Guidance on information collection for industrial persistent organic pollutants

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1. Introduction

Stockholm Convention lists 31 persistent organic pollutants (POPs), of which 15 are used as industrial chemicals. The sectors and supply chains using industrial POPs are very complex compared to agricultural and forestry sectors using pesticides. Even relatively simple products, such as outdoor clothing, could contain many POPs that have been used at different levels of the production process. Tracing the chemicals used in the supply chain and ensuring compliance with potential regulations could be challenging.

The need for the functionality provided by a POP in any product could be driven e.g., by regulatory requirements (e.g. building code requiring the use of flame-retardant or self-extinguishing materials), safety (e.g. insurance companies requiring the use of flame-retardant materials), performance (e.g. flexibility, plasticity, corrosion-resistance) or convenience (stain and water repellency; ease of use). It is useful to consider this when beginning to investigate whether certain POPs might be used in the country. Understanding the reasons for these uses is especially important.

Parties to the Stockholm Convention must identify uses of POPs in their countries. Article 6 of the Convention requires Parties to develop strategies for identifying stockpiles consisting of or containing chemicals listed in Annexes A and B, in order to ensure their management in an environmentally sound manner. The Convention does not specify whether articles containing POPs should be considered as stockpiles. Parties could have different interpretations and strategies, e.g. in the European Union holders of articles containing POPs must notify them as stockpiles in line with Article 6 of the Stockholm Convention.

The wastes must be managed according to the provisions laid out in Article 6 of the Convention. This has proven challenging for many new POPs that are still in use. As a consequence, POPs may end up in new products and articles through material recycling (Brosché et al. 2021).

It would also be beneficial for a Party to identify uses of chemicals that have been nominated for inclusion in the Stockholm Convention. Better understanding of the national needs and circumstances would benefit the negotiations, when exemptions for production and use are discussed based on information that is accurate and up-to-date. Requests for exemptions that are not needed complicate the decision-making and undermine the work of the POPs Review Committee (POPRC).

The identification of production and needs for industrial POPs throughout their life cycle is a challenge when listing new chemicals in the Convention. The purpose of this document is to look at the inventory process from a sector-specific angle, to assist country experts and authorities in addressing all relevant POPs anticipated to be of interest for a certain sector at one go. This will help avoid several processes that follow from addressing POPs substance by substance. The goal is to make the inventory process more comprehensive and save time and costs for both administration and industry.

This document focuses on intentionally used applications for industrial POPs. It does not address presence of POPs in unintentional application due to e.g. use of recycled materials.

Although the objective is to take stock of all present and past known applications, those POPs which are not believed to be in production anymore and hence have no current use, are excluded. Brominated flame-retardants including commercial pentabromodiphenyl ether (c-pentaBDE) (listed as tetra- and pentaBDE; production discontinued in ca. 2004), commercial octabromodiphenyl ether (c-octaBDE) (listed as hexa- and heptaBDE; no known production), and hexabromobiphenyl (HBB; production ceased several decades ago) are not included. Furthermore, the industrial chemicals polychlorinated biphenyls (PCB), polychlorinated naphthalenes (PCN), and pentachlorobenzene (PeCB) are also excluded from this guidance. All such POPs, nevertheless, can be and are likely still present in articles in use and in waste.

The remaining eight industrial POPs, with potential continued use and addressed in this guidance, include historical uses that have been prohibited in the Stockholm Convention listings. The Parties are, therefore, encouraged to refine the scope of their national inventory activities based on their national circumstances, such as existing restrictions, e.g. following ratification of the Convention or amendments.

The information below is based on the work of the POPRC, substance-specific inventory guidance documents developed by the Secretariat, information from the respective industries (including during the listing process), and available open literature and assessments.

2. Existing guidance for inventories

The Secretariat of the Basel, Rotterdam, and Stockholm Conventions has developed a series of guidance documents to assist countries in making inventories for individual POPs. They comprise a general introduction to the inventory approach to be used in conjunction with detailed substance-specific inventory guidance documents. The detailed guidance documents provide examples on approaches and information sought, including questionnaires.

The following guidance documents for preparing inventories are already available:

- General Guidance on POPs Inventory Development (June 2020) (UNEP 2020);
- Guidance on preparing inventories of perfluorooctane sulfonic acid (PFOS) and related chemicals listed under the Stockholm Convention on Persistent Organic Pollutants (UNEP 2017a);
- Draft guidance on preparing inventories of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants. (UNEP 2021a);
- Draft guidance on preparing inventories of hexabromocyclododecane (HBCD) (UNEP 2021b);
- Draft guidance on preparing inventories of short-chain chlorinated paraffins (SCCPs) (UNEP 2021c);
- Draft guidance on sampling, screening and analysis of persistent organic pollutants in products and recycling (UNEP 2021d);
- Draft guidance on preparing inventories pentachlorophenol and its salts and esters (UNEP 2021e).

To be mentioned, the following two draft guidances are in preparation:1) Draft guidance on preparing inventories of dicofol, and 2) Draft guidance on preparing inventories of PFOA, PFOS, PFHxS, their salts, and related compounds.

3. Existing guidance on identifying POPs

In addition to industrial POPs having a variety of uses on different levels of supply chain, there are additional difficulties in identification of their uses. Often information on their presence in the mixtures, materials, products and articles is not conveyed up the chain from the raw material producers or parts manufacturers to the end-user whether it be the industry or the individual consumer. Although there are global agreements on how chemical preparations should be labelled and classified, the concentrations of POPs used are sometimes below the thresholds. Furthermore, once incorporated into materials and end-products and articles, the information on chemicals contained in them is usually not available, making it difficult for the end-user to know. Thus, the information sought by the government expert for inventories, may not simply be known and must be acquired through chemical analyses in the laboratory.

The BRS Secretariat has developed guidance documents to address these issues:

- Guidance for the control of the import and export of POPs under the Stockholm Convention (UNEP 2019b);
- Guidance on the labelling of products and articles that contain POPs (UNEP 2019c);
- Draft guidance on sampling, screening and analysis of persistent organic pollutants in products and recycling (UNEP 2021d).

