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Comments from Academics, Scientists and Clinicians on the TSCA Review of Persistent, Bioaccumulative and Toxic (PBT) Chemicals

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These comments are submitted on behalf of the undersigned academics, scientists, and clinicians. We declare collectively that we have no direct or indirect financial or fiduciary interest in any chemical or product that is the subject of these comments. The co-signers' institutional affiliations are included for identification purposes only and do not imply institutional endorsement or support.

We appreciate the opportunity to provide written comments on EPA's review of PBT chemicals pursuant to the Toxic Substances Control Act (TSCA), as amended by the Frank R. Lautenberg Chemical Safety for the 21st Century Act. In the amended TSCA, Congress recognized the scientific consensus that PBT chemicals pose global health and environmental threats[1] and directed EPA to take expedited action, without a risk evaluation, on PBT chemicals.[2] In TSCA section 6(h), EPA is required to identify PBT chemicals from the 2014 TSCA Work Plan[3] according to criteria established in the TSCA Work Plan Chemicals Methods Document.[4] EPA is required to address the health and environmental risks posed, and reduce exposures to the extent practicable if exposure of the general population, a potentially exposed or susceptible subpopulation, or the environment is likely under the conditions of use of the chemical. The conditions of use are the circumstances under which a chemical substance is intended, known or reasonably foreseen to be manufactured, processed, distributed in commerce, used or disposed of.[5]

Our comments address the following main points:

1. **The five chemicals EPA identified meet the PBT requirements of TSCA Section 6(h): Decabromodiphenyl ethers (DecaBDE); hexachlorobutadiene (HCBD); pentachlorothiophenol (PCTP); Phenol, isopropylated, phosphate (3:1); and 2,4,6-Tris(tert-butyl) phenol.**
2. **The intended, known and reasonably foreseen conditions of use for DecaBDE result in exposures to the general population and susceptible sub-populations, as described below. Therefore, EPA**

[1] Stockholm Convention (2008) What are POPs? http://chm.pops.int/TheConvention/ThePOPs/tabid/673/Default.aspx Accessed Dec 18, 2017

[2] 15 U.S.C. § 2605(h), referred to as TSCA 6(h) throughout these comments

[3] US EPA (Oct 2014) TSCA Work Plan for Chemical Assessments: 2014 Update. Available: https://www.epa.gov/sites/production/files/2015-01/documents/tsca_work_plan_chemicals_2014_update-final.pdf

[4] US EPA (Feb 2012) TSCA Work Plan Chemicals: Methods Document. Available: https://www.epa.gov/sites/production/files/2014-03/documents/work_plan_methods_document_web_final.pdf

[5] US EPA. Persistent, Bioaccumulative, and Toxic (PBT) Chemicals under TSCA Section 6(h). Retrieved Jan 5, 2018 from: https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/persistent-bioaccumulative-and-toxic-pbt-chemicals-under

action is required by law to eliminate exposures resulting from the manufacture, import, uses, processing and disposal of the PBT chemical DecaBDE.

a. **In assessing conditions of use of DecaBDE, the law requires including reasonably foreseen circumstances. Therefore, EPA must assume that historical uses and associated exposures continue, unless EPA has sufficient evidence documenting that manufacture, import, processing, use or disposal has been discontinued.**

b. **The conditions of use of DecaBDE result in routine exposures to the general population, including susceptible sub-populations of concern such as pregnant women, infants and children, the elderly, college/university students, airline and other workers. EPA must take action to eliminate these known and likely exposures.**

c. **Existing stocks as well as recycling and disposal of DecaBDE-containing materials result in known and reasonably foreseeable human exposures that will continue for decades. EPA must address exposures from existing stocks, recycling and disposal to effectively reduce exposure to DecaBDE.**

d. **EPA should prohibit manufacturing, import, processing, and use of DecaBDE and DecaBDE-containing articles to address risks and reduce exposures. This is practicable because feasible alternatives are available for DecaBDE uses.**

3. **In the future EPA should use the current criteria to identify additional PBTs for expedited action.**

We are appreciative of the opportunity to provide public input. Please do not hesitate to contact us with any questions regarding these comments.

Sincerely,

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DETAILED COMMENTS

1. **The five chemicals EPA identified meet the PBT requirements of TSCA Section 6(h): Decabromodiphenyl ethers (DecaBDE); hexachlorobutadiene (HCBD); pentachlorothiophenol (PCTP); Phenol, isopropylated, phosphate (3:1); and 2,4,6-Tris(tert-butyl) phenol.**

EPA identified five PBT chemicals from the TSCA Workplan following statutory mandates: Decabromodiphenyl ethers (DecaBDE); hexachlorobutadiene (HCBD); pentachlorothiophenol (PCTP); Phenol, isopropylated, phosphate (3:1); and 2,4,6-Tris(tert-butyl) phenol.

