.2	0.6	0.1	0.5
SUM	**0.4**	**1.5**	**0.4**	**1.4**
Mothers				
DEHP	0.1	0.2	0.1	0.2
DBP	0.1	0.3	0.1	0.3
BBP	0.0	0.0	0.0	0.0
DIBP	0.1	0.4	0.1	0.3
SUM	**0.3**	**0.9**	**0.3**	**0.9**

Note: RCRs ≥1 marked in yellow

When looking at the DEMOCOPHES data in combination with the Myridakis data, RAC notes there is an EU-wide risk for the reasonable worst case (P95) for both children and mothers (see Table 17).

Table 17. RCRs for exposure to the four phthalates as estimated from median and 95th percentile urinary biomonitoring exposure levels from DEMOCOPHES (calculated for "Europe") and from Myridakis et al. (2015); data from study report and extrapolated to 2014

	RCRs based on biomonitoring			
	2011		2014	
	Median	**P95**	**Median**	**P95**
GREECE (Myridakis et al. 2015)				
Children (~2 yr)				
DEHP	0.12	0.64	0.12	0.63
DBP	0.15	0.99	0.14	0.90
BBP	0.00	0.00	0.00	0.00
DIBP	0.17	0.99	0.15	0.90

SUM	**0.44**	**2.61**	**0.41**	**2.43**
Mothers				
DEHP	0.13	0.75	0.13	0.75
DBP	0.28	1.70	0.26	1.55
BBP	0.00	0.00	0.00	0.00
DIBP	0.25	1.33	0.23	1.21
SUM	**0.67**	**3.78**	**0.62**	**3.50**
EU (DEMOCOPHES and Myridakis)				
Mothers				
DEHP	0.07	0.30	0.07	0.30
DBP	0.13	0.52	0.12	0.48
BBP	0.00	0.00	0.00	0.00
DIBP	0.13	0.53	0.12	0.48
SUM	**0.33**	**1.36**	**0.31**	**1.26**

Note: RCRs ≥1 marked in yellow

The Dossier Submitter also calculated RCRs for the modelled exposure estimates for exposure via indoor environment, food and contact with articles. These appeared to be in reasonably good agreement with the biomonitoring RCRs, as can be seen in Table 18 where RCRS for the typical and reasonable worst case modelling exposure estimates were compared to the respective biomonitoring RCRs from DEMOCOPHES.

Table 18. RCRs for the typical and reasonable worst case modelling exposure estimates and the range of the median and 95th percentile of biomonitoring exposure estimates from different countries

	Infants					**Children**					**Mothers**				
	Indoor	Food	Articles	Total	BM	Indoor	Food	Articles	Total	BM	Indoor	Food	Articles	Total	BM
TYPICAL CASE															
DEHP	0.12	0.14	0.10	0.36	NA	0.03	0.10	0.07	0.20	0.04-0.14	0.01	0.04	0.06	0.12	0.03-0.10
DBP	0.04	0.10	0.18	0.33	NA	0.01	0.03	0.12	0.16	0.08-0.46	0.00	0.01	0.11	0.13	0.07-0.30
DIBP	0.03	0.12	0.13	0.29	NA	0.00	0.05	0.09	0.14	0.08-0.36	0.00	0.02	0.08	0.10	0.05-0.19
BBP	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00-0.00	0.00	0.00	0.00	0.00	0.00-0.00
Total	**0.20**	**0.37**	**0.41**	**0.98**	NA	**0.04**	**0.18**	**0.28**	**0.50**	**0.23-0.89**	**0.02**	**0.07**	**0.25**	**0.34**	**0.16-0.49**
REASONABLE WORST CASE*															
DEHP	0.64	0.21	0.81	1.67	NA	0.16	0.16	0.51	0.83	0.16-0.88	0.07	0.08	0.35	0.51	0.08-1.02
DBP	0.22	0.19	0.97	1.37	NA	0.04	0.04	0.65	0.74	0.28-1.21	0.02	0.02	0.47	0.51	0.15-0.89
DIBP	0.17	1.09	0.81	2.07	NA	0.03	0.08	0.54	0.65	0.25-1.21	0.02	0.03	0.37	0.42	0.27-0.72
BBP	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00-0.01	0.00	0.00	0.00	0.00	0.00-0.00
Total	**1.03**	**1.48**	**2.60**	**5.11**	NA	**0.23**	**0.28**	**1.71**	**2.22**	**0.75-2.94**	**0.11**	**0.14**	**1.20**	**1.45**	**0.50-1.98**

* For articles the RCRs presented are based on the Monte Carlo reasonable worst case estimates

B.1.2.4. Uncertainties in the risk characterisation

In Table 19 the main sources of uncertainty in the risk as identified by the Dossier Submitter are given. In the opinion of RAC this presents a rather complete overview. Taken together, the uncertainties point to an underestimation rather than an overestimation of the risks.

Table 19. Overview of main sources of uncertainty in the phthalate risk assessment based on biomonitoring data and influence on RCRs (↓ towards lower RCR, ↑ towards higher RCR)

Source	Description	Effect on RCR
Hazard		
DNEL DEHP	Alternative (lower) DNELs of 0.007 and 0.008 mg/kg bw/day may be derived from Christiansen et al. (2010) and Andrade et al. (2006).	↑
DNEL DEHP	Endpoints that appeared to be the most sensitive for DBP have not been investigated for DEHP. In view of equipotency for effects on testosterone production as compared to DBP, the PoD could be about 5 times lower.	↑
DNEL BBP	BBP appears to have comparable potency to DEHP and DBP on foetal testosterone production. It may be speculated that further studies on effects of BBP on endocrine sensitive endpoints would reveal effects at lower doses than 50 mg/kg bw/day, potentially leading to a lower DNEL (if similar to DEHP the DNEL for BBP would be a factor 10 lower).	↑
DNEL DIBP	In the absence of conclusive experimental data, read-across from DBP has been performed to DIBP. The experimental evidence for concluding that DIBP is of similar anti-androgenic potency is considered robust, but the assumption of potency difference (25%) is uncertain.	-
DNELs for children	The DNELs are relevant for both pregnant women and for children, albeit it is possible that the DNELs for children would be higher.	↓
Species differences	There are indications of species differences in metabolism and possibly in effects on foetal steroidogenesis, but the evidence is insufficient to deviate from the assumption that humans are more sensitive than the test species.	↓
Effects on the immune system	A number of experimental and epidemiological studies provide moderate to strong indications for effects on the immune system. Some of these studies indicate that reproductive toxicity may not be the most sensitive endpoint and that the selected DNELs may not be sufficiently protective against these immune effects.	↑
Effects on the metabolic system and neurological development	A number of experimental and epidemiological studies suggested possible effects on the metabolic system and neurological development. It is not clear from the data whether the selected DNELs based on reproductive toxicity are sufficiently protective against these other effects.	?
Threshold	When following the recent (16 Feb 2017) REACH Committee vote the Commission formally decides that the four phthalates give rise to equivalent level of concern due to their endocrine disrupting properties for human health, it has to be determined whether a threshold for such effects can be demonstrated if any applications for authorisation would be submitted in the future (European Commission, 2014). The existence of a threshold for endocrine disruption has not yet been assessed and documented for DEHP, DBP, DIBP and BBP.	↑
Exposure		
Data availability	There are uncertainties to the biomonitoring estimates as a result of data availability issues (on individual participants). The effect appears to be minimal based on a comparison of Dossier	-