4. Identification of products and articles containing POPs

Labelling products and articles containing a POP is required in the listing decisions of HBCD and pentachlorophenol (PCP) to ensure that they can be identified throughout their lifecycles. These provisions are related to only production and use taking place under the specific exemption and is therefore not relevant for non-ratified Parties. Labelling is also required for PCB (Annex A, Part II, para. a (i and ii)).

A specific label in the chemical, mixture, product or articles identifying that it contains POPs could facilitate the control of POPs and the implementation of the Convention through the supply chain and communicate their hazards when they are marketed and traded (UNEP 2019a). That is not typically, however, the case and the identification of POPs is based on information from the manufacturer or chemical analyses (see UNEP 2021d).

The voluntary Globally Harmonized System of Classification and Labelling of Chemicals (GHS) is an international harmonized standard for classification of chemicals and mixtures and hazard communication via labelling and safety data sheets. It is the predominant system for classification and labelling of chemicals as substances and mixtures and can be useful for all POPs chemicals, but it does not cover articles.

The Secretariat has developed a draft guidance to assist countries in sampling, screening and analysis of persistent organic pollutants in products and recycling (UNEP 2021d). National inventories, however, cannot be based on laboratory analyses and the tiered approach outlined in the General inventory guidance (UNEP 2020) should be followed:

The first phase (**Tier I**) in the inventory is to make an initial assessment on the production and use of the POP in the country based on available information. The outcome could be a literature study complemented with information in the inventory team stakeholders. A full picture of the particular POP may not be achieved based only on available information, but the workplan and scope of the inventory may be further refined by e.g. being able to exclude some applications in the country.

In the second phase (**Tier II**), further information (and likely the main body of the information) is collected through interviews and questionnaires to stakeholders, i.e. producers, users, users of the products/articles consisting of, containing or contaminated with the POP, waste managers etc. Based on information from the producers and users of the POP, the team should have a reasonable understanding on the flows and uses of the chemical in the country as well as the magnitude and concerned sectors of stockpiles and materials containing the chemical.

In the third phase (**Tier III**), in-depth information can be acquired for sectors of special interest and uses of importance to fill-in gaps in the information through chemical analyses and site visits. Analyses are usually expensive and require a lot of technical expertise. Moreover, analytical methods may not be readily available for some POPs.

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention) has developed a set of guidelines assisting Parties in identifying waste consisting, containing, or contaminated with POPs. These guidelines contain information available on uses of POPs in the manufacture of products and articles as well as quantities used for different applications and can be helpful in identifying the relevant types of industry:

- General technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (General POPs) (UNEP 2022a);
- Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexabromodiphenyl ether and heptabromodiphenyl ether, or tetrabromodiphenyl ether and pentabromodiphenyl ether (POP-PBDEs) (UNEP 2015a);
- Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexachlorobutadiene (HCBD) (UNEP 2017b);
- Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with pentachlorophenol and its salts and esters (PCP) (UNEP 2017c);
- Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with hexabromocyclododecane (HBCD) (UNEP 2019d);
- Technical guidelines on the environmentally sound management of wastes containing or contaminated with unintentionally produced polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans, hexachlorobenzene, polychlorinated biphenyls, pentachlorobenzene or polychlorinated naphthalenes (Unintentionally produced POPs) (UNEP 2019e);
- Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with short-chain chlorinated paraffins (SCCP) (UNEP 2019f);
- Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) and perfluorooctanoic acid (PFOA), its salts and PFOA-related compounds (UNEP 2022b).

5. Identifying relevant stakeholders

General guidance on POPs inventory (UNEP 2020) and detailed inventory guidance documents contain lists of suggested stakeholders, which are dependent on the chemical in question and its uses. They need to be identified and contacted during the process.

For industrial POPs, the stakeholders could include the producers and/or importers, environmental authorities, chemicals registration authorities (as appropriate), chemicals trade and associations and relevant industry

associations, manufacturers and user organizations and larger enterprises using the POP, recycling and end-of-life treatment facilities, relevant research and educational institutions, and consumer and environmental non-governmental organisations (NGOs). All areas with continued or suspected use should be included.

Especially with industrial POPs used in the production of materials, equipment, products/articles, or those sold for household use, the information on uses and amounts may only be available from the relevant industry and trade. Therefore, special effort should be made to list all relevant stakeholders in the country who might have information on the POP. Identifying stakeholders that produce, import and use the chemical can be used in the future for direct outreach, for example, when regulating.

Tracking the use of POPs in different stages of the supply chain is difficult because of the large number of actors in different stages of the life-cycle of the chemical and often a large variety of applications of a given chemical in many sectors. The information on chemicals contained in the materials is seldom conveyed down the supply chain by means of labelling, material safety data sheets or other material. RPA (2014) provides an example of the supply chain for Decabromodiphenyl Ether (decaBDE, Figure 1), containing many stages relevant for making an inventory of POPs as well.