The criteria used in the TSCA Work Plan Chemicals Methods Document[6] to categorize the persistence and bioaccumulative potential of these PBT chemicals are supported by current science and are consistent with well-established criteria used in regulatory science and regulation, including EPA's New Chemicals Program and the Stockholm Convention on Persistent Organic Pollutants.[7,8]

2. **The intended, known and reasonably foreseen conditions of use for DecaBDE result in exposures to the general population and susceptible sub-populations, as described below. Therefore, EPA action is required by law to eliminate exposures resulting from the manufacture, import, uses, processing and disposal of the PBT chemical DecaBDE.**

Decabromodiphenyl ether (DecaBDE) is a mixture of polybrominated diphenyl ether (PBDE) chemicals widely used as additive flame retardants in plastics, textiles and electronics.[9] DecaBDE is recognized as a persistent organic pollutant (POP) by the Stockholm Convention and targeted for global elimination. In the U.S., the agreement to voluntarily phase out manufacture and import of DecaBDE by 2013 only covered some domestic manufacturers. Data for 2014 and 2015 indicate over 300,000 pounds of DecaBDE were manufactured, imported, used and disposed, including in rubber, electronics, plastics and fabrics.[10] But even if new manufacture and import ceased, existing products still contain enormous volumes of DecaBDE—an estimated 70,000 tonnes (154 million pounds) will remain within in-use products in the U.S. and Canada by 2020, which contribute to exposures under the conditions of use.[11]

EPA documented a number of the conditions of use in its Support Document, and exposures to DecaBDE are likely under those conditions of use.[12] In addition to the direct support for the presence of likely exposures in that document, we provide additional comments in points 2(a)-(d) below.

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[6] US EPA (Feb 2012) TSCA Work Plan Chemicals: Methods Document, pg. 15

[7] Federal Register, Vol 64, No 213. Nov 4, 1999. EPA: Category for Persistent, Bioaccumulative, and Toxic New Chemical Substances.

[8] Stockholm Convention on Persistent Organic Pollutants, Annex D. Information Requirements and Screening Criteria. Available: http://chm.pops.int/Portals/0/download.aspx?d=UNEP-POPS-COP-CONVTEXT-D.En.pdf

[9] US EPA (August 2017) Preliminary Information on Manufacturing, Processing, Distribution, Use, and Disposal: Decabromodiphenyl Ethers.

[10] US EPA (August 2017) Preliminary Information on Manufacturing, Processing, Distribution, Use, and Disposal: Decabromodiphenyl Ethers. Pg. 4-5

[11] Abbasi G, Buser AM, Soehl A, Murray MW, Diamond ML. Stocks and Flows of PBDEs in Products from Use to Waste in the U.S. and Canada from 1970 to 2020. Environ Sci Technol. 2015 Feb 3;49(3):1521–8.

[12] US EPA (August 2017) Preliminary Information on Manufacturing, Processing, Distribution, Use, and Disposal: Decabromodiphenyl Ethers.

2(a). In assessing conditions of use of DecaBDE, the law requires including reasonably foreseen circumstances. Therefore, EPA must assume that historical uses and associated exposures continue, unless EPA has sufficient evidence documenting that manufacture, import, processing, use or disposal has been discontinued.

Although companies may claim to no longer manufacture, import, process, use or dispose of DecaBDE, without supporting documentation, such claims alone are not sufficient to establish the actual conditions of use of DecaBDE. A more accurate forecast and reasonably foreseeable circumstance is that known conditions of use and exposures will continue, as this is the logical consequence EPA not taking enforceable action to restrict the conditions of use. Specifically, EPA believed that all domestic manufacturers and importers of DecaBDE would cease these activities by 2013, even though only some had made a voluntary phase out agreement with EPA. But Chemical Data Reporting and Toxics Release Inventory information indicates over 300,000 pounds of DecaBDE were manufactured, imported, used and disposed subsequent to 2013.[13]

Additionally, although Samsung claimed that its electronics would not contain PBDEs after 2006,[14] testing in 2017 found that a Samsung television case contained over 2% DecaBDE by weight. [15] Additionally, despite Washington state's 2011 ban on televisions containing DecaBDE,[16] about 17% of the cases from televisions purchased in Washington in 2017 contained DecaBDE.[17] This illustrates that EPA cannot accept manufacturer, processer and user statements about DecaBDE without documentation (such as analytical chemistry showing products are free of DecaBDE, attestations from suppliers listing the flame retardants used, or other reliable sources) to support such claims. This is true for electronics casings as well as many other DecaBDE uses which industry claims to have abandoned.

EPA should assume that all historical DecaBDE conditions of use are ongoing unless manufacturers, importers, processers and users can provide sufficient documented evidence proving otherwise.

2(b). The conditions of use of DecaBDE result in routine exposures to the general population, including susceptible sub-populations of concern such as pregnant women, infants and children, the elderly, college/university students, airline and other workers. EPA must take action to eliminate these known and likely exposures.

