



The potential impact of flame retardants on the “end of life” of upholstered furniture and furnishings

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Technical Services Department

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GLOSSARY OF TERMS:

BADP - Bisphenol A (bis-[diphenyl]phosphate)
 BAT- Best Available Technique
 BFR - Brominated Flame Retardant
 CAS – Chemical Abstracts Service
 CLP – Classification, Labelling and Packaging Regulation
 COP - Convention of Parties
 DecaBDE- Decabromodiphenyl ether
 EBP – Decabromodiphenyl ethane
 ECHA - European Chemicals Agency
 EFRA – European Flame Retardants Association
 ELV - End of Life Vehicle (directive)
 ELW – European List of Waste
 EPA – US Environmental Protection Agency
 EPS - Expanded Polystyrene
 FR- Flame Retardant
 GHS – Globally Harmonised System
 HBCD - Hexabromocyclododecane
 HSE - Health and Safety Executive
 IPCS - International Programme on Chemical Safety
 LRET - Long Range Environmental Transport
 NIP - National Implementation Plan
 OctaBDE- Octabromodiphenyl ether
 OSPAR - Oslo and Paris Conventions
 PBB - Polybrominated Biphenyl
 PBDE - Polybrominated diphenyl ether
 PBT- Persistent, Bioaccumulative and Toxic
 PCDD - Polychlorinated Dibenzofurans
 PeCB - Pentachlorobenzene
 PentaBDE- Pentabromodiphenyl ether
 PFOS - Perfluorooctanesulfonic acid
 PHS – Priority Hazardous Substance
 POP - Persistent Organic Pollutant
 POPRC- Persistent Organic Pollutant Review Committee
 PUR - Polyurethane
 REACH- Registration, Evaluation, Authorisation and restriction of CHemicals
 RoHS - Restriction of Hazardous Substances
 SCCP – Short-chain chlorinated paraffins
 SVHC - Substance of Very High Concern
 TetraBDE- Tetrabromodiphenyl ether
 TCEP - Tris (2-chloroethyl)phosphate
 TDCPP - Tris (1,3-dichloro-2-propyl)phosphate
 TFA – Textile Finishers Association
 TBBPA - Tetrabromobisphenol-A
 TPHP - Triphenylphosphate
 UNEP - United Nations Environment Program

VECAP - Voluntary Emissions Control Action Program
WEEE- Waste Electrical and Electronic Equipment (directive)
WFD - Water Framework Directive
XPS - Extruded Polystyrene

1. Introduction

The upholstered furniture and furnishings industry is facing challenges with a number of flame retardant (FR) chemicals being placed on REACH (Registration, Evaluation, Authorisation and restriction of Chemicals) candidate lists. In addition some are also being considered for designation as Persistent Organic Pollutants (POP's). These factors have a significant impact on the use of, and responsibilities for, such chemicals and, potentially, on how to deal with products containing them at the end of their lives.

Products containing persistent organic pollutants are classed as hazardous waste at the end of their lives if the concentrations of these chemicals exceed designated limits. Hazard classification, of waste is also categorised by the relevant authority in respect to the Waste Framework Directive. If classed as hazardous this has a number of implications such as export of waste overseas and importing of flame retardant chemicals into the UK.

This report investigates the impact of the presence of flame retardants on the furniture industry in relation to the disposal of upholstery and furnishings. Specifically it focuses on:

- The nature of the FR problem and how it relates to furniture
- FR chemicals used previously, currently and potentially in the future
- How these chemicals are governed and controlled throughout manufacturing and waste stages
- Future solutions covering issues such as labelling, disposal and traceability

1.1 Why are FR chemicals used in upholstery?

Homes, workspaces and public buildings contain a significant amount of potentially flammable materials (furniture, carpets, toys, clothes magazines etc). Flame retardants are used to reduce fire risks from the growing number of products in these environments, and to prevent modern materials from igniting and spreading a fire.

When a fire starts in a room it can develop quickly if it spreads to items adjacent to the source. Once a number of items are burning, the temperature in the room will climb and may reach "flash over" point. This refers to when hot burning gases effectively cause the whole room to catch light, often violently. Once this occurs, escape from the room is almost impossible, and spread of fire is rapid. Flame retardants act by preventing the initial start of a fire by obstructing ignition and by slowing down the spread of fire, therefore increasing escape time, and possibly preventing "flash over".

According to a report by Greenstreet Berman¹, the number of UK fire related deaths in the home showed a rising trend from the 1960s to the late 1980s. These deaths rose from 400 per year at the start of 1960 to 700 by the end of the decade, with a further increase over the 1970s. As a reaction to these statistics, The UK government introduced the Furniture and Furnishings (Fire) (Safety) Regulations 1988 (as amended)².

A study by the University of Surrey estimates that flame retardants led to a 20 percent reduction in fire deaths in the United Kingdom. Statistics for the UK show that over 3,000 lives

have been saved since 1988 as a result of legislation mandating that upholstered furniture for the home be made with a high level of fire resistance³.