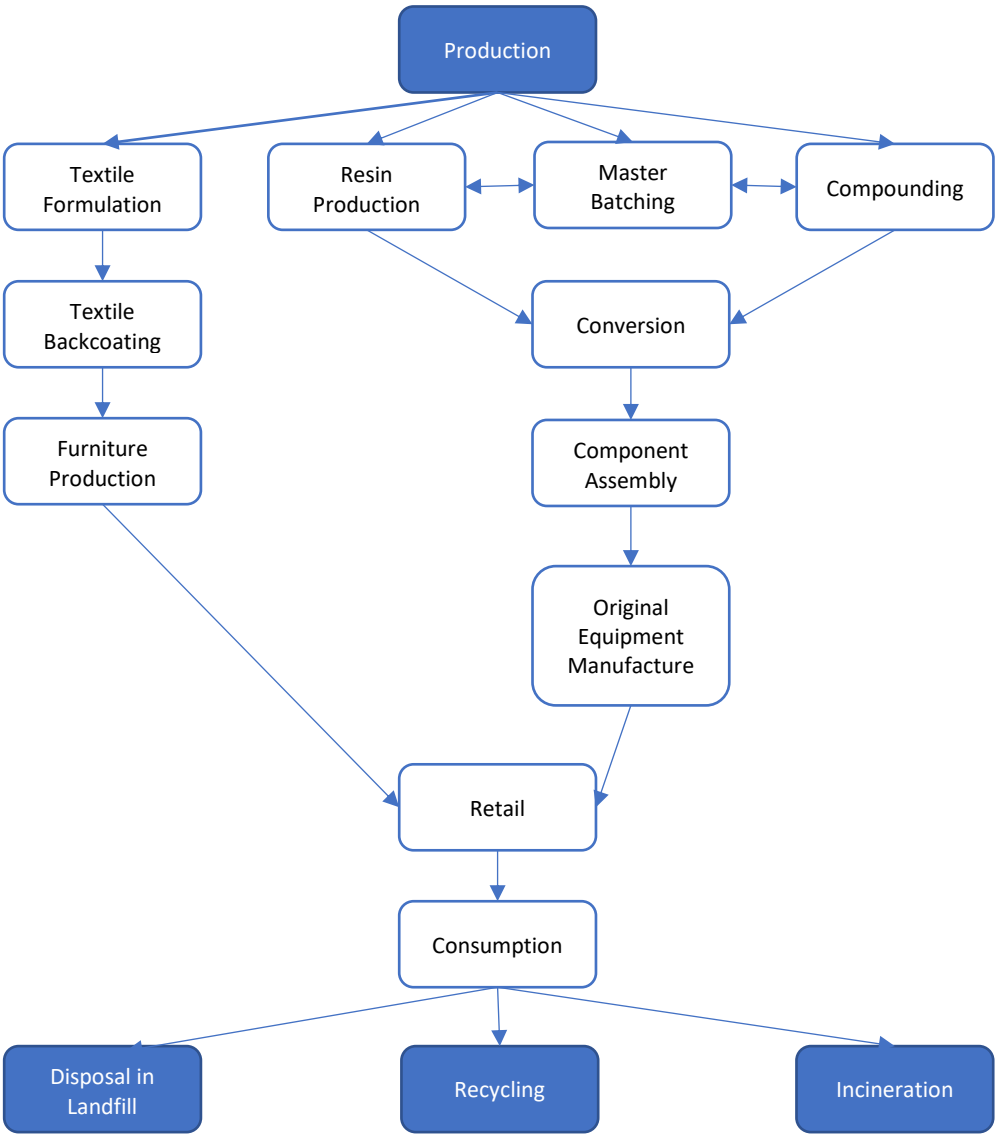

Figure 1. Schematic representation of decaBDE supply chain (adapted from RPA 2014). DecaBDE example is applicable to most industrial POPs that are used in different levels of supply chain.

Information on POPs in the country should be sought from different actors, depending on which are relevant for the country. The following elements are adapted from the decaBDE example in RPA (2014):

- Production of the chemical: Production of industrial POPs is mostly a very specialized industry and does not take place in all countries. Countries where manufacture takes place have usually been identified in the risk profile documents prepared by the POPRC (see www.pops.int);
- Import of chemicals, mixtures, and articles: POPs could be imported for use as chemicals or already formulated mixtures (such as extended polystyrene (EPS) raw material (beads) or surface treatment chemicals) or products and articles containing POPs (such as spare parts for autos) for further processing or retail. Importers of chemicals may have information on the downstream use in the country or be retailers themselves;
- Formulation: Formulation refers to the mixing and blending of the substance in a mixture for textiles or plastics, adhesives, sealants, coatings, etc. In the case of e.g. decaBDE and HBCD, this could mean the compounding process where the flame-retardant is mixed with plastic and other additives (e.g. EPS raw material production), or the formulation of the coating mixture for textiles. Formulators may have information on the subsequent users of the POPs in the country;
- Industrial use of chemical or mixture: This refers to the use of the mixture or substance in an industrial context. For example, flame-retardants and surface treatment chemicals are intended to be included in or on the article matrix. Conversion of plastic compounds in semi-finished or finished articles and coating of textiles fall in this category;
- Article manufacture with textile or plastic components or by application of adhesives, sealants or coatings: This life cycle stage concerns use by a large number of users. This could include e.g. the use of textiles as upholstery by professionals.

Table 1. Industrial sectors and relevant POPs. (x) = production discontinued, but could be formed as a by-product for continued use. Note that the table reflects substances believed to be in current use and placed on the market. They can be found in articles in use, especially in energy and construction sectors, where the waste must be managed according to Article 6 of the Convention.

Production Sector	DecaBDE	HBCD	HCB	HCBD	PCP	PFOA, its salts and PFOA-related compounds	PFOS	SCCPs
Chemicals industry[1]	x	x	(x)	(x)	x	x	x	x
Construction materials	x	x			x	x	x	x
Electrical and electronic equipment	x	x		x				x
Semi-conductors						x	x	
Automotive parts	x	x				x	x	x
Aerospace parts	x			x		x	x	
Medical equipment						x	x	
Leather					x	x	x	x
Plastics	x	x				x	x	x
Rubber				x				x
Textile	x	x			x	x		
Metal industry							x	x
Mining								x
Petrochemical							x	x
Forestry					x			
Agriculture							x	
Fire-fighting						x	x	
Fireworks			x					

[1] Chemicals industry contains the production of chemicals as well as production of mixtures such as adhesives and paints.

6. Chemicals industry

The chemicals industry either produces industrial POPs (e.g. flame-retardants or solvents), or uses them as intermediates (e.g., PFOA) or ingredients for preparations (e.g. SCCPs in metalworking fluids). A large proportion of the industrial POPs are flame-retardants (e.g., c-decaBDE, HBCD, SCCPs), which are produced by a specialized industry and small number of companies. Some POPs are still in use (PeCB, HCB) as industrial solvents or pesticides. HCB may also be formed as a by-product in the production of other chlorinated solvents.