Human health hazard concerns of DecaBDE include neurodevelopmental toxicity, thyroid hormone disruption and reproductive toxicity.[18] Fetuses, infants and children are especially susceptible to reproductive and developmental toxicants because of critical windows of vulnerability during important

[13] US EPA (August 2017) Preliminary Information on Manufacturing, Processing, Distribution, Use, and Disposal: Decabromodiphenyl Ethers. Pg. 4-5

[14] Samsung Electronics (2005) Respecting Nature, Serving Communities: Samsung Electronics 2005 Green Management Report. Pg. 13 Available: http://images.samsung.com/is/content/samsung/cz-aboutsamsung-2005Environmentalnsocialreport

[15] Toxic-Free Future and Clean Production Action (Sept 2017) TV Reality: Toxic Flame Retardants in TVs. Available: https://toxicfreefuture.org/science/research/flame-retardants-tvs/

[16] Washington Department of Ecology (Jan 2008) Focus on Washington State's PBDE Ban. Available: https://fortress.wa.gov/ecy/publications/publications/0807001.pdf

[17] Toxic-Free Future and Clean Production Action (Sept 2017) TV Reality: Toxic Flame Retardants in TVs. Available: https://toxicfreefuture.org/science/research/flame-retardants-tvs/

[18] Persistent Organic Pollutants Review Committee (Oct 2014) Risk profile on decabromodiphenyl ether (commercial mixture, c-decaBDE). United Nations Environment Program.

stages of development.[19] Further, infants and young children have higher exposures to PBDEs compared to adults due to breast milk and house dust exposures, as well as other behaviors like mouthing.[20,21]

Pregnant women are exposed to DecaBDE. BDE-209, a main DecaBDE congener, is found in breast milk samples from around the world including the U.S.,[22] and data indicates that breast milk is a significant source of exposure for infants.[23] In the EU, product testing detected a significant percentage of children's toys contaminated with DecaBDE.[24,25] Manufacturers reported DecaBDE in children's products such as clothing, jewelry and toys in the state of Washington.[26] Thus children's exposure through dermal and ingestion contact with toys, clothing and jewelry is likely.

Other populations of concern include the elderly, college/ university students, airline and other workers. As described below, all of these populations likely experience higher exposures to DecaBDE. Further, the elderly population is more vulnerable to chemical toxicity because of compromised physiological systems and metabolic limitations.[27] College students are largely young adults (ages 18-26), a group of prime reproductive age the Institute of Medicine and National Research Council identified as experiencing a critical period of development distinct from adolescents and adults.[28] Workers typically experience many concurrent chemical exposures, which can result in increased susceptibility to chemical toxicity.[29]

BDE-209 was detected at significant levels in 100% of dust samples collected from U.S. elderly care facilities in 2015.[30] The highest reported concentrations of BDE-209 ever measured in U.S. dust were in

[19] US EPA and NIEHS (2017) NIEHS/EPA Children's Environmental Health and Disease Prevention Research Centers: Impact Report.

[20] US EPA (2013) America's Children and the Environment, Third Edition: Biomonitoring: PBDEs. Available: https://www.epa.gov/ace/biomonitoring-pbdes-report

[21] Toms LML, Harden F, Paepke O, Hobson P, Ryan JJ, Mueller JF. Higher accumulation of polybrominated diphenyl ethers in infants than in adults. Environ Sci Technol. 2008 Oct 1;42(19):7510–5.

[22] Frederiksen M, Vorkamp K, Thomsen M, Knudsen LE. Human internal and external exposure to PBDEs - A review of levels and sources. Int J Hyg Environ Health. 2009 Mar;212(2):109–34.

[23] US EPA (2013) America's Children and the Environment, Third Edition: Biomonitoring: PBDEs. Available: https://www.epa.gov/ace/biomonitoring-pbdes-report-contents

[24] International POPs Elimination Network (2015) Toxic Toy or Toxic Waste: Recycling POPs Into New Products: Summary for Decision-Makers. Available: http://ipen.org/sites/default/files/documents/toxic_toy_or_toxic_waste_2015_10-en.pdf

[25] Ionas AC, Dirtu AC, Anthonissen T, Neels H, Covaci A. Downsides of the recycling process: Harmful organic chemicals in children's toys. Environ Int. 2014 Apr 1;65:54–62.

[26] Washington Department of Ecology. Children's Safe Product Act Reported Data. https://fortress.wa.gov/ecy/cspareporting/

[27] Risher JF, Todd GD, Meyer D, Zunker CL. The elderly as a sensitive population in environmental exposures: making the case. Rev Environ Contam Toxicol. 2010;207:95–157.

[28] Institute of Medicine and National Research Council. (2015) Investing in the Health and Well-Being of Young Adults; The National Academies Press: Washington, DC.

[29] National Research Council. Science and Decisions: Advancing Risk Assessment. Washington, D.C.: National Academies Press; 2009.