This evidence indicates the important life saving impact of flame retardants for furniture and furnishings. However, there is a possible environmental cost associated with some of these chemicals due to the potentially hazardous nature of some of their chemical constituents.

2. FR chemicals and their uses

2.1 Background to flame retardants

Flame retardants are chemicals used to reduce risk of fire through reducing the ignitability of materials and/or the heat generated from materials. Because materials with thermally stable structures are often difficult and costly to process, manufacturers use other means, such as adding flame retardant chemical treatments. There are a large number of flame retardants on the market and they offer cost-effective solutions for providing fire safety. Within the furniture and furnishings sector these chemicals are used in a broad range of products including upholstery cover fabrics and foams.

Whilst flame retardants stall ignition and contribute to a reduced fire risk in a product, some are associated with environmental hazards and hazardous by-products. Some also yield hazardous by-products during partial combustion and at the decomposition stage at the end of the products' lives.

2.2 Flame retardant classification

Flame retardants are usually incorporated throughout the composition of a material, although they can also be coated on the external surface of the material to form a protective barrier. According to the Environmental Protection Agency they can be broadly classified into two types according to the way they are incorporated into the material:

- *Reactive*: Reactive flame retardants are built into the material and will become a permanent part of the polymer structure – i.e. chemically-bound. Compared to an additive flame retardant, reactive flame retardants can have a greater effect on a polymer's physical/chemical properties.
- *Additive*: Additive flame retardants are also incorporated into the material during manufacturing and may interact with the composition, but they remain as independent chemicals. They are not chemically bound to the material so have a potential to migrate under certain conditions over time. Additive flame retardants are far more versatile because they can be incorporated into the product up until the final stages of production and are a popular choice throughout the furniture industry⁴.

Both reactive and additive flame retardants can significantly change the properties of the materials into which they are integrated. They have the capability of altering the viscosity,

flexibility, density, tensile strength, and flexural strength. They may also increase the sensitivity of the material to photochemical and thermal degradation.

Most current flame retardants can be classified into four main categories according to chemical composition:

- *Halogenated*: Halogenated flame retardants are primarily based on chlorine and bromine. In 2006, brominated compounds represented approximately 18% by volume of global flame retardant consumption. Typical halogenated flame retardants are 'halogenated aliphatic and aromatic compounds', 'halogenated polymeric materials', and 'halogenated paraffins'. Some halogenated flame retardants also contain other elements, such as phosphorus or nitrogen. Halogenated additives interfere with unstable substances that are created in the burning process thus decreasing their combustibility.
- *Inorganic*: This includes inorganic flame retardants and flame retardant stimulants. These can consist of metal hydroxides e.g., aluminium hydroxide and magnesium hydroxide, antimony compounds e.g. antimony trioxide, boron compounds e.g. zinc borate (which are both often used as synergists for both halogenated and non-halogenated flame retardants), and metal compounds.. Synergists work in combination with another chemical resulting in an increased combined effect on molecules reacting with combustible gases in a fire, and the result is greater than if the two components worked separately. By itself, antimony oxide has little flame retardant effect in the presence of most burning materials.
- *Phosphorus-based*: This category, covers a wide range of phosphorus compounds with different oxidation properties, and according to the US Environment Protection Agency, represented about 16% by volume of the global consumption of flame retardants in 2006. It includes organic and inorganic phosphates, phosphonates, and phosphinates as well as red phosphorus⁵. There are also halogenated phosphate esters, often used as flame retardants for polyurethane foams or as flame retardant plasticizers.
- *Nitrogen-based*: These flame retardants include melamine and melamine derivatives (e.g., melamine cyanurate, melamine polyphosphate). Nitrogen compounds were estimated to account for a very small portion of the global flame retardant consumption. Nitrogen-containing flame retardants are often used in combination with phosphorus-based flame retardants.

2.3 Past, present and future flame retardant chemicals used throughout the furniture industry

The following list includes some of the flame retardants which have previously and are currently being used throughout the furniture industry. These have been categorised according to their chemical type.

Family group	Chemical	Still in use?
Brominated Flame Retardants	Hexabromobiphenyl (HBB)	No longer in use
	Pentabromodiphenyl ether (pentaBDE)	(Come under the group-polybromodiphenyl ethers (PBDEs)) No longer in use
	Octabromodiphenyl ether (octaBDE)	
	Hexabromodiphenyl ether (hexaBDE)	
	Tetrabromodiphenyl ether (tetraBDE)	
	Decabromodiphenyl ether (decaBDE)	Currently in use
	Hexabromocyclododecane (HBCD)	Currently in use for polystyrene foams in buildings. Not being used for textile applications.
	Decabromodiphenyl ethane (EBP)	Currently in use
	Perfluorooctane sulfonic acid (PFOS)	US production phased out in 2000, however still produced in China and currently in use ⁶
Chlorinated Flame Retardants	Short-chained chlorinated paraffins (SCCPs)	Currently in use
	Tris (1,3-dichloro-2-propyl)phosphate (TDCPP)	Not widely used
	Tris (2-chloroethyl)phosphate (TCEP)	Stopped being produced in Europe in 2002. No longer in use ⁷
	Pentachlorobenzene (PeCB)	No longer in use
Phosphorous-based Flame Retardants	Triphenylphosphate (TPHP)	Currently in use
	Bisphenol A (bis-[diphenyl]phosphate) (BADP, BAPP, BPADP, BDP)	Currently in use
Nitrogen-based flame retardants	Melamine	Currently in use
	Melamine derivatives	Currently in use
	Melamine homologues	Currently in use