	Submitter's estimates and published estimates for DK.	
Sampling approach	There is both a diurnal and a day to day variation in the quantities of metabolites excreted in urine in response to the variation in intakes of phthalates over a 24 hour period. As a result of this variability, a single spot urine sample may not be representative for the mean daily concentration.	↑↓
Creatinine based method	When using volume based method of intake calculation from urinary biomonitoring data higher exposure estimates may be obtained (possibly by a factor of 2).	↑
Use of 95th percentile exposure and summation of 95th percentiles of several phthalates	The exposure estimates are derived from a fairly limited number of samples per country (around 120). This results in relatively high uncertainties to whether the actual 95th percentile exposure in the entire population is lower or higher: the sample might not be representative for highly exposed sub-populations. Even a short elevated exposure level may be sufficient to cause adverse effects from exposure within the critical windows of exposure. On the other hand, maxima may arise from analytical and methodological errors or might result from non-representative exposure situations. Furthermore, adding RCRs based on 95th percentiles of several phthalates may lead to some overestimation of the RCRs, although consistent evidence indicates that it is not uncommon that individuals are exposed to high levels of more than one phthalate simultaneously.	↑↓
Selection of population	Patients with haemodialysis were not admissible to the DEMOCOPHES study (FPS, 2013) and thus it is highly unlikely that any patients with recent (within a day) exposure from medical devices would have been included in the study population. These specific situations may lead to exposure that exceeds the daily intake in the general population by several orders of magnitude (Koch and Angerer, 2012). Thus, for those children and women that regularly undergo medical treatment with DEHP containing medical devices, the risk as estimated in the current risk assessment is likely to be underestimated.	↑
Infants	The children in the study population of DEMOCOPHES were 6-11 years old. Younger children appear to be exposed at higher levels to the four phthalates and thus the estimates may underestimate exposure of younger children. In addition, medical devices may contribute to exposure to DEHP, for example in preterm neonates (SCENIHR, 2016). Since the population in biomonitoring studies such as DEMOCOPHES does not include neonates, there may be additional risks from phthalates to infants not accounted for in the current risk assessment.	↑
FUEs$^{\#}$ used for children	The FUEs used for children are for adults and may result in underestimation of exposure to DBP, BBP and DIBP.	↑
Estimates for specific Member States	The RCRs for combined exposure are underestimated for Slovenia since no measurement of DIBP metabolites was available. For the same reasons, the RCRs for the Slovak Republic, Sweden, Czech Republic and Hungary may also be underestimated, although potential issues with chromatic separation may have compensated for the lack of a measurement value for DIBP. Due to the small sample size (n=21), the data from the UK is not considered representative for the exposure in the UK and might be underestimated.	↑
Other considerations		
Other anti-androgenic substances may contribute significantly to the total risk	The combined risk assessment considers only DEHP, DBP, DIBP and BBP, but other substances may contribute to mixture effects on male reproductive development. Several substances are evaluated to be able to cause anti-androgenic effects. Exposure to other substances affecting male reproductive development can contribute significantly to the total risk.	*

	Therefore, the combined risk assessment of DEHP, DBP, DIBP and BBP alone is likely to be an underestimation of the risk for mixture effects on male reproductive development. Examples are other anti-androgenic phthalates such as DINP, DnHP, DIHepP, DnHepP (Health Canada, 2015a; ECHA 2013d).	

An arrow pointing upwards (↑) indicates that uncertainties suggest RCRs may be higher and thus may be underestimated. An arrow pointing downwards (↓) suggest RCRs may be lower and thus may be overestimated. An uncertainty with minimal impact on the RCRs is indicated with a dash (-). Where arrows are pointing in both directions, this indicates that uncertainties may have a significant impact on the RCRs, but it is not possible to evaluate whether the parameter leads to under- or overestimation of the RCRs.

* No influence on RCRs as such, but relevant for total burden to anti-androgenic substances.

FUE = fraction [of phthalates] excreted in urine

In light of mechanistic evidence suggesting equipotent or similar anti-androgenic potencies for the four phthalates, a sensitivity scenario was constructed on request by RAC to show the effect on the RCRs when it is assumed that the DNELs for all four phthalates are equal to the DNEL of DBP (6.7 µg/kg bw/day). The results are presented in Tables 20 (RCRs based on geometric mean) and 21 (RCRs based on 95th percentile). In comparison to the RCRs calculated for the 95th percentile combined exposure to the four phthalates as projected to 2014 (Table 15), the RCRs are about double when it is assumed that all four phthalates have the same DNEL. In this sensitivity scenario, RCRs were >1 for children and mothers in almost all Member States based on the 95th percentile of combined exposure to the four phthalates in 2014. In several Member States (PL, ES, SK, CZ and RO) RCRs based on the geometric mean combined exposure were ≥1 for children. According to the sensitivity scenario, approximately 25% of new born boys (640 000) were at risk through in utero exposure and about 47% boys (1 200 000) were at risk from direct exposure in 2014.

Table 20. RCRs for exposure to the four phthalates as estimated from geometric mean (GM) urinary biomonitoring exposure levels from DEMOCOPHES data projected to 2014, assuming that the DNELs for all four phthalates are equal to 6.7 µg/kg bw/day

		Mother						Child				
Country	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**
CH	117	0.2	0.1	0.0	0.1	0.3	119	0.3	0.1	0.0	0.1	0.5
CY	59	0.2	0.1	0.0	0.2	0.4	60	0.2	0.1	0.0	0.2	0.5
LU	58	0.2	0.1	0.0	0.1	0.3	60	0.2	0.1	0.0	0.1	0.5
SI	120	0.3	0.1	0.0	NA	0.4	120	0.4	0.1	0.0	NA	0.5
UK	21	0.2	0.1	0.0	0.1	0.3	21	0.4	0.1	0.0	0.1	0.6
DE	116	0.2	0.1	0.0	0.1	0.4	120	0.4	0.2	0.0	0.2	0.7
BE	125	0.2	0.1	0.0	0.2	0.5	125	0.3	0.1	0.0	0.2	0.7
PT	117	0.4	0.1	0.0	0.1	0.6	116	0.5	0.1	0.0	0.2	0.8
HU	115	0.3	0.1	0.0	NA	0.5	117	0.5	0.2	0.0	NA	0.8
DK	143	0.3	0.1	0.0	0.2	0.5	142	0.4	0.1	0.0	0.2	0.8
IE	120	0.3	0.1	0.0	0.1	0.5	120	0.5	0.1	0.0	0.2	0.8
SE	96	0.3	0.2	0.1	NA	0.6	97	0.5	0.3	0.1	NA	0.9
RO	117	0.5	0.1	0.0	0.1	0.8	119	0.7	0.1	0.0	0.2	1.0
CZ	117	0.4	0.2	0.0	0.0	0.7	120	0.7	0.4	0.0	0.0	1.1
SK	125	0.4	0.3	0.0	NA	0.6	127	0.7	0.4	0.0	NA	1.1
ES	118	0.5	0.1	0.0	0.2	0.8	119	0.7	0.2	0.1	0.2	1.2
PL	119	0.4	0.2	0.0	0.2	0.8	115	0.7	0.3	0.0	0.4	1.5

NA = not available; RCRs ≥1 marked in yellow

Table 21. RCRs for exposure to the four phthalates as estimated from 95th percentile urinary biomonitoring exposure levels from DEMOCOPHES data projected to 2014, assuming that the DNELs for all four phthalates are equal to 6.7 µg/kg bw/day