There is no specific guidance available for addressing the chemicals industry. It is recommended to contact chemicals industry associations or stakeholder directly.

The Basel Convention has relevant technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with unintentionally produced POPs, including HCB (UNEP 2019e).

Guiding questions:

Are there chemical industries producing chlorinated, brominated or fluorinated chemicals in the country?

Are there industries in the country that produce flame-retardants?

Where are chemicals imported from?

7. Construction sector

The construction sector covers construction materials containing POPs. These include piping, insulation materials, adhesives, sealants, paints, and textiles (predominantly public buildings). Use of POPs could be driven by e.g. fire-safety specifications for materials but POPs also have technical functions in materials, as plasticizers or making them repellent against dirt and water or corrosion.

In construction materials, POPs are used as flame-retardants (decaBDE and HBCD), plasticizers (SCCPs), agents which provide desirable functions such as corrosion prevention, grease and water resistance (PFOA- and PFOS-related compounds) (Table 2). The use of flame-retardants may be dictated by material flammability standards that define specific ignitability requirements for different materials and fire-safety regulations. Flame-retardant properties represent an extra cost for the material producers and the same materials may be available without flame-retardancy.

In the past, other POPs (mainly penta-BDE and octa-BDE, PCB) have been used in various materials used in construction, but as there is no known production, they are currently only believed to be present in articles in use and waste.

PCN and PCB have been used from 1930s in construction, in particular in sealants, coatings, paints, adhesives and cables (UNEP 2017f). They should have been phased out, however, there might still be usage in the world. PCP was a major wood preservative for buildings, stables and other constructions (UNEP 2017g; Huwe et al. 2004). Its use may still be ongoing and these chemicals might still be produced in Asia and Mexico. Other POPs pesticides such as DDT, lindane, mirex, chlordane, and endosulfan were used as wood preservatives in construction.

DecaBDE has been used in the building and construction sector, for instance, in polyurethane (PUR) and extruded polystyrene (XPS) insulation, cladding panels, polyethylene (PE) or polypropylene (PP) films, cables and electrical ducts and fittings or piping insulation. Continued use is allowed for the manufacturing of polyurethane foam for building insulation under Stockholm Convention. DecaBDE is used in a range of other polymers such as polyolefins (PE, PP, ethylene-vinyl acetate (EVA)), styrenics (polystyrene (PS), high impact polystyrene (HIPS), acrylonitrile butadiene styrene (ABS), engineering Thermoplastics (polyethylene terephthalate (PET), polybutylene terephthalate (PBT), polyamide (PA), polycarbonate (PC), PC-ABS, PEE-HIPS, thermosets (unsaturated polyester (UPE), epoxies, melamine-based resins), elastomers (ethylene propylene diene monomer (EPDM) rubber, thermoplastic PUR, EVA), and waterborne emulsions and coatings (acrylic-, polyvinyl chloride (PVC)-, ethylene vinyl chloride- and urethane-emulsion) (UNEP/CHW.14/7/Add.3; UNEP 2021a).

SCCPs have been used as plasticisers in sealants and adhesives. SCCPs were contained in polymers such as acrylic and butyl sealants, polyurethanes, and polysulfides. In the construction sector, these types of polymers were used for various applications, for example (UNEP 2021c):

- Filling of expansion and movement joints (horizontal and vertical);
- Filling of gaps around doors and windows;

- Sealants for water storage applications (reservoirs) and for protecting areas from oil and fuel spillages, areas around petrol stations, sewage treatment works;
- Sealants for underground facilities such as basements and subways but also for the waterproofing of constructions such as bridges and culverts;
- Sealants in waterproof roof coating.

HBCD has been a common flame-retardant for self-extinguishing grades of EPS and XPS insulation materials, furniture and decoration (and also packaging materials). Pure styrenic polymers like HIPS, EPS and XPS require flame-retardants to reach the desired fire safety standards. HBCD has been used especially in 'one-step' EPS manufacturing process[2]. Although alternatives have replaced HBCD in many countries starting from 2015, HBCD is still used in many countries. As a bulky material, EPS is often expanded domestically, although the raw material ('beads') can be also imported. The concentrations at which HBCD is used depend on the polymer it is used with as well as the fire safety requirements the product needs to meet (UNEP/POPS/POPRC.7/19/Add.1). Therefore, there are regional differences in the amounts HBCD is applied[3].

Use of PFOA, PFOS and other per- and polyfluoroalkyl substances (PFAS) in construction materials has been reported (Becanova et al. 2016; Green Science Policy Institute 2021). A specific application reported was phenolic insulation foams. These could also be present in stain and water repellent finishes (DWR) applied on the surface of carpets and upholstery. Both PFOS and PFOA, as other PFAS, have been produced for direct use in commercial products and use in industrial product streams.

The major worldwide use of PCP, since it was first produced in 1936, has been as a heavy-duty wood preservative, used for utility poles and cross-arms, pilings, railway ties, outdoor construction materials and as a remedial treatment of timber and as a surface biocide for masonry (UNEP 2021e). Use of PCP for impregnation of utility poles and cross-arms is an exempted use in the Convention listing.

Table 2. Known applications of industrial POPs in building materials. Data are not exhaustive.