[30] Salamova A, Arnold K, Teixeira JP, Mendes A, Madureira J, and Costa S. (2017) Semivolatile organic compounds (SVOCs) in Settled Dust in Elderly Care Facilities. Poster Presentation, International Society of Exposure Science Meeting (Attached as Appendix)

dormitory common areas and bedrooms of college campuses.[31] 100% of dust samples collected from commercial airplanes contained BDE-209, on average at significantly higher levels than other indoor environments.[32] The presence and levels of DecaBDE in indoor dust raise concerns because dust is a major exposure route for PBDEs.[33]

Biomonitoring studies find that workers including firefighters, rubber manufacturers and electronic waste (e-waste) handlers have significantly elevated exposures to DecaBDE because they handle DecaBDE-containing materials or they are exposed to DecaBDE routinely on the job.[34,35, 36,37] E-waste workers have the highest body burdens of DecaBDE ever measured.[38, 39] Consistent with other occupational exposure which workers can carry home on clothing and in vehicles, secondary exposures are reasonably foreseeable for the family members of these workers and must be included in EPA's assessment.

By law under TSCA 6(h), these documented and likely exposures compel EPA to take action and ensure enforceable protections that will eliminate the exposures of the susceptible sub-populations discussed here. As discussed in more detail below, this will entail addressing not only the production of new DecaBDE and Deca-BDE containing articles, but also the in-use stocks, recycling and disposal of DecaBDE.

2(c). Existing stocks as well as recycling and disposal of DecaBDE-containing materials result in known and reasonably foreseeable human exposures that will continue for decades. EPA must address exposures from existing stocks, recycling and disposal to effectively reduce exposure to DecaBDE.

An estimated 380,000 tonnes (838 million pounds) of DecaBDE entered the use phase from 1970-2013 in the U.S. and Canada, with 70,000 tonnes (154 million pounds) remaining within in-use products by

[31] Dodson RE, Rodgers KM, Carey G, Cedeno Laurent JG, Covaci A, Poma G, et al. Flame Retardant Chemicals in College Dormitories: Flammability Standards Influence Dust Concentrations. Environ Sci Technol. 2017 Apr 13;acs.est.7b00429.

[32] Allen JG, Stapleton HM, Vallarino J, McNeely E, McClean MD, Harrad SJ, et al. Exposure to flame retardant chemicals on commercial airplanes. Environ Health. 2013 Feb;12(1):17.

[33] US EPA (2013) America's Children and the Environment, Third Edition: Biomonitoring: PBDEs. Available: https://www.epa.gov/ace/biomonitoring-pbdes-report

[34] Park J-S, Voss RW, McNeel S, Wu N, Guo T, Wang Y, et al. High Exposure of California Firefighters to Polybrominated Diphenyl Ethers. Environ Sci Technol. 2015 Mar;49(5):2948–58.

[35] Thuresson K, Bergman A, Jakobsson K. Occupational exposure to commercial decabromodiphenyl ether in workers manufacturing or handling flame-retarded rubber. Environ Sci Technol. 2005 Apr;39(7):1980–6.

[36] Eguchi A, Nomiyama K, Devanathan G, Subramanian A, Bulbule K a, Parthasarathy P, et al. Different profiles of anthropogenic and naturally produced organohalogen compounds in serum from residents living near a coastal area and e-waste recycling workers in India. Environ Int. 2012 Oct;47:8–16.

[37] Bi X, Thomas GO, Jones KC, Qu W, Sheng G, Martin FL, et al. Exposure of electronics dismantling workers to polybrominated diphenyl ethers, polychlorinated biphenyls, and organochlorine pesticides in South China. Environ Sci Technol. 2007 Aug;41(16):5647–53.

[38] Qu W, Bi X, Sheng G, Lu S, Fu J, Yuan J, et al. Exposure to polybrominated diphenyl ethers among workers at an electronic waste dismantling region in Guangdong, China. Environ Int. 2007 Nov;33(8):1029–34.

[39] Zhao X-R, Qin Z-F, Yang Z-Z, Zhao Q, Zhao Y-X, Qin X-F, et al. Dual body burdens of polychlorinated biphenyls and polybrominated diphenyl ethers among local residents in an e-waste recycling region in Southeast China. Chemosphere. 2010 Feb;78(6):659–66.

2020. Per-capita use of DecaBDE was estimated at 200-2,000 g/ year. [40] In-use products include long-lived items like automobiles, with both personal and re-sale vehicles documented to contain significant levels of BDE-209 in the dust inside the car.[41,42]

DecaBDE-containing materials are often recycled into new products. In the EU, product testing detected a large percentage of children's toys contaminated with DecaBDE.[43,44] Manufacturers reported DecaBDE in children's products such as clothing, jewelry and toys in the state of Washington.[45] DecaBDE within in-use and recycled products will result in ongoing human exposures from the indoor environment for decades. The recycling process will also continue to expose workers to DecaBDE and a myriad of other potentially harmful chemicals.

Existing products will release DecaBDE to the environment, with human exposures resulting from contaminated air, water, soil and food.[46] In 2014, atmospheric emissions of about 0.35-3.5 tonnes/ year of DecaBDE are expected from existing stocks in the U.S. and Canada.[47] Researchers measured DecaBDE in numerous waste products and streams in California, including telephones, computers, autoshredder waste and sewage sludge. Based on these measurements, the scientists estimated over 700 metric tons of DecaBDE per year in California wastestreams.[48]

Biomonitoring shows that there is likely a substantial lag time between production bans and any exposure decline; there was no significant difference in BDE-209 levels in breast milk samples from 2010 compared to 2014-15 in the UK.[49] Other studies find that human exposure to PBDEs initially declines after production bans, but that these declines appear to level off because of ongoing exposures from in

[40] Abbasi G, Buser AM, Soehl A, Murray MW, Diamond ML. Stocks and Flows of PBDEs in Products from Use to Waste in the U.S. and Canada from 1970 to 2020. Environ Sci Technol. 2015 Feb 3;49(3):1521–8.