		Mother						Child				
Country	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**
UK	21	0.4	0.1	0.0	0.3	0.8	21	0.8	0.3	0.1	0.3	1.5
SI	120	0.9	0.4	0.1	*NA*	1.3	120	1.0	0.4	0.1	*NA*	1.5
LU	60	0.7	0.2	0.1	0.3	1.3	60	0.6	0.2	0.1	0.8	1.7
CH	117	0.9	0.2	0.1	0.2	1.4	119	1.1	0.3	0.1	0.3	1.8
CY	59	2.2	0.2	0.0	0.5	2.9	60	1.2	0.2	0.1	0.5	1.9
DE	116	0.6	0.3	0.1	0.3	1.2	120	1.1	0.5	0.1	0.4	2.1
DK	143	0.8	0.2	0.1	0.4	1.5	142	1.1	0.3	0.1	0.7	2.2
PT	117	1.7	0.2	0.1	0.3	2.3	116	1.3	0.3	0.1	0.5	2.2
IE	120	1.0	0.2	0.1	0.4	1.7	120	1.5	0.2	0.1	0.5	2.4
HU	115	1.3	0.4	0.1	NA	1.8	117	1.9	0.6	0.1	NA	2.6
SE	96	0.9	0.7	0.3	NA	1.8	97	1.7	0.9	0.4	NA	2.9
SK	125	1.1	0.7	0.1	NA	1.8	127	2.1	1.0	0.1	NA	3.2
BE	125	0.7	0.4	0.1	0.7	1.9	125	1.8	0.4	0.1	1.2	3.5
CZ	117	1.2	0.7	0.2	NA	2.0	120	2.1	1.2	0.2	NA	3.5
ES	118	1.3	0.3	0.1	0.4	2.1	119	1.8	0.8	0.2	1.0	3.8
PL	119	1.8	0.8	0.1	0.8	3.5	115	2.6	1.0	0.2	1.4	5.2
RO	117	5.1	0.2	0.0	0.4	5.8	119	4.4	0.5	0.1	0.7	5.7

NA = not available; RCRs ≥1 marked in yellow

B.1.3. Evidence if the risk management measures and operational conditions implemented and recommended by the manufacturers and/or importers are not sufficient to control the risk

B.1.3.1. Summary of proposal:

Workers

Of the four phthalates, only for DEHP there are applications for authorisation for its use in articles in the scope of the restriction proposal. Workers are exposed to DEHP during manufacturing of DEHP, the formulation of DEHP (compounds, dry-blends and plastisol formulations) and the production of articles (polymer processing by calendering, spread coating, extrusion, injection moulding). Workers are furthermore exposed to the substance during formulation of recycled soft PVC containing DEHP in compounds and dry-blends. During the service life stage of articles worker exposure may also occur (professional handling of PVC articles during installation of building materials and workers wearing PVC work clothes and footwear.

RAC confirmed that the risk assessment based on the limited exposure data in the applications for DEHP does not demonstrate adequate control of risks for workers from the use applied for. RAC's assessment based on these limited exposure data in the application showed a risk for the use applied for (ECHA 2014d,f).

General population

As mixtures containing the four phthalates are not allowed to be sold to the public, the main source of exposure of the general population to the four phthalates is from articles. As a consequence, the risk management measures and operational conditions that can be implemented and recommended by the manufacturers of DEHP are limited in scope. Manufacturers of DEHP have taken some measures to protect the general population by

excluding certain article groups from the scope of the applications for authorisation (e.g., erasers and sex toys were not covered). In most countries the RCR for 95th percentile exposure to DEHP is below 1. However, in Romania the RCR for the 95th percentile exposure of children to DEHP is close to 1 and in mothers equal to 1. Moreover, combined exposure to the four phthalates raises concern with RCRs for 95th percentile of exposure above 1. This implies that the existing risk management measures are insufficient and the exposure from indoor environment, food and contact with articles poses a risk.

Conclusion

The Dossier Submitter has concluded that the risk management measures and operational conditions implemented and recommended by the manufacturers and/or importers are not sufficient to control the risks from the four phthalates to workers and the general population.

B.1.3.2. RAC conclusion(s):

RAC concludes that the risk management measures and operational conditions implemented and recommended by the manufacturers and/or importers are not sufficient to control the risk.

B.1.3.3. Key elements underpinning the RAC conclusion(s):

RAC agrees with the Dossier Submitter's assessment.

B.1.4. Evidence if the existing regulatory risk management instruments are not sufficient

B.1.4.1. Summary of proposal:

The Dossier Submitter assessed that:

- DEHP, DBP and BBP are subject to restrictions in toys and childcare articles. DIBP is only restricted in toys.
- The use of DEHP, DBP and BBP in plastic for food contact materials is regulated under Regulation (EC) No 1935/2004 and specific measures thereunder (e.g. Commission Regulation (EU) 10/2011). The use of DIBP is not allowed in plastic for food contact materials. However, significant phthalate contamination has been found in food.
- DEHP, DBP, DIBP and BBP have all been identified as Substances of Very High Concern (SVHC), and all four are already included in REACH Annex XIV and thus subject to the authorisation process (with sunset date 21 February 2015). The authorisation process, however, does not cover placing on the market of articles containing the phthalates and therefore does not cover imported articles. Numerous articles therefore still contain the four phthalates. It is also noted that the authorisation process does not

take into account combined exposure from both individual articles and individual substances.

General population

The combined exposure to the four phthalates raises concern with RCRs for 95th percentile of exposure above 1. This implies that the existing risk management instruments are insufficient and the exposure from indoor environment, food and contact with articles poses a risk.

Workers

See section B.1.3.1 above. In addition to DEHP, workers are also exposed to DBP, BBP and DIBP during the service life stage of imported articles (professional handling of PVC articles during installation of building materials and workers wearing PVC work clothes and footwear).

Conclusion

The Dossier Submitter has concluded that the existing regulatory risk management instruments are not sufficient to manage the risks from the four phthalates.

B.1.4.2. RAC conclusion(s):

RAC concludes that the existing regulatory risk management instruments are not sufficient.

B.1.4.3. Key elements underpinning the RAC conclusion(s):

RAC agrees with the Dossier Submitter's assessment.

B.2. JUSTIFICATION IF ACTION IS REQUIRED ON A UNION WIDE BASIS

B.2.1. Summary of proposal:

The Dossier Submitter concludes that risks associated with EU manufactured or imported articles containing the four phthalates need to be addressed on a Union-wide basis for the following reasons:

i. Placing on the market and use of PVC articles under scope, as well as exposure takes place in all Member States.

ii. Due to the free circulation of goods within the European market, either of EU-manufactured or imported goods, there is a need for an EU-wide measure rather than an individual action by Member States.

iii. Furthermore, an EU wide measure will safeguard a level playing field in the EU market for goods and items containing the four phthalates either manufactured within the EU (currently requiring an authorisation) or imported.

B.2.2. SEAC and RAC conclusion(s):

Based on the key principles of ensuring a consistent level of protection across the Union and of maintaining the free movement of goods within the Union, SEAC and RAC support the view that any necessary action to address risks associated with the four phthalates should be implemented in all Member States.

B.2.3. Key elements underpinning the SEAC and RAC conclusion(s):

In view of the EU-wide risk identified for combined exposure to the four phthalates, RAC agrees with the Dossier Submitter's assessment.

B.3. JUSTIFICATION WHETHER THE SUGGESTED RESTRICTION IS THE MOST APPROPRIATE EU WIDE MEASURE

B.3.1. Scope including derogations

B.3.1.1. Summary of proposal:

In the Annex XV report, the Dossier Submitter proposes to restrict the placing on the market of the following articles containing the four phthalates in a concentration, individually or in combination, in excess of 0.1% w/w of the plasticised material:

a) any (indoor or outdoor) articles whose phthalate containing material may be mouthed or is in prolonged contact with human skin or any contact with mucous membranes, and

b) any phthalate containing articles that are used (including stored) in an indoor environment where people are present under normal and reasonably foreseeable conditions and potentially exposed via inhalation. This does not apply to articles that are used only in industrial or agricultural workplaces by workers.