Chemicals	Insulation Material	Roofing	Other Interior & Exterior Construction Materials	Paints and Coatings	Wires and Cables	Sealants and Adhesives	Fabrics
DecaBDE[4]	PUR insulation (formerly also XPS); Piping insulation and pipes	PE/PE films/plastic sheeting used under the roof and to protect building areas	Facing laminates for insulation panels; Cladding panels	Paintinig	Cables	Adhesives	Blinds and curtains
HBCD	Expanded and extruded polystyrene insulation (EPS/XPS)		Molded EPS decorative elements, ornaments				Flame retardant textiles (HBCD in polymer dispersion)
SCCPs	PUR foam insulation		PVC materials	DIY, commercial and specialty paints; Painted articles;			
PFOA, PFOS, their salts	Wood fibre insulation	Used in coating on metal sheet	Composite wood materials;	Additives which improve weath-	Used as non-conductive plastic sheath		Water- and oil repellent fabrics used in

[2] 'One-step' EPS manufacturing process is used at least in Europe and generally in North America. In the 'one-step' production process all additives are mixed in the styrene solution prior to polymerisation. In the alternative 'two-step' process the beads are polymerized in the first step without the flame retardant additive and pentane; the possible flame retardant and pentane are added in the second step. In the 'two-step' process, the flame retardant must be able to penetrate into the ready-made bead. HBCD penetrates the beads poorly after polymerization, and therefore other flame retardants must be used in the "two-step" process (see HBCD Risk Management Evaluation UNEP/POPS/POPRC.7/19/Add.1).

[3] Typically EPS 5,000-10,000 mg/kg; XPS 8,000-25,000 mg/kg (UNEP 2021b).

[4] DecaBDE has been used in a wide range of polymers in the construction sector including polyurethane, polyethylene, polypropylene, and PVC (see Table 40 in UNEP 2021).

Chemicals	Insulation Material	Roofing	Other Interior & Exterior Construction Materials	Paints and Coatings	Wires and Cables	Sealants and Adhesives	Fabrics
and related compoun ds		roofs; Used in weather-proofing membranes; Used in textile-based roof		erability, color and gloss retention, resistance to chemicals			furniture, curtains, floor coverings and carpets etc.
PCP			Wooden indoor and outdoor structures				

Addressing the construction sector for information on POPs

The inventory process should begin by addressing country specific fire-safety requirements for construction and building materials (e.g. building code). Depending on the local or national fire-safety regulations, insulation materials, cladding panels, electrical ducts, textiles in public buildings (including hospitals and prisons), airports or hotels may be required to be flame retardant (UNEP/POPS/POPRC.6/13/Add.2; UNEP 2010a; Horrocks 2013).

A known challenge in making an inventory of use of POPs in construction materials or import of materials containing POPs is the likely large number of stakeholders. Production could be of different scales, from small and medium sized enterprises, manufacturing e.g. plastic construction materials from raw-materials from a supply chain that could even be in another country. Usually, however, the need for flame-retardant properties is in the specifications.

For guidance on general approach to developing an inventory of POPs used in the construction sector, please consult the General inventory guidance (UNEP 2020). Also, specific guidance documents for HBCD (UNEP 2021b), PBDE including decaBDE (UNEP 2021a), PCP (UNEP 2021e), PFOS (UNEP 2017a and UNEP 2019a), and SCCPs (UNEP 2021c).

The Basel Convention's technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with POPs contains detailed information on uses of POPs in different stages of production cycle. Relevant guidelines are available for PBDEs (UNEP 2015a), HBCD (UNEP 2015b), PFOS and PFOA (2022b), PCP (UNEP 2017c), and SCCPs (UNEP 2019f).

Guiding questions:

What kind of construction material producers and suppliers are there in the country?

What fire-safety regulations or standards exist for construction materials in the country, e.g. in the building code, or even local requirements or regulations by fire authorities? Are there specific requirements for flame-retardancy in public buildings such as offices, hotels and theatres?

Are polystyrene insulation materials used in the country? Domestic production or import?

Is there production of EPS raw material ('compounders') in the country or is it imported? From where?

Are there down-stream users producing EPS insulation panels, decorative elements or ornaments in the country? Where do they get their raw material?

Is XPS used in construction? Imported or domestic?

8. Electrical and electronic equipment (EEE) sector

This sector includes producers of electrical and electronic equipment and components (Table 3). The most typical uses of POPs in EEE are as flame-retardants in appliances that generate heat. Components where flame-retardants are used include plastic housings, panels, and printed circuit boards of e.g. TVs, computers and monitors. There are several alternative flame-retardants on the market that are not POPs, many of them brominated.

PFOA, PFOS, their salts and related compounds can be found in the semiconductor industry. They are contained in equipment used to manufacture semiconductors and are used in the photolithography and etching processes during the semiconductor production. PFOA, its salts and PFOA-related compounds are used for the production of in fluoropolymer and fluoroelastomer coatings for high-voltage electrical wire and cables, semiconductor production, as well as in electronics . Both PFOS and PFOA, as well as other PFAS, have been produced for direct use in commercial products and use in industrial product streams.

SCCPs have been generally used as plasticizers in flexible plastics and rubbers, and electronics are not their main application. Some uses have been identified, however, although some might be unintentional.

Table 3. Known applications of industrial POPs in EEE. Data are not exhaustive.

Chemicals	Plastics	Cables and Wires	Semiconductor	Other Applications
DecaBDE[5]	Plastic housings, panels, printed circuit boards in flat screens, TV, CRT monitors & displays and small household appliances, IT & telecommunications consumer electronics	Cables and connectors		
HBCD	Production of casings for electronic and electric equipment (HIPS); Styrene-acrylonitrile plastics			
PFOS			Used in photolithography or etch processes in semiconductor device (microchips) manufacturing	Used in vitro diagnostic medical devices, such as video endoscopes, and CCD colour filters; Electric and electronic parts for some colour printers and colour copy machines
PFOA, its salts and PFOA-related compounds		Fluoropolymer and fluoroelastomer coatings for high-voltage electrical wire and cables	Used in chemical-mechanical polishing slurries; Photolithography or etch processes	Used in coatings applied to consumer and professional films (e.g. in x-ray photographic imaging); Manufacture of polytetrafluoroethylene (PTFE) and polyvinylidene fluoride (PVDF) for the production of: High-performance, corrosion-resistant gas filter membranes, water filter membranes and membranes for medical textiles, industrial waste heat exchanger equipment, industrial sealants

[5] DecaBDE has been used in a wide range of polymers in the construction sector including polyurethane, polyethylene, polypropylene, and PVC (see Table 40 in UNEP 2021).