[41] Lagalante AF, Oswald TD, Calvosa FC. Polybrominated diphenyl ether (PBDE) levels in dust from previously owned automobiles at United States dealerships. Environ Int. 2009 Apr;35(3):539–44.

[42] Lagalante AF, Shedden CS, Greenbacker PW. Levels of polybrominated diphenyl ethers (PBDEs) in dust from personal automobiles in conjunction with studies on the photochemical degradation of decabromodiphenyl ether (BDE-209). Environ Int. 2011 Jul;37(5):899–906.

[43] International POPs Elimination Network (2015) Toxic Toy or Toxic Waste: Recycling POPs Into New Products: Summary for Decision-Makers. Available: http://ipen.org/sites/default/files/documents/toxic_toy_or_toxic_waste_2015_10-en.pdf

[44] Ionas AC, Dirtu AC, Anthonissen T, Neels H, Covaci A. Downsides of the recycling process: Harmful organic chemicals in children's toys. Environ Int. 2014 Apr 1;65:54–62.

[45] Washington Department of Ecology. Children's Safe Product Act Reported Data. https://fortress.wa.gov/ecy/cspareporting/

[46] Harrad S, Diamond ML. New Directions: Exposure to polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs): Current and future scenarios. Atmos Environ. 2006 Feb;40(6):1187–8.

[47] Abbasi G, Buser AM, Soehl A, Murray MW, Diamond ML. Stocks and Flows of PBDEs in Products from Use to Waste in the U.S. and Canada from 1970 to 2020. Environ Sci Technol. 2015 Feb 3;49(3):1521–8.

[48] Petreas M, Oros D. Polybrominated diphenyl ethers in California wastestreams. Chemosphere. 2009;74(7):996–1001.

[49] Tao F, Abou-Elwafa Abdallah M, Ashworth DC, Douglas P, Toledano MB, Harrad S. Emerging and legacy flame retardants in UK human milk and food suggest slow response to restrictions on use of PBDEs and HBCDD. Environ Int. 2017;105.

situ and environmental sources.[50] This is similar to the exposure pattern seen for another PBT chemical, polychlorinated biphenyls (PCBs).[51,52]

These data all indicate that it is critical for EPA to address recycling and disposal to effectively reduce human exposure to DecaBDE. These public health protections are required by law.

2(d). EPA should prohibit manufacturing, import, processing, and use of DecaBDE and DecaBDE-containing articles to address risks and reduce exposures. This is practicable because feasible alternatives are available for DecaBDE uses.

The Stockholm Convention Persistent Organic Pollutants Review Committee found that technically feasible alternatives are available for all applications of DecaBDE. These include both chemical and non-chemical alternatives, such as non-flammable materials choices or design changes like barriers.[53] EPA's Design for the Environment assessment of chemical alternatives to DecaBDE in 2014 found a number of potential substitutes with preferable hazard profiles.[54]

In 2012, EPA proposed a Significant New Use Rule (SNUR) that would have designated manufacturing, importing and processing of DecaBDE, including in articles, as a significant new use requiring notification to the Agency. EPA also proposed a Test Rule that would require anyone who manufactures or processes DecaBDE, including in articles, to conduct testing on its health and environmental effects.[55] It is important to note that processing includes recycling of DecaBDE containing materials. However, both the SNUR and Test Rule currently remain in draft form and are thus currently insufficient to meet the legal requirements of TSCA 6(h). As part of its actions to eliminate exposures to DecaBDE, EPA should finalize the proposed SNUR and Test Rule as proposed expeditiously. The examples given in 2(a) above demonstrate why federally enforceable constraints with ongoing surveillance are critical in this regard.

Finally, as noted above, to effectively reduce exposure to DecaBDE, EPA must address disposal of existing stocks. Updated guidance from the Stockholm Convention on Persistent Organic Pollutants provides extensive analysis and recommendations on best available techniques and environmental practices for the recycling and waste disposal of articles containing PBDEs.[56] It is clear from this document that all of the current options have some drawbacks; EPA should prioritize funding and

[50] Parry E, Zota AR, Park J-S, Woodruff TJ. Polybrominated diphenyl ethers (PBDEs) and hydroxylated PBDE metabolites (OH-PBDEs): A six-year temporal trend in Northern California pregnant women. Chemosphere. 2018;195:777–83.

[51] Harrad S, Diamond ML. New Directions: Exposure to polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs): Current and future scenarios. Atmos Environ. 2006 Feb;40(6):1187–8.