Both paragraph a) and b) do not apply to:

- articles placed on the EU market for the first time prior to the date of entry into force plus three years of transitional period (entry into force is assumed to take place in 2017);

- articles covered under existing legislation on food contact materials (Regulation (EC) No 1935/2004 and Regulation (EU) No 10/2011); immediate packaging of medicinal products (Regulation (EC) No 726/2004, Directive 2001/82/EC or Directive 2001/83/EC); medical devices (Directive 90/385/EEC, Directive 93/42/EEC or Directive 98/79/EC); toys and childcare articles containing DEHP, DBP and BBP (existing restriction entry 51 in Annex XVII of REACH);

- measuring devices for laboratory use.

Prior to formulating the restriction measure, the Dossier Submitter evaluated the possibility to address the risks to human health and the environment from the four phthalates under other REACH regulatory measures, existing EU legislation and other possible Union-wide risk management measures. However, these were deemed inappropriate to address all article categories contributing to the risk. The possibility to impose a restriction under REACH was investigated further and seven restriction options were considered.

Revised restriction wording

Following the submission of the dossier, the following changes to the proposed restriction wording were made as a result of the Forum advice on the enforceability of the Annex XV proposal for restriction on four phthalates (adopted on 21.09.2016) and public consultation comments:

Electric and electronic equipment (EEE) under RoHS

The scope of the proposed restriction originally included wires & cables as these articles can cause dermal exposure or release phthalates to indoor air and thus, contribute to cumulative exposure and risk of the four phthalates. However, the relevant Commission services (DG GROW and DG ENV) requested following the submission of the dossier that the ECHA's Committees (RAC and SEAC), when adopting their opinions, exclude electric and electronic equipment (EEE), as defined in Article 3(1) of RoHS, from the scope of the proposal to restrict these four phthalates under REACH. As the changes to RoHS enter into effect in mid-2019, the Dossier Submitter incorporated the consequent phasing-out of the use of the four phthalates in wires & cables under the baseline scenarios. Therefore, the presented analysis of the effectiveness of the proposed restriction is not affected by the exclusion of wires & cables from the scope of the restriction. The proposed restriction wording was amended to introduce a derogation on EEE falling under RoHS.

DIBP in entry 51

The scope of the originally proposed restriction already restricted DIBP in toys and childcare articles in a concentration greater than 0.1% w/w. This is because from a hazard and risk perspective there is no reason to treat DIBP differently from DEHP, DBP and BBP, which already have such a restriction (entry 51 of Annex XVII of REACH). Furthermore, although DIBP is at the moment restricted under the Toys Safety Directive, the concentration limit set for DIBP in this Directive is higher than 0.1%, and there are notable differences in the scope of entry 51 and the Toys Safety Directive (e.g., childcare articles are not covered by the Toys Safety Directive). The Forum advice indicated that the most practical way of introducing the proposed restriction on DIBP is to revise the existing entry 51 of REACH to include DIBP. The revised restriction wording follows the Forum recommendation and proposes explicitly to amend entry 51 to include DIBP in the scope of that entry.

As a result of the Forum advice, the Dossier Submitter further made the following changes to the wording of the proposed restriction to improve its clarity and enforceability:

- clarifications to ensure that parts of articles are also included in the scope of the proposed restriction;
- introduction of more detailed definitions for agricultural and industrial workplaces, prolonged contact with skin, as well as for indoor/outdoor environment;

- clarifications to assist with the interpretation whether articles with dual use fall in the scope of the restriction;

- editorial changes to improve clarity, e.g., paragraphs were numbered and all definitions were gathered in one paragraph that applies to the whole restriction entry;

- rewording to define the restriction in terms of what is restricted (version B as presented in section 2.2.1 of the Background Document) rather than in terms of a total ban with derogations for the articles outside the scope (as presented in the original proposal).

Derogations

During the public consultation, requests for additional derogations were received. These requests were assessed as follows by the Dossier Submitter:

1. Components for derogated medical devices

As the intention of the proposed restriction is to still allow medical devices subject to Directive 90/385/EEC, Directive 93/42/EEC or Directive 98/79/EC, components required for such medical devices also need to be allowed. The requested derogation is specifically directed at imported components, as these would have been affected by the originally proposed restriction. The request is considered justified by the Dossier Submitter and the derogation (for imported and EU manufactured components used in exempted medical devices) has been included in the revised restriction proposal.

2. Aerospace articles used in the interior of aircrafts

The rationale for the request is that development and implementation of alternatives in the aerospace industry is a lengthy process (2-7 years), which necessitates the demonstration of equivalent performance of aerospace articles to airworthiness authorities. The Dossier Submitter evaluated the information provided. There are no known uses for which there are no alternatives for the four phthalates and additional consultation with aviation industry representatives did not reveal specific cases for which recertification may be required. Therefore, the Dossier Submitter concluded there is insufficient information to justify a derogation at this stage.

3. Materials that are hidden within, or below, assemblies in vehicles (automotive) that are currently in the engineering pipeline

The rationale for the request is that more time would be required (typically 4-5 years) to allow suitable testing and validation of alternatives. Although industry has provided information that they have transitioned to alternatives and very few article types still contain the four phthalates, sufficient information (e.g., volume of phthalates used, number of vehicles impacted, definition of “hidden” articles, etc.) for an assessment of such a derogation was not provided. Therefore, the Dossier Submitter concluded that such a derogation cannot be justified at this stage.

4. Spare parts (legacy spare parts, service and remanufactured parts), for vehicles (automotive and aircraft in particular) placed on the market prior to the entry into effect of the proposed restriction

The intent of the restriction is to allow for the maintenance and repair of vehicles[15] placed on the market prior to the entry into effect of the proposed restriction. Considering risk reduction and costs, on balance, the requested derogation for the placing on the market of spare parts for vehicles is considered justified by the Dossier Submitter.

5. Wellingtons and boots made from recycled PVC

The Dossier Submitter evaluated the need for a derogation on boots and wellingtons (for which no direct skin contact is claimed due to the presence of a lining inside the boots, and only negligible emission to indoor air) at the time of the dossier preparation, on the basis of information resubmitted during the public consultation. The information helped establish that the DEHP containing recyclate is used mainly in industrial and agricultural applications (outside scope of the restriction proposal) and very few tonnages in boots and wellingtons manufacturing. While this information assisted with the justification of the derogations on industrial and agricultural applications, it was concluded that a derogation on boots and wellingtons will be problematic as it will be difficult to differentiate between those produced from virgin and those from recycled material. As very few tonnes of recyclate are used in the manufacture of boots and wellingtons, there are a number of strategies that can be taken by these manufacturers to minimise the impacts of the proposed restriction, e.g., temporarily export to markets without similar restrictions, source DEHP-free recyclate or virgin material, manufacture articles outside the scope of the proposed restriction, etc. The costs and benefits of a mixture of these strategies was taken into account in the estimation of the overall costs and benefits of the proposed restriction[16]. As shown in the Background Document, the proposed restriction, excluding a derogation on boots and wellingtons, is effective, practical and monitorable. The Dossier Submitter therefore concluded that the transitional period gives sufficient time to manufacturers of boots and wellingtons to comply with the proposed restriction, and considered the derogation not justified.