Chemicals	Plastics	Cables and Wires	Semiconductor	Other Applications
				capable of preventing leakage of volatile organic compounds and PM2.5 particulates
SCCP	Consumer articles (such as toys, game controllers, water heaters)	Insulation of wire and cables		Lubricant additives in electric generators (This application has been mentioned also in Table 4).

Addressing the EEE sector for information on POPs

For guidance on the general approach to develop an inventory of POPs used in the EEE sector, please consult the General inventory guidance (UNEP 2020). Specific guidance documents for HBCD (UNEP 2021b), PBDE including decaBDE (UNEP 2021a), and SCCPs (UNEP 2021c) are also relevant. The Basel Convention's technical guidelines on the environmentally sound management of waste consisting of, containing or contaminated with POPs contain detailed information on uses of POPs in different stages of production cycle. Relevant guidelines are available for PBDEs (UNEP 2015a), HBCD (UNEP 2015b), SCCPs (UNEP 2019f), and PFOS and PFOA (2022b).

Guiding questions:

What types of electronic and electrical equipment, including cables and printed circuit boards, are produced in the country?

Are there technical or regulatory requirements (such as flame-retardancy) for the manufacture/sale/import of EEE that may contain POPs?

Are there semiconductor industries in the country?

Are the raw materials used for the production of plastic casings imported or produced domestically?

9. Automotive sector

Vehicles are complex articles made of thousands of parts. It suggests that there could be a number of actors in different levels of supply chains belonging to this sector. Even in countries where vehicles or their parts are not produced, they are serviced; therefore, parts are used and importers and distributors for these parts still exist in these countries.

The use of POPs in vehicles is primarily be driven by the need for specific technical functions in materials, such as meeting fire safety specifications, as plasticizers or to increase repellence to dirt and water or corrosion. An example of specific materials used in cars and potentially containing POPs are fluoropolymers, which are known to be used in tubing and sealants.

Addressing the automotive industry requires identifying all companies in the manufacturer supply chain using POPs. Information on this could be requested from the manufacturer of the vehicle. However, the information on the chemical content seldom follows the product along the supply chain to the retail level. Additionally, there is likely a significant number of companies with little understanding of the chemical content of the parts produced or imported or of aftermarket spare parts available for vehicles on the market.

Similar to the construction sector, country-specific or regional product specifications apply to vehicles, e.g. concerning fire safety. Chemical composition of a certain make and model could, therefore, vary in different regions and data from one region may not automatically be valid for others. In addition, the composition of parts and components has varied over time and applications for POPs may not be valid anymore.

DecaBDE has been used in upholstery and other textiles (e.g. seats, visors), reinforced plastic parts, and certain under the hood or dash polymers and cables (Table 4) (RPA 2014; UNEP 2021a). Such parts are commonly available from parts distributors and could be produced domestically or imported. DecaBDE could also be used as a flame-retardant in plastics for electric and electronic equipment (EEE) used in cars, such as radios and displays[6].

HBCD has been used at least as a flame-retardant in upholstery (back-coating of fabrics especially for public transport vehicles). Little information, however, is available on which automotive textiles may contain HBCD, as various flame-retardants have been used for different fabrics. HBCD was detected in door trim fabrics and floor coverings but in none of the analysed seat fabrics in Japan (Kajiwara et al. 2014). HBCD has also been used in seat belts and thermal covers (protection from heat sources), as well as in the EPS insulation in cold storage trucks. Use of HBCD in vehicles is less common than decaBDE and it is assumed that, especially in fabrics, HBCD was been replaced because of its high costs.

A study from the Danish Ministry of the Environment suggests PFOS, its salts and PFOS-related compounds have previously been used in stain-repellent coatings on cars (Danish EPA 2005). This includes apparel and leather, upholstery, carpet, automobile interiors.

PFOA, its salts or PFOA-related compounds have been also used in stain-repellent coatings on cars. Moreover, PFOA, its salts and PFOA-related compounds have been used during the manufacture of fluoroelastomers for the production of O-rings, v-belts and plastic accessories for car interiors.

SCCPs have been used as lubricant additives and as plasticisers in sealants and adhesives. SCCPs were contained in polymers such as acrylic and butyl sealants, polyurethanes, and polysulfides. In the automotive sector these types of polymers were used for various applications, for example as sealants for windows and sealants that may act as intumescent (fire protection) coatings (UNEP 2021c).

Table 4. POPs used in automotive sector and their applications. Data are not exhaustive.

Chemicals	Applications
DecaBDE	Fabrics (upholstery); Reinforced plastics; Under the hood polymeric parts: terminal/fuse block; high power wire and cable jacketing (e.g. spark plug wire); Cables and heat shrinkable tubing/products; Electric and electronic components.
HBCD	Upholstery; Seat belts;

[6] According to a Swiss study deca-BDE was the dominant BDE in EEE (Taverna et al. 2017) but this could vary regionally.

Chemicals	Applications
	Thermal covers; Insulation (e.g. in cold storage trucks).
PFOS, its salts, and PFOS-related compounds	Car interior foam[7]; stain-repellent coatings textiles.
PFOA, its salts, and PFOA-related compounds	Stain-repellent coatings textiles; O-rings, V-belts and plastic accessories for car interiors; raw material for components such as low-friction bearings & seals, lubricants (ECHA 2018);
SCCP	Motor lubricant additives (This application has been mentioned also in Table 3); Used as plasticisers in sealants and adhesives; SCCPs were contained in sealants for windows and sealants that may act as intumescent (fire protection) coatings.

Addressing the automotive sector for information on POPs

For guidance on the general approach to develop an inventory of POPs used in the automotive sector, please consult the General inventory guidance (UNEP 2020). Also, specific guidance documents for HBCD (UNEP 2021b), PBDE including decaBDE (UNEP 2021a), PFOS (UNEP 2017a), and SCCPs (UNEP 2021c) are relevant. The Basel Convention's technical guidelines on the environmentally sound management of waste consisting of, containing or contaminated with POPs contains detailed information on uses of POPs in different stages of production cycle. Relevant guidelines are available for PBDEs (UNEP 2015a), HBCD (UNEP 2015b), SCCPs (UNEP 2019f), and PFOS and PFOA (2022b).