[52] Zota AR, Linderholm L, Park J-S, Petreas M, Guo T, Privalsky ML, et al. Temporal Comparison of PBDEs, OH-PBDEs, PCBs, and OH-PCBs in the Serum of Second Trimester Pregnant Women Recruited from San Francisco General Hospital, California. Environ Sci Technol. 2013 Oct 15;47(20):11776–84.

[53] Persistent Organic Pollutants Review Committee (Oct 2015) Risk management evaluation on decabromodiphenyl ether (commercial mixture, c-decaBDE). United Nations Environment Program.

[54] US EPA (2014) An Alternatives Assessment for the Flame Retardant Decabromodiphenyl Ether (DecaBDE). Available: https://www.epa.gov/sites/production/files/2014-05/documents/decabde_final.pdf

[55] Federal Register Vol 77, No. 63 April 2, 2012. Certain Polybrominated Diphenyl ethers; Significant New Use Rule and Test Rule

[56] Stockholm Convention on Persistent Organic Pollutants, 2015. Revised draft guidance on best available techniques and best environmental practices for the recycling and waste disposal of articles containing polybrominated diphenyl ethers listed under the Stockholm Convention. Geneva, Switzerland.

research into methods for safe destruction and disposal of PBDEs, especially those that could separate PBDEs from feedstocks and destroy them through non-thermal methods. Any type of thermal treatment, whether for energy or material recovery, has the potential to result in the production of highly toxic brominated dioxins and furans. Incineration facilities often disproportionately impact low-income and communities of color and thus thermal treatment should not be considered a viable option for disposal of DecaBDE-containing materials. As recommended in the San Antonio Statement on Brominated and Chlorinated Flame Retardants and in concurrence with Article 6 of the Stockholm Convention, "Wastes containing flame retardants with POP characteristics, including products and articles, should be disposed of in such a way that the POP content is destroyed or irreversibly transformed so that they do not exhibit the characteristics of POPs."[57]

3. In the future EPA should use the current criteria to identify additional PBTs for expedited action.

Because of the long-lived, global and unmanageable risks of PBTs, sound chemical policy around the world including in Canada, the European Union, and the global Stockholm Convention treaty continuously identifies PBTs for restriction. EPA should develop a process to use the current criteria to identify additional PBTs for expedited action on an ongoing basis.

[57] Digangi, J et al. 2010. San Antonio statement on brominated and chlorinated flame retardants. Env Health Perspect 118(12):A516-519.

SEMIVOLATILE ORGANIC COMPOUNDS (SVOCs) IN SETTLED DUST IN ELDERLY CARE FACILITIES

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Introduction

- Aging of the population is one of the main future challenges in developed countries
- Older adults are particularly susceptible to environmental exposures due to frailty
- Older adults residing in elderly care facilities spend around 95% of their time indoors
- Elderly care facilities may potentially have elevated exposure levels to many SVOCs due to their intense cleaning, pest control, and fire safety protocols
- Evidence from prior studies suggests that there are significant associations between exposure to indoor air pollutants in elderly care facilities and adverse health outcomes among their residents.
- However, these prior assessments of indoor exposures in elderly care facilities have focused on common indoor pollutants, and have not addressed exposures to a large group of ubiquitous indoor contaminants, semi-volatile organic compounds (SVOCs), including flame retardants, plasticizers, and pesticides.

Project goals

- The main goal of this study was to assess the levels of SVOCs in dust collected from elderly care facilities in the United States and in Portugal.
- Five SVOC groups (~120 distinct compounds), including organophosphate esters (OPEs), brominated flame retardants (BFRs), polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides (OCPs), and polychlorinated biphenyls (PCBs), were measured in settled dust samples collected in elderly care facilities in the United States and in Portugal. This is the first study reporting a wide range of SVOCs in elderly care facilities and presenting important information on indoor SVOC exposures in a vulnerable population of older adults.

Experimental Details

- **Sampling of settled floor dust**

- 11elderly care facilities in Porto, Portugal (n=28) during spring 2013;
- 3 facilities in Indiana, United States (n=14) during summer 2015.
- Main living areas, such as living rooms, bedrooms, and corridors by using a portable vacuum cleaner (Stanley, model SL18116P). The wand and the attachment were rinsed with isopropyl alcohol and allowed to dry before a pre-cleaned nylon sock was inserted into the wand and held in place by the attachment before each sample collection.

- **Sample analyses**

The dust was sieved using a 500 µm sieve (USA Standard Test Sieve from Newark) to remove the coarse particles. Approximately 0.1 g of dust was placed in glass centrifuge tubes then spiked with surrogate recovery standards. Five mL of 1:1 (v/v) of acetone and hexane was added to the samples and vortexed for 1-2 min, sonicated for 30 min, and then centrifuged for 5 min at 3200 RPM. The top organic layer of the mixture was separated and placed in a clean centrifuge tube. The extraction was repeated twice, and all three organic layers were combined together. The resulting extract was further concentrated to ~2 mL for fractionation. The extract was fractionated using 3.5% (w/w) water deactivated silica gel. Three fractions were collected: the first fraction consisted of 25 mL of hexane, the second fraction consisted of 25 mL of 1:1 (v/v) hexane and dichloromethane, and the third fraction consisted of 25 mL of 7:3 (v/v) acetone and dichloromethane. PCBs, some OCPs and some BFRs eluted in the first fraction; the rest of the OCPs and BFRs, as well as all PAHs, eluted in the second fraction; and all OPEs eluted in the third fraction. The fractions were reduced in volume to 1 mL and spiked with quantitation internal standards. Target chemicals were analyzed by gas-chromatography (for PCBs and OCPs) and gas-chromatography-mass spectrometry (for OPE, PAHs, and BFRs) using established analytical methods (Salamova et al., 2011; Liu et al., 2016; Salamova et al., 2016).