B.3.1.2. RAC conclusion(s):

RAC agrees with the Dossier Submitter that the proposed restriction is the most appropriate EU wide measure, and that the proposed scope is consistent with the aims to restrict the placing on the market of only those articles that present risks to human health via the critical routes of exposure. The changes to the text of the original restriction wording following the Commission request and the advice of Forum are supported and presented in the table in Summary section A.1. RAC supports all derogations proposed, except for the one on spare parts.

B.3.1.3. Key elements underpinning the RAC conclusion(s):

Derogations

[15] Vehicles are wagons, bicycles, motor vehicles (motorcycles, cars, trucks, buses), railed vehicles (trains, trams), watercraft (ships, boats), aircraft and spacecraft.
[16] For example, if the boots and wellingtons are produced from a virgin material instead of recyclate, the Dossier Submitter estimated an increase in their raw material costs will be about 1-2% of their sales price.

RAC agrees with the derogations originally proposed and the one on EEE under RoHS added following the Commission request since they mostly clarify the interface between the proposed restriction and sectoral regulations that already cover some articles under the general scope. RAC also agrees with the exclusion of second-hand articles from the scope, for ensuring the practicality and proportionality of the proposed restriction.

As to the additional requests for derogations received during the public consultation, RAC supports the conclusion by the Dossier Submitter for components for derogated medical devices (derogation). Similarly, RAC supports the conclusion not to derogate aerospace articles used in the interior of aircrafts, for the reasons given by the Dossier Submitter. If a derogation were to be given for these aerospace articles, RAC notes that such derogation would decrease the risk reduction capacity of the proposed restriction. But presumably the decrease will be minimal, given the limited time spent by children and pregnant women in airplanes and the diminishing number of articles still containing the four phthalates due to the ongoing substitution in the aerospace industry.

The conclusion for 'no derogation' for wellingtons and boots is supported, although it is acknowledged that the requested derogation as such might have a limited effect on the risk reduction capacity as a result of the limited volumes involved and the likelihood of limited exposure (none claimed via skin, due to the presence of a lining inside the boots, and negligible via inhalation). Whereas this might be true for these individual articles (and possibly for other individual article types as well), RAC notes the restriction is aimed at limiting the overall risk from combined exposure (i.e., from the sum of individual articles). Furthermore, RAC has no information regarding the effectiveness of the lining in preventing direct skin exposure. Aside from the derogation concluded to be difficult to enforce and the proposed restriction (excluding a derogation on boots and wellingtons) concluded to be effective, practical and monitorable, also from a risk assessment perspective the requested derogation is not considered justified.

Requested derogation for materials that are hidden within, or below, assemblies in vehicles (automotive) that are currently in the engineering pipeline (and thus not on the market yet): When looking at information from the automotive industry on which typical parts may contain these four phthalates (wiring harnesses, hoses, rubbers, seals and tapes) and where these parts are mostly contained (within, or hidden behind, larger assemblies such as carpets, seats, doors, headliners and instrument panels), RAC is not convinced there will hardly be emission to indoor air, in particular in the vehicle interior where carpets, seats etc. can be found and people are present. Without a proper definition for what is to be regarded as "hidden within, or below", RAC considers these kind of articles to be included in the scope, with the exception of EEE that would normally be covered by RoHS, as automotives are legislated under the End of Life Vehicle (ELV) Directive. From a risk assessment perspective the requested derogation is however not considered justified by RAC, in the absence of information on the degree of inhalation exposure and the contribution to the risk. RAC further noted that the automotive industry indicated they can transition to alternatives within the foreseen transition period.

The final request for a derogation relates to spare parts, for vehicles (automotive and aircraft in particular) placed on the market prior to the entry into effect of the proposed restriction. This request was considered justified by the Dossier Submitter, as the intent of the restriction is to allow for the maintenance and repair of vehicles. RAC however notes that the justification provided for this derogation is solely based on technical and economic arguments. No data

were provided on the tonnages of phthalates involved. RAC suspects though that spare parts (legacy spare parts, service and remanufactured parts) potentially concerns large amounts of parts/articles and thus, potentially a high volume of the four phthalates, given the (broad) definition of vehicles in footnote 13, the vast number of vehicles currently in use, and the long useful lifetime of these vehicles. Moreover, phthalates have been important and are widely used plasticisers in many articles/parts of vehicles, although industry indicates the use of phthalates is declining as they shift to alternatives. The request for this derogation also did not contain information on the degree of exposure resulting from either prolonged skin contact or inhalation, so the contribution to the risk is not known. The impact this derogation would have on the risk reduction potential of the proposed restriction therefore cannot be assessed. RAC concludes that from a risk assessment perspective the requested derogation is not justified.

Other Risk Management Options

The Dossier Submitter analysed other legislative and non-legislative measures than the proposed restriction that could be implemented in order to achieve the aims of the proposed restriction. These include other REACH processes (the authorisation process, REACH Article 68(2)), other EU legislation (Water Framework Directive, Industrial Emissions Directive, Waste legislation, sector specific legislation, General Product Safety Directive), taxation, labelling instruments, and voluntary measures. None of these alternative measures were considered realistic, effective or balanced means to solve the problem, and were deemed inappropriate to address all the article categories that give rise to risks to human health. RAC agrees with the Dossier Submitter's assessment as described in section D.1.3 of the Background Document.

In addition to the proposed restriction and the above RMOs, five other restriction measures were considered by the Dossier Submitter (see below) and discarded on the grounds that they would not be as effective, practical or monitorable as the proposed restriction. RAC agrees with the Dossier Submitter's assessment as described in section D.1.2 of the Background Document, in particular because of the following:

1. Restricting all articles containing the four phthalates

RAC's view is that it is not proportionate to restrict articles where under normal and reasonably foreseeable conditions they hardly, if any, contribute to the exposure/risk of the general population, in particular of children (e.g. articles only for use in industrial or agricultural workplaces, or articles only present in building frames or in (between) walls).

2. Restricting not only the placing on the market, but also the production of all articles containing the four phthalates

Further to point 1, RAC's view is that this restriction option would also make future applications for authorisation impossible.

3. Restricting only DEHP, DBP and DIBP (not BBP)

BBP has the same mode of action and appears of comparable potency to DEHP, DBP and DIBP, and can be used as substitute in several applications.

4. An additional derogation for DIBP in toys and childcare articles

The hazard profile of DIBP is similar to DEHP, DBP and BBP, and toys and childcare articles (not all of which are covered in the Toys Safety Directive) can contribute considerably to the exposure, and thus risks, of infants to DIBP.

5. No derogation for food contact materials (FCMs)

RAC notes the important contribution of food consumption to exposure to the four phthalates. From that perspective, including the FCM use of the phthalates in the scope of the proposed restriction could make sense. On the other hand, it is not clear what is the contribution of FCMs to the exposure via food, relative to other sources. Furthermore, the FCM use of the four phthalates is already regulated via the (sector-specific) FCM regulation, and additionally regulating it under REACH might result in unclarity for actors in the food supply chain. Hence, RAC agrees with the Dossier Submitter that the sector-specific legislation would lead to a more efficient use of regulatory resources and to improved clarity. However, RAC also acknowledges that the FCM regulation does not consider the overall phthalate burden from repeated contact with FCMs or combined effects from other sources of exposure. Therefore, in addition to the proposed restriction, RAC would encourage the relevant authorities in the EU to take the necessary measures to reduce the risks relating to the four phthalates from food consumption.