Typically, automotive spare parts are imported by either official importers or retail directly. These spare parts are also destined to be in the market longer than the vehicles to accommodate for the lifespan of the vehicle itself. Addressing the origin and the composition of the parts may therefore be laborious. The automotive manufacturing sector is heavily integrated, often relying on parts that may originate from different countries. The supply chains can also be complex and have many levels and it will require thorough investigation and communication with the stakeholders to be able to gain understanding on production and supply issues.

Guiding questions:

Does any level of automotive manufacturing take place in the country?

Is there production of components/parts, such as cables, gaskets or plastic parts for vehicles, taking place?

Are the raw materials domestically extracted/produced or imported (e.g. plastic pellets)?

What fire safety regulations or standards apply to the automotive sector?

Are there importers of automotive parts and spare parts?

Is there direct import of parts and vehicles from abroad by retailers? Where are the imported parts manufactured in? Do manufacturers maintain an inventory of spare parts for a long time (10 year plus) and how are they disposed when they are no longer necessary?

[7] Becanova et al. 2016.

10. Textile industry and leather

Textiles and leather are produced in some form in almost every country, although the majority of textiles are currently produced in Asia. POPs are used in textiles to e.g. achieve fire-safety, durability, dirt and water repellence or protection against microbial decay (Table 5). Information on the chemical contents of textiles seldom accompanies the final product so accessing the information on the retail level may be difficult. Chemicals are used throughout the supply chain and can be communicated through specifications, if any.

While many governments have agreed on global bans of several POPs through the Stockholm Convention, value chains still use thousands of hazardous chemicals, such as PFAS (UNEP, 2022). Processing mills from developing countries, which are major producers of textiles, often lack the awareness and technical expertise needed to manage chemicals according to best practices.

In the textile sector, c-decaBDE has been used to treat a wide range of synthetic, blended and natural fibres. Main end uses are upholstery, window blinds, curtains, mattress textiles, tentage (e.g. military tents and textiles, also commercial marquees, tents and canvasses) and transportation (e.g. interior fabrics in cars, rail passenger rolling stock and aircraft) (UNEP 2021a). Although use has been restricted with the listing to the Stockholm Convention in 2019, several exemptions were granted and few opt-in Parties have ratified the amendment.

PFOS- and PFOA-related chemicals have been used as formulars/mixtures for the oil-, water- and chemical-repellent finishing of textiles, leather, apparel, carpet and upholstery. For PFOS, according to Decision SC-9/4, as there were no longer any Parties registered for specific exemptions for the production and use of PFOS, its salts and PFOFS for carpets, leather and apparel, textiles and upholstery. For PFOA, Parties to the Convention agreed on specific exemptions for PFOA, its salts and related compounds used in worker-protection textiles (5-year exemption) at the COP meeting in May 2019. For non-technical textiles used in outdoor applications (e.g. awnings and outdoor furnishing, camping gear), alternatives are available and an exemption was not granted.

SCCPs have been used as a flame-retardant for textiles and as fat liquoring agents in the leather industry (RPA, 2021; UNEP 2021c). Commercial and military tents were impregnated (i.e. 'dry proofing' of heavy textiles) using SCCPs. SCCPs were used as a flame retardant in backcoating of textiles, for example textiles in upholstery or workwear of industrial workers. It is not known whether SCCPs are still used for these applications.

Chlorinated paraffins, including SCCPs, are used in leather treatment for light-fastness and a dry surface feel mainly in leathers for the top end of the quality range. This may include leather used for furniture, clothing or car seats. Different chlorinated paraffin mixtures are used in leather treatment and SCCPs were already phased out in some regions (e.g. EU). SCCPs have also been used in textile finishing as flame-resistant and water repellent in military tenting, sail cloths and industrial protective clothing and tarpaulins (ECB 2000). Typical applications for back-coated textiles included furniture upholstery, seating upholstery in transport applications, and interior textiles such as blinds and curtains (see UNEP; 2021c). These uses may be phased out, as need for them was not raised by any Party during the SCCP listing process.

A typical car contains 20-30 kg textiles (Sinha and Taylor 2015), and automotive industry is a large client for the textile industry. Automotive textiles are, however, discussed in more detail in section 9, Automotive sector.

PCP, or rather its ester, pentachlorophenyl laureate (PCP-L), has been used in the preservation of textiles and fabrics, particularly those used in heavy-duty/out-door military applications, which are subject to attack by fungi and bacteria during storage and use. These include wool, cotton, flax and jute fabrics and yarns used in covers, tarpaulins, awnings, tents, webbing, netting, sails and ropes (UNEP 2017g).

Table 5. POPs used in textile industry and leather. Data are not exhaustive.

DecaBDE	Upholstery textile (sofas, office chairs, mattresses); Blinds, draperies, blackout curtains; Geotextiles, wall coverings; Tents and tarps; Carpets.
HBCD	Residential and commercial upholstered furniture; Seating and other textile interior in transportation (trains, air planes, ships); Wall coverings and draperies; Interior textiles e.g. roller blinds and curtains; Protective clothing and other technical textiles (e.g. fire-fighters and military); Tents.

PFOS, PFOA, their salts, and related substances, including sidechain-fluorinated-polymers	Safety clothing for workers; Medical textile; Outdoor clothing, tents, umbrellas, footwear; Carpets and upholstery; Surface treatment agents for stain-resistancy.
SCCP	Leather; Commercial and military tents; Sail cloths, industrial protective clothing and tarpaulins.
PCP, PCP-L	Heavy duty military textiles (tents, tarpaulins); Wool, cotton, flax and jute fabrics and yarns used in covers, tarpaulins, awnings, tents, webbing, netting, sails and ropes.