- **Target analytes**:

OPEs: *tris*(2-chloroethyl) phosphate (TCEP), *tris*(1-chloro-2-propyl) phosphate (TCPP), *tris*(1,3-dichloro-2- propyl) phosphate (TDCPP), tri-*n*-butyl phosphate (TNBP), triphenyl phosphate (TPHP), 2-ethylhexyl-diphenyl phosphate (EHDP).
BFRs: 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (EHTBB), *bis*(2-ethylhexyl) tetrabromophthalate (BEHTBP), decabromodiphenyl ethane (DBDPE), BDE-47, 99, and 209.
PAHs: 11 PAHs, including 3-6 ring PAHs.
OCPs: α-hexachlorocyclohexane (α-HCH), β-hexachlorocyclohexane (β-HCH), γ-hexachlorocyclohexane (γ-HCH); α-chlordane, γ-chlordane, *trans*-nonachlor; endosulfan I, endosulfan II, endosulfan sulfate; *o,p'*-DDT, *p,p'*-DDT, *p,p'*-DDE, *o,p'*-DDD, *p,p'*-DDD.
PCBs: 84 PCB congeners.

Results

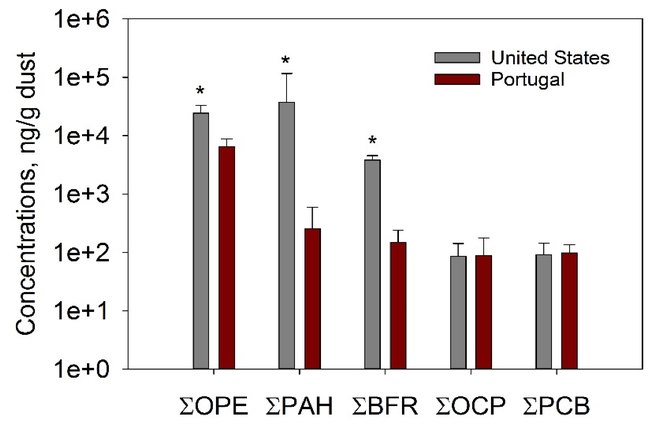

Figure 1. ∑OPE, ∑PAH, ∑BFR, ∑OCP, and ∑PCB concentrations (geometric mean ± standard error) in dust samples collected in elderly care facilities in the United States and in Portugal. The asterisks mark statistically different distributions at $P < 0.05$.

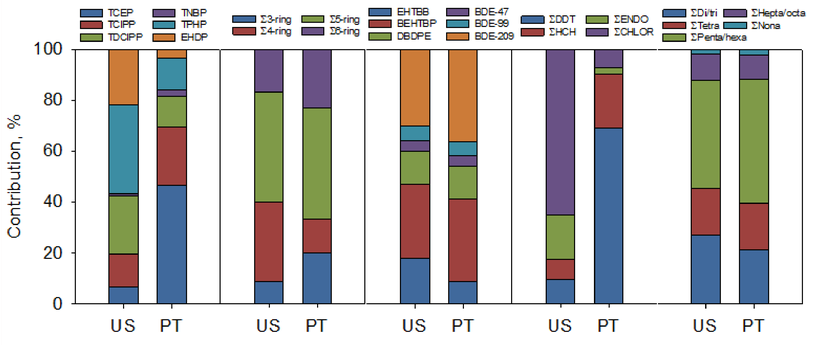

Figure 2. Contributions (%) to the ∑OPE, ∑PAH, ∑BFR, ∑OCP, and ∑PCB concentrations in the dust samples collected in United States' and in Portuguese elderly care facilities. US: United States; PT: Portugal.

Table 2. ∑OPE, ∑PAH, ∑BFR, ∑OCP and ∑PCB geometric mean concentrations (ng/g) and their standard errors in each microenvironment (bedroom, living room, and corridor).

	∑OPE	∑PAH	∑BFR	∑OCP	∑PCB
Bedrooms (n = 18)	8240 ± 3564	874 ± 3809	292 ± 573	147 ± 400	78.8 ± 51.2
Living rooms (n = 14)	10911 ± 5511	780 ± 23194	489 ± 827	56.2 ± 73.2	141 ± 52.1
Corridors (n = 6)	17074 ± 18688	8197 ± 15844	1049 ± 775	77.3 ± 151	73.4 ± 23.7

Results

Table 1. Concentrations (geometric means and their standard errors [GM ± SE], minimum [Min] and maximum [Max]; ng/g) of OPEs, PAHs, BFRs, OCPs, and PCBs in dust collected in elderly care facilities in the United States and in Portugal. Detection frequencies (Det%) and individual chemical contributions (Contr%) to total concentrations are also included.