During the public consultation actors from the EU plasticiser industry asked to consider another restriction option, i.e. restricting non-authorised uses only, to create a level playing field for EU manufacturers of articles made with DEHP compared to non-EU manufacturers of articles made with DEHP. However, the commenters did not provide a fully assessed restriction option. The Dossier Submitter discarded this restriction option as this option would include FCMs (cf. restriction option 5 above) and articles contributing hardly, if any, to the exposure/risk (cf. restriction option 1 above). Moreover, the current restriction proposal respects the recommended/granted review period for the authorised uses of DEHP in articles within the scope (until 2019). RAC supports the Dossier Submitter's response, given also that the intention of the restriction proposal is to address the health risks from the use of all four phthalates in all articles presenting exposure via critical routes under normal and reasonably foreseeable conditions.

Conclusion

Based on the above, RAC agrees with the Dossier Submitter that the proposed restriction is the most appropriate EU wide measure, and that the proposed scope is consistent with the aims to restrict the placing on the market of only those articles that present risks to human health via the critical routes of exposure. As from a risk perspective there is no reason to treat DIBP in toys and childcare articles differently from the other three phthalates, RAC supports Forum's proposal to introduce a restriction on DIBP in toys and childcare articles via an amendment of entry 51 of Annex XVII.

B.3.1.4. SEAC conclusion(s):

See the opinion of SEAC.

B.3.1.5. Key elements underpinning the SEAC conclusion(s):

See the opinion of SEAC.

B.3.2. Effectiveness in reducing the identified risks

B.3.2.1. Summary of proposal:

The Dossier Submitter proposes a restriction targeted at those articles that present risks to human health, i.e., those that lead to exposure from direct contact (mouthing and contact with the skin or mucous membrane) and exposure via the indoor environment (inhalation and ingestion).

The proposed restriction eliminates the possibility to replace the phthalates in the current restriction entry 51 with an equally hazardous substance: DIBP.

The Dossier Submitter concludes that the proposed restriction is capable of significantly reducing the risks to human health of combined exposure (RCRs are expected to be reduced to levels equal to or below 1 at the 95th percentile) within a reasonable period of time, starting from 2020, although some delay is caused by the service-life of articles in use. Considering the important contribution of food consumption to exposure to the four phthalates, in addition to the proposed restriction, the Dossier Submitter calls on the relevant authorities in the EU to take the necessary measures to reduce the risks relating to the four phthalates from food consumption. Any associated risks for the environment from the articles in scope would also be reduced as a result of the proposed restriction. The proposed restriction may furthermore reduce occupational risks due to substitution of DEHP in the production of articles in the EU.

If it is concluded that no threshold exists for the endocrine properties of the four phthalates, there would be a remaining risk following the entry into force of the proposed restriction. In this case, the restriction would contribute to reducing the exposure and thus the remaining risk.

The Dossier Submitter concludes that suitable and technically feasible alternative plasticisers with more benign human health and environmental hazard and risk profile are available for all uses in articles in the scope of the proposed restriction. These alternatives will therefore lead to overall risk reduction for workers and the general population in comparison to continued use of the four phthalates.

B.3.2.2. RAC conclusion(s):

RAC is of the opinion that the proposed restriction on the four phthalates in indoor articles and in outdoor articles (if in contact with human skin or mucous membranes) is effective in reducing the health risks identified from use of these articles. Any associated risks for the environment from the articles in scope (e.g. due to emissions to wastewater and possibly drinking water) would also be reduced as a result of the proposed restriction.

RAC shares the conclusion of the Dossier Submitter that the available alternatives are generally of lower risk, and therefore will result in an overall risk reduction. RAC however

notes that one of the main alternatives (DINP) can lead to similar human health impacts albeit at higher exposure levels.

B.3.2.3. Key elements underpinning the RAC conclusion(s):

In showing the effectiveness of the proposed restriction in reducing the risk, the Dossier Submitter used the baseline projections (see Table 3) to project the risk in 2020 and 2039, both in the presence and absence of a restriction, based on the 2011/2012 DEMOCOPHES data and the assumption that 25% of DEHP exposure and 75% of DBP, DIBP and BBP exposure result from article exposure. It is recognized that there are inherent uncertainties in the estimations of the future volumes, and that there is no one-to-one relation between volume/tonnages and exposure. Yet, the pragmatic approach shows (see Tables 22-24) that the proposed restriction in most, if not all, cases will reduce the RCR to below one, indicative for the effectiveness of the measure.

Table 22. RCRs for four phthalates as estimated from 95th percentile urinary biomonitoring values projected to 2020 in the main baseline scenario (no restriction)

		Mother						Child				
Country	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**
SI	120	0.2	0.2	0.0	*NA*	0.4	120	0.2	0.2	0.0	*NA*	0.4
UK	21	0.1	0.1	0.0	0.1	0.3	21	0.1	0.1	0.0	0.1	0.4
CH	117	0.2	0.1	0.0	0.1	0.4	119	0.2	0.1	0.0	0.1	0.5
CY	59	0.4	0.1	0.0	0.2	0.7	60	0.2	0.1	0.0	0.2	0.6
LU	60	0.1	0.1	0.0	0.1	0.4	60	0.1	0.1	0.0	0.4	0.6
PT	117	0.3	0.1	0.0	0.2	0.6	116	0.2	0.2	0.0	0.2	0.6
IE	120	0.2	0.1	0.0	0.2	0.5	120	0.3	0.1	0.0	0.2	0.7
DE	116	0.1	0.2	0.0	0.1	0.4	120	0.2	0.3	0.0	0.2	0.7
DK	143	0.1	0.1	0.0	0.2	0.4	142	0.2	0.2	0.0	0.3	0.7
HU	115	0.2	0.2	0.0	NA	0.5	117	0.4	0.3	0.0	NA	0.7
SE	96	0.2	0.4	0.0	NA	0.5	97	0.3	0.5	0.0	NA	0.8
SK	125	0.2	0.4	0.0	NA	0.6	127	0.4	0.6	0.0	NA	1.0
CZ	117	0.2	0.4	0.0	NA	0.6	120	0.4	0.7	0.0	NA	1.1
BE	125	0.1	0.2	0.0	0.3	0.6	125	0.3	0.2	0.0	0.5	1.1
ES	118	0.2	0.2	0.0	0.2	0.6	119	0.3	0.5	0.0	0.4	1.2
RO	117	1.0	0.1	0.0	0.2	1.3	119	0.8	0.3	0.0	0.3	1.4
PL	119	0.3	0.4	0.0	0.4	1.1	115	0.5	0.6	0.0	0.6	1.7

NA = not available; RCRs ≥1 marked in yellow

Table 23. RCRs for four phthalates as estimated from 95th percentile urinary biomonitoring values projected to 2039 in the main baseline scenario (no restriction)

		Mother						Child				
Country	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**
SI	120	0.2	0.2	0.0	*NA*	0.4	120	0.2	0.2	0.0	*NA*	0.4
UK	21	0.1	0.1	0.0	0.1	0.3	21	0.2	0.2	0.0	0.2	0.5
CH	117	0.2	0.2	0.0	0.1	0.4	119	0.2	0.2	0.0	0.1	0.5
CY	59	0.4	0.1	0.0	0.2	0.8	60	0.2	0.1	0.0	0.2	0.6
LU	60	0.1	0.1	0.0	0.2	0.4	60	0.1	0.1	0.0	0.4	0.7
PT	117	0.3	0.1	0.0	0.2	0.6	116	0.3	0.2	0.0	0.2	0.7
IE	120	0.2	0.1	0.0	0.2	0.5	120	0.3	0.1	0.0	0.3	0.7
DE	116	0.1	0.2	0.0	0.1	0.4	120	0.2	0.3	0.0	0.2	0.7
DK	143	0.2	0.1	0.0	0.2	0.5	142	0.2	0.2	0.0	0.3	0.7
HU	115	0.2	0.3	0.0	NA	0.5	117	0.4	0.4	0.0	NA	0.8
SE	96	0.2	0.4	0.0	NA	0.6	97	0.3	0.5	0.0	NA	0.9
SK	125	0.2	0.4	0.0	NA	0.7	127	0.4	0.6	0.0	NA	1.0
CZ	117	0.2	0.4	0.0	NA	0.7	120	0.4	0.7	0.0	NA	1.2
BE	125	0.1	0.2	0.0	0.3	0.7	125	0.3	0.2	0.0	0.6	1.2
ES	118	0.2	0.2	0.0	0.2	0.6	119	0.3	0.5	0.0	0.5	1.3
RO	117	1.0	0.1	0.0	0.2	1.3	119	0.9	0.3	0.0	0.3	1.5
PL	119	0.4	0.5	0.0	0.4	1.2	115	0.5	0.6	0.0	0.7	1.8