Addressing the textile and leather sector for information on POPs

The textile industry is often small or medium sized and the number of stakeholders can be high. The textile industry is not only limited to clothing but also covers manufacture of equipment, such as tents, backpacks, tarpaulins etc. The three categories of textiles are the technical textiles commonly called industrial textiles (geotextiles, medical gowns, protective gear, etc.), Apparel (clothing, coats, etc.) and Home textiles (curtains, towels, tents, etc.) (UNEP, 2022c).

The textile sector is a major user of Persistent Organic Pollutants (POPs). Wet processing factories in few countries in Asia, where materials are turned into fabrics through bleaching, printing, dyeing, finishing and laundering typically use 0.58 kg of chemical inputs for every 1 kg of fabric produced. These compounds leak into the environment at all phases of the textile lifecycle, from production to use, disposal and recycling (UNEP, 2022c).

The textile supply chain could be long, from treatment of raw fibres, producers of yarn to actual production of the fabric, and further on to production of the actual articles. Some POPs are used already in the production of yarn, some could be applied at any point in the production chain as surface treatment chemicals or finishes, and studying the complex chains is likely to take time. Good communication within the supply chain is important.

For guidance on the general approach to develop an inventory of POPs used in the textile and leather sector, please consult the General inventory guidance (UNEP 2020). Also, specific guidance documents for HBCD (UNEP 2021b), PBDE including decaBDE (UNEP 2021a), PFOS (UNEP 2017a), and SCCPs (UNEP 2021c) are relevant. The Basel Convention's technical guidelines on the environmentally sound management of waste consisting of, containing or contaminated with POPs contains detailed information on uses of POPs in different stages of production cycle. Relevant guidelines are available for PBDEs (UNEP 2015a), HBCD (UNEP 2015b), SCCPs (UNEP 2019f), PFOS and PFOA (2022b) and PCP (UNEP 2017c).

The international policy alignment in the textile sector with best practices, supply chain transparency, investment for chemical management and eco-innovation will help to create the enabling environment needed to phase out POPs, PFAS and other chemicals of concern (UNEP, 2022c).

Guiding questions:

Is there production of yarn, fabrics, leather and articles made of textiles and leather?

Is there furniture production that uses textiles as upholstery? Where are the upholstery materials made?

How do the supply chains of articles produced for market work? Are raw materials imported or produced domestically?

What fire safety regulations or standards apply to use of textiles for different applications (protective equipment, furniture upholstery, carpets, draperies)? How are they met (chemicals or inherently flame-retardant materials)?

What surface treatment chemicals are used in the industry? Are surface treatment chemicals sold for the general public to treat carpets, furniture, car interiors? What do they contain?

11. Fire-fighting foams

Per- and polyfluoroalkyl substances (PFAS; among them PFOS and PFOA, their salts and related compounds) have been used in firefighting foam, including at airports and industrial facilities handling flammable liquids for more than 50 years as well as being used by Municipal Fire Brigades.

Aqueous Film-Forming Foam (AFFF) is the most commonly used foam that contains PFAS as surfactant. Fluorosurfactant-containing foams are generally used for flammable liquid hazards ("Class B fires"). However, they have also been used in "general purpose" extinguishers for solid materials (wood, paper, etc.) fires in some cases.

Fire-fighting foams are sold and stored typically as concentrates, which are mixed with water and air to produce foam for extinguishing fires on site. The users and holders of the stockpiles are municipal or industrial fire brigades, industries, fuel storages, airports, harbours etc. Foams can, however, also be available on the market for households in hand-held portable extinguishers (typically 9 L), which may contain either the concentrate or a finished pre-mix for direct application.

Due to the extensive and dispersive mode of use, fire-fighting foams containing PFOS and PFOA have been the focus of attention. Over the past decades, manufacturers have been replacing PFOS- and PFOA-based products with fluorotelomer-based fluorosurfactants, often 6:2-based products. However, significant amounts of AFFF containing PFOS may still be stored. Because AFFF have a long shelf life (10–20 years or longer), it is therefore possible that use of PFOS-containing fire-fighting foams may still be allowed.

Addressing fire-fighting foams for information on POPs

The main holders of AFFF fire-fighting foam are fire brigades and industries dealing with flammable liquids and solvents. These include chemicals industry, petrochemical industry, pharmaceutical industry, mines, harbours, airports, military etc.

A specific challenge with foam concentrates is their long shelf-life: stakeholders may easily have usable stockpile awaiting use originating from 20-30 years ago. The composition of the foam, including the potential PFOS or PFOA content, may be unknown. Trade names are seldom sufficient for excluding the potential POP content, as the composition may have changed and the product name kept. Preparing an inventory may, therefore, require chemical analyses. For certain newer foams, information on low contamination with PFOA ("C6-Pure") or PFAS in general may be visible. The origin of the foam and the requirements for the composition of the foam, if any, are important in defining the potential for finding PFOS or PFOA substances in the foam.

Information on the contents of foam concentrates may be available from the material safety data sheet, manufacturer, or importer.

Municipal fire brigades may also hold stockpiles of AFFF, which has been viewed by some as a "general purpose" foam. Large stores of AFFF are, however, expected to be found in facilities that have large storage tanks for fuels etc., such as refineries, oil terminals, chemicals industry, airports and harbours.

A reasonable approach for evaluating the potential stockpiles of PFOS or PFOA containing foam is to seek AFFF foams. For guidance on the general approach to developing an inventory of POPs used in the fire-fighting sector, please consult the General inventory guidance (UNEP 2020). The specific guidance document on PFOS (UNEP 2017a) is also relevant.

Guiding questions:

Are there activities typically related to use of AFFF foams, such as chemicals industry, petrochemical industry, pharmaceutical industry, mines, harbours, airports, or similar military activities? What kind of foams are used and stored for fire protection?

Is there production of fire-fighting foams?

What kind of foams are marketed by the manufacturers or importers?

Are there portable AFFF extinguishers on the market? What is the origin of the content?

What foams are used by municipal and industrial fire brigades in the country?

Are there requirements for fire-fighting equipment that would require use of AFFF?

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