	United States (n = 14)					Portugal (n = 28)				
	GM ± SE	Min	Max	Det%	Contr %	GM ± SE	Min	Max	Det%	Contr %
OPE										
TCEP	1239 ± 416	392	6497	100	6.9	2312 ± 1555	123	37222	89	47
TCIPP	2246 ± 1175	449	17889	100	13	1139 ± 820	16.3	19684	96	23
TDCIPP	4099 ± 1267	1090	14004	86	23	607 ± 938	56.2	16465	61	12
TNBP	161 ± 227	40.8	3312	100	0.9	115 ± 50.5	13.4	929	79	2.3
TPHP	6252 ± 2943	960	34441	100	35	633 ± 304	16.0	6783	100	13
EHDP	3846 ± 6296	552	82145	100	22	163 ± 57.7	29.8	1364	89	3.3
∑Cl-OPE	7533 ± 2041	2495	26914	100	37	4650 ± 2105	196	47353	100	82
∑nCl-OPE	12731 ± 8408	1636	112904	100	63	1006 ± 324	63.4	7142	100	18
∑OPE	24176 ± 8930	8585	125266	100		6480 ± 2256	345	53244	100	
PAH										
∑3-ring	3223 ± 7073	547	99900	100	8.7	119 ± 81.3	6.59	2010	100	20
∑4-ring	11638 ± 28499	1396	398467	100	31	80.4 ± 136	3.39	3345	89	14
∑5-ring	15932 ± 31808	2995	446372	100	43	259 ± 232	12.2	2538	46	44
∑6-ring	6235 ± 11190	1047	156000	100	17	136 ± 79.1	20.7	800	32	23
∑PAH	37546 ± 78551	6172	1100739	100		255 ± 336	10.0	8007	100	
BFR										
EHTBB	566 ± 140	139	1554	100	18	13.8 ± 28.2	0.75	575	71	8.6
BEHTBP	905 ± 519	170	6334	100	29	52.2 ± 102	3.63	1480	50	33
DBDPE	398 ± 128	35.1	1592	100	13	21.0 ± 16.9	2.02	237	57	13
BDE-47	132 ± 27.2	34.7	361	100	4.2	6.24 ± 2.64	0.85	51.0	71	3.9
BDE-99	176 ± 34.0	50.2	395	100	5.6	8.80 ± 4.64	0.98	99.0	89	5.5
BDE209	942 ± 233	205	2872	100	30	58.3 ± 71.3	2.78	1651	89	36
∑BFR	3827 ± 744	1272	11261	100		148 ± 93.5	5.40	1836	96	
OCP										
∑DDT	8.43 ± 9.08	1.30	115	93	10	86.1 ± 356	1.08	6816	68	69
∑HCH	6.75 ± 16.1	0.80	85.2	36	7.8	26.5 ± 13.4	0.69	225	71	21
∑ENDO	15.0 ± 5.45	1.74	48.3	57	17	3.12 ± 0.91	1.24	10.8	36	2.5
∑CHLOR	55.8 ± 53.0	14.5	783	100	65	8.93 ± 11.9	0.52	96.3	36	7.2
∑OCP	85.8 ± 56.0	20.6	824	100		88.0 ± 90.7	1.08	6852	89	
PCB										
∑Di/tri	22.0 ± 7.67	2.18	110	100	27	20.8 ± 20.2	0.64	406	86	21
∑Tetra	15.0 ± 15.2	3.72	223	100	18	17.9 ± 11.0	0.76	238	86	18
∑Penta/Hexa	34.5 ± 13.0	9.25	154	100	42	48.1 ± 15.7	0.72	276	100	49
∑Hepta/Octa	8.19 ± 17.6	0.97	251	100	10	9.13 ± 9.80	1.84	175	64	9.3
∑Nona	1.61 ± 7.06	0.052	65.2	64	2.0	2.27 ± 0.92	0.16	11.4	43	2.3
∑PCB	92.2 ± 50.2	23.5	746	100		97.8 ± 38.4	2.45	685	100	

Conclusions

- This is the first study to report on the indoor occurrence of a wide range of SVOCs in elderly care facilities in the United States and in Portugal.
- OPEs, PAHs, and BFRs, were the most abundant SVOCs found in dust, and OCPs and PCBs were the least abundant SVOC groups in these indoor environments.
- OPEs, PAHs, and BFRs were significantly higher in the United States' facilities compared with Portuguese facilities, reflecting the legacy of extensive use of some of these chemicals in the United States.
- ∑OPE, ∑PAH, and ∑BFR concentrations were up to 5 times higher in corridors compared to bedrooms and living rooms. ∑OCP and ∑PCB concentrations were overall higher in bedrooms and in living rooms and lower in corridors.

References

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