NA = not available; RCRs ≥1 marked in yellow

Table 24. RCRs for four phthalates as estimated from 95th percentile urinary biomonitoring values in case of a restriction (2020 and onwards)

		Mother						Child				
Country	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**	**N**	**DEHP**	**DBP**	**BBP**	**DIBP**	**SUM**
SI	120	0.1	0.1	0.0	*NA*	0.2	120	0.2	0.1	0.0	*NA*	0.3
UK	21	0.1	0.0	0.0	0.1	0.2	21	0.1	0.1	0.0	0.1	0.3
CH	117	0.1	0.1	0.0	0.0	0.2	119	0.2	0.1	0.0	0.1	0.3
LU	60	0.1	0.1	0.0	0.1	0.2	60	0.1	0.1	0.0	0.2	0.3
CY	59	0.3	0.0	0.0	0.1	0.5	60	0.2	0.1	0.0	0.1	0.3
PT	117	0.3	0.1	0.0	0.1	0.4	116	0.2	0.1	0.0	0.1	0.4
DE	116	0.1	0.1	0.0	0.1	0.2	120	0.2	0.1	0.0	0.1	0.4
DK	143	0.1	0.0	0.0	0.1	0.3	142	0.2	0.1	0.0	0.1	0.4
IE	120	0.1	0.1	0.0	0.1	0.3	120	0.2	0.1	0.0	0.1	0.4
HU	115	0.2	0.1	0.0	NA	0.3	117	0.3	0.2	0.0	NA	0.5
SE	96	0.1	0.2	0.0	NA	0.3	97	0.2	0.2	0.0	NA	0.5
SK	125	0.2	0.2	0.0	NA	0.4	127	0.3	0.3	0.0	NA	0.6
BE	125	0.1	0.1	0.0	0.2	0.4	125	0.3	0.1	0.0	0.3	0.6
CZ	117	0.2	0.2	0.0	NA	0.4	120	0.3	0.3	0.0	NA	0.6
ES	118	0.2	0.1	0.0	0.1	0.4	119	0.3	0.2	0.0	0.2	0.7
RO	117	0.8	0.1	0.0	0.1	0.9	119	0.7	0.1	0.0	0.2	1.0
PL	119	0.3	0.2	0.0	0.2	0.7	115	0.4	0.3	0.0	0.3	1.0

NA = not available; RCRs ≥1 marked in yellow

In a sensitivity analysis, the Dossier Submitter tested two extreme case baseline scenarios (High tonnage and Low tonnage) for their impact on the risk reduction capacity, as compared to the baseline scenario (Main). It appears that the projected risks are not very sensitive to the baseline assumptions: the High tonnage scenario leads to 2% and 12% higher RCRs compared with the Main scenario in 2020 and 2039 respectively, the Low tonnage scenario to 2% and 10% lower RCRs, respectively (see Annex E.1 of the Appendix to the Background Document).

Due to the placing of the four phthalates on Annex XIV, the manufacture/use of these phthalates in articles, and the export, will be strongly reduced as only for DEHP there are applications for authorisation for its use in articles in the scope of the restriction proposal. In addition, under the RoHS Directive the use of the four phthalates in wires & cables will be phased out by 2019. By taking away these sources of exposure, the exposure to phthalates will (after a certain while, given some delay caused by the service-life of the articles in use) decrease considerably. It is noted however that the authorisation process does not apply to the import of articles containing phthalates. Over the last few years there has already been a substantial increase in the import of phthalate-containing articles (by approximately 23 000 tonnes between 2011 and 2014), that for a great deal compensates the decrease in manufacture/use and export (approximately 30 000 tonnes over the same period). In the future, import is anticipated to continue to increase, from countries where the EU regulations do not apply and where no regulatory actions for phthalates are currently announced (e.g. China). Hence, exposure to the four phthalates will continue, and the risk that has been identified for the current situation will largely remain in the future if no further action is taken. Given that articles are an important contributor to the exposure and identified risks, whether from direct contact or via indoor environment, a restriction on the import of articles will take away an important source of exposure for all four phthalates. RAC therefore agrees with the Dossier Submitter that the proposed restriction will be effective in reducing the risk. RAC also agrees with the Dossier Submitter that measures to reduce the risks from phthalates in food (although also indirectly affected by the proposed restriction as it will decrease environmental releases, also to drinking water) deserve further attention, but this is outside the scope of the current restriction proposal.

Risk reduction capacity of alternatives

As reviewed in the previous restriction dossier/RAC opinion on the four phthalates[2] and applications for authorisation for DEHP and DBP submitted to ECHA in 2013 (AfA 2013a,b,c), and shortly summarised in the Background Document, the alternatives will lead to an overall risk reduction for workers and the general population in comparison to the continued use of the four phthalates:

- In general, the alternatives have more a benign human health hazard profile in comparison to the four phthalates, thus, replacement with these alternatives would be beneficial with regards to risks to human health, e.g., ASE, ATBC, DEGD, DGD, DEHT.

- None of the alternative substances have harmonised classification, or meet the criteria for PBP or vPvB, or are identified as SVHC, or are included in Annex XIV.

- With the exception of DINP, none of the presented alternatives exhibit anti-androgenic effects. DINP has the same anti-androgenic mode of action but is significantly less

potent than DEHP, DBP and DIBP when comparing DNELs for reproductive toxicity[17] and in reducing foetal testosterone production[18]. A proposal to classify DINP as Repr. 1B has been submitted to ECHA.

- DNELs for repeated dose toxicity with DINP and DIDP are higher than the DNELs for reproductive toxicity for the four phthalates and ECHA (2013d) concluded that no risks are to be expected from exposure to DINP and DIDP given the existing restriction on toys and childcare articles.

- The applicants for DEHP (AFA 2013a,c) concluded that the alternatives have similar environmental effect profiles and comparable PNECs. Thus, none of the alternatives would appear to introduce an environmental concern following substitution.

- As with any assessment of alternatives, there are some uncertainties regarding the extent to which risks will be reduced following substitution. Some of the alternatives are not REACH registered (hence the body of evidence is limited), some have already raised concerns among the regulators and therefore, may be subject to Substance Evaluation following their listing on the Community Rolling Action Plan (CoRAP). Furthermore, some of the alternatives are subject to restrictions (DINP and DIDP) on their uses impacting vulnerable groups (i.e., in toys and childcare articles) and for others CLP notifications have been provided to ECHA (self-classification by manufacturers, importers and downstream users).

B.3.3. Socio-economic impact

B.3.3.1. Costs

See the opinion of SEAC.

B.3.3.2. Benefits

See the opinion of SEAC.

B.3.3.3. Other impacts

See the opinion of SEAC.

B.3.3.4. Overall proportionality

B.3.3.4.1. Summary of proposal:

The Dossier Submitter concluded that:

[17] The oral DNELs for reproductive toxicity are: 250 µg/kg bw/day for DINP (ECHA 2013d); 34 µg/kg bw/day for DEHP; 6.7 µg/kg bw/day for DBP; 8.3 µg/kg bw/day for DIBP; and 500 µg/kg bw/day for BBP.

[18] DINP is approximately 2.3-fold less potent in reducing foetal testicular testosterone production than DEHP and DIBP (Hannas et al., 2011)

- the proposed restriction is estimated to break-even by preventing a small number of negative human health impacts, for example 2 110 cases of male infertility plus 250 cases per year of cryptorchidism (or 420 cases of hypospadias). These avoided cases would represent less than 0.1% of the average annual male births projected in the EU28;

- the proposed restriction is estimated to cost €130 per tonne of the four phthalates replaced. This is nearly 20 times more cost-effective than the restrictions on phthalates in toys and childcare articles adopted earlier;

- the costs to transition to the alternatives are anticipated to be affordable for the majority of the impacted stakeholders: the proposed restriction is estimated to increase the price per tonne of imported articles in scope by about 2%.

B.3.3.4.2. SEAC conclusion(s):

See the opinion of SEAC.

B.3.3.4.3. Key elements underpinning the SEAC conclusion(s):

See the opinion of SEAC.

B.3.3.5. Uncertainties in the proportionality section

See the opinion of SEAC.

B.3.4. Practicality, incl. enforceability

B.3.4.1. Summary of proposal:

The Dossier Submitter concludes on the practicality of the proposed restriction on the basis of its implementability, enforceability and manageability. The Dossier Submitter concludes the following regarding the three criteria:

B.3.4.1.1. Implementability

- There is a high degree of familiarity in the supply chains regarding many of the articles that may contain the four phthalates. Information is available to downstream users and consumers via provisions in REACH (e.g., Article 7).

- Technically feasible alternatives with lower risk are currently available at similar prices for all uses in the scope of this proposal.

- The proposed restriction gives sufficient time to the impacted supply chains to transition to alternatives.

B.3.4.1.2. Enforceability

- Enforcement authorities can set up efficient supervision mechanisms to monitor industry's compliance with the proposed restriction. Testing and sampling methods exist and both industry and enforcement authorities have experience applying them.

- The restriction clearly defines which articles are in its scope.

B.3.4.1.3. Manageability

Given the availability of information regarding which articles may contain the four phthalates and stakeholder experience with regulatory action on phthalates, the level of administrative burden for the actors concerned to implement the restriction is anticipated to be low.

B.3.4.2. RAC and SEAC conclusion(s):

RAC considers the proposed restriction to be implementable, enforceable and manageable.

B.3.4.3. Key elements underpinning the RAC and SEAC conclusion(s):

The proposed restriction is a practical and monitorable measure for industry and enforcement authorities. It builds on the existing industry compliance and Member State enforcement practices on phthalates in articles. It is implementable, enforceable and manageable. RAC further notes that the final restriction proposal (see table in Summary section A.1) addresses all comments made by Forum to further improve the enforceability of the restriction. This includes addition of "under normal and reasonably foreseeable conditions of use" to the definition of prolonged contact with human skin, as Forum considered this might help to assess compliance with requirements, although determining duration of contact is still seen as quite challenging. However, if no contact duration were specified (merely stating, e.g., 'potential for skin contact'), the scope would include articles that hardly, if at all, contribute to the risk following short, intermittent dermal exposure. Such a definition of the scope would be in conflict with the intention of the restriction. RAC therefore sees the need to specify contact duration in the wording of the restriction, and considers the Dossier Submitter's proposals reasonable and in line with the exposure modelling assumptions.

B.3.5. Monitorability

B.3.5.1. Summary of proposal:

The Dossier Submitter highlights that for imported articles the compliance control can be accomplished by border authorities and notifications of any violation of the restriction can be reported in the RAPEX system. For EU produced articles, the notification system for downstream users under Article 66 under Title VII – Authorisation of the REACH Regulation can also assist with monitoring the effectiveness and implementation of the proposed restriction. This monitoring can be done by ECHA and national enforcement authorities.

Furthermore, it is possible to monitor the result of the implementation and the effectiveness of the proposed restriction via biomonitoring studies similar to the COPHES and DEMOCOPHES projects.

B.3.5.2. RAC and SEAC conclusion(s):

RAC considers the proposed restriction to be monitorable.

B.3.5.3. Key elements underpinning the RAC and SEAC conclusion(s):

RAC agrees with the Dossier Submitter's assessment.

B.4. UNCERTAINTIES IN THE EVALUATION OF RAC AND SEAC

RAC

B.4.1. RAC conclusion(s):

Although several sources of uncertainty have been identified in both the estimated risk and estimated effectiveness, overall, the proposed restriction is considered a balanced and justified measure.

B.4.2. Key elements underpinning the RAC conclusion(s):

The main sources of uncertainty in the risk are presented in Table 19. Taken together, the uncertainties point to an underestimation rather than an overestimation of the risk, mostly because of the uncertainties around the DNELs used in the risk characterisation: there is evidence for effects other than reproductive toxicity as well, with indications that these could occur at lower doses. That would potentially mean lower DNELs (and thus higher RCRs) for the four phthalates, but also an increased population at risk, as these other effects would affect also girls and men. Another source of uncertainty is the absence of sufficient biomonitoring data for very small children, whereas from limited data available it appears that the younger the children, the higher the exposure to the four phthalates. Working with the RCRs for 6-11 year old children from the DEMOCOPHES study may therefore underestimate the risk for infants, an age group for which articles form the main exposure source to the four phthalates.

One source of uncertainty in demonstrating the effectiveness of the proposed restriction lies in the predictions of the future market volumes of the four phthalates. These are inherently uncertain, plus there is no simple one-to-one relation between the volume of the four phthalates in articles placed on the market and exposure. The sensitivity analysis performed by the Dossier Submitter has however shown that the risk reduction capacity of the proposed restriction is not very sensitive to the baseline assumptions.

Another source of uncertainty is how the contribution of food to the overall exposure to the four phthalates affects the risk reduction capacity of the proposed restriction. The Dossier Submitter assumed the exposure via food will not be affected by the declining baseline, and

that FCMs are the principle source of food contamination. Given that for DEHP the major part of the exposure comes from food intake, the assumptions made lead to a lower impact of the baseline projections for DEHP as compared to the other three phthalates. However, the assumption that FCMs are the principle source of food contamination for DEHP may be rather worst case, as the environmental releases (a.o. from articles within the scope) or from other sources (e.g., agricultural machinery and equipment) will certainly also contribute. Given that these environmental releases will decline (over time) with the proposed restriction, the exposure via food will be affected by the declining baseline. The effectiveness thus may well be underestimated.

SEAC

B.4.3. SEAC conclusion(s):

See the opinion of SEAC.

B.4.4. Key elements underpinning the SEAC conclusion(s):

See the opinion of SEAC.

B.5. ADDITIONAL REFERENCES

Dallongeville A, Costet N, Zmirou-Navier D, Le Bot B, Chevrier C, Deguen S, Annesi-Maesano I and Blanchard O (2016). Volatile and semi-volatile organic compounds of respiratory health relevance in French dwellings. *Indoor Air* **26**: 426-438.

Luongo G and Östman C (2016). Organophosphate and phthalate esters in settled dust from apartment buildings in Stockholm. *Indoor Air* **26**: 414-425.