**this list is not exhaustive but gives a good overview of the major popular flame retardant technologies*

A 2009 report by OSPAR (the mechanism by which fifteen Governments of the western coasts and catchments of Europe, together with the European Union, cooperate to protect the marine environment of the North-East Atlantic) reported that of the 75 commercially recognised brominated flame retardants (BFRs), tetrabromobisphenol-A (TBBPA), HBCD, and decaBDE (mainly used in plastics, textiles such as upholstery fabrics, and synthetic carpets) constituted more than 97% of the BFRs used in Europe.

In textile back coating, the flame killing action of brominated flame retardants is particularly desirable, since it allows the flame retardant to be coated on one side of the textile, with the flame killing effect on the other side. This is extremely important for upholstered furniture textiles as it has very little impact on the appearance and finish of the fabric. These reactive substances diffuse from the back, where they are released, through the fabric to the front, and then extinguish the developing fire through their activity in the gaseous phase.

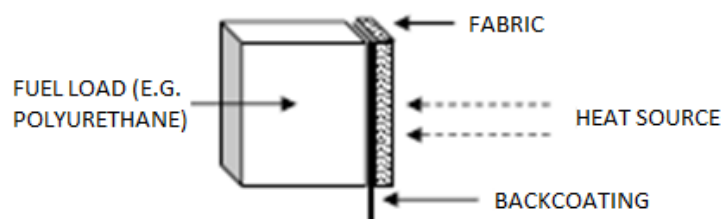


Figure 1: How back coating can provide a fire barrier within upholstery⁸

Combinations of mixtures of salts like sodium bromide and diammonium phosphate, and back coating formulations based on combinations of ammonium polyphosphate, melamine, and phosphate with decabromodiphenyl oxide (decaBDE) and or hexabromocyclododecane (HBCD) have all been used in coating textiles⁹.

It is important to note that whilst polybrominated diphenyl ethers (PBDEs) are generally known for their bioaccumulative and toxic properties, a study by the Public Health England centre for Radiation, Chemical and Environmental Hazards has shown that exposure to decaBDE does not have as much toxicological impact as the lower brominated PBDEs like octaBDE and pentaBDE¹⁰.

The Agency for Toxic Substances and Disease Registry defines PBDEs as classes of brominated hydrocarbons, also referred to as brominated flame retardant chemicals. They are structurally similar, containing a central biphenyl structure surrounded by up to ten bromine atoms¹¹.

Whilst fire safety is paramount, the chemicals used to achieve these standards can sometimes be a cause for concern and need to be reviewed to see if their environmental impact outweighs their positive contribution. As a result of this, some of the chemicals on the list above have been reviewed and in some cases been restricted or phased out of use due to their bio-accumulative properties. This section investigates which chemicals have previously and are currently being reviewed for their environmental impact and which chemicals are not currently considered to be causes for concern.

2.4. Control of chemicals

There is a range of legislation governing the use of flame retardants and other chemicals used in the furniture industry, as well as voluntary best practices. Some of these require disclosure of their inclusion within a product, and some completely prohibit their use. This section summarises key legislation impacting on the use of the chemicals listed in [section 2.3](#).

2.4.1 REACH (Registration, Evaluation, Authorisation and restriction of Chemicals)

REACH is the system for controlling chemicals in Europe and became enshrined in UK law on 1st June 2007. Since 1st December 2008, chemical substances manufactured in Europe in amounts of 1 tonne or more per year have needed to be registered with the European Chemicals Agency (ECHA) in Helsinki¹². REACH replaces a number of previously separate European Directives and Regulations into a single, harmonised structure. It is not limited to industrial chemicals and includes chemicals used in day-to-day life.

The European Chemicals Agency (ECHA) manages registration, evaluation, authorization and restriction processes for chemical substances across the EU. In the UK the lead authority for administering REACH is the Health and Safety Executive (HSE).

2.4.1.1 Registration

Under REACH, each producer and importer of chemicals in volumes of 1 tonne or more per year (around 30,000 substances), was required to register with the ECHA. They had to provide information on the properties and uses of substances along with details regarding safe handling procedures. The producers and importers also had to pass this information on to 'downstream users' i.e. manufacturers that use these chemicals in their production processes, enabling them to use the substances safely and without creating risks for their workers, end consumers and the environment. The ECHA has made non-confidential information available to the public.

2.4.1.2 Evaluation

Dossiers of information registered by importers and manufacturers are subject to evaluation by enforcing authorities. At this stage they will also scrutinise all proposals for animal testing to limit it to the absolute minimum. Moreover, REACH makes data sharing on animal test results compulsory and prescribes the use of alternative methods wherever possible. An evaluation is also undertaken on substances that have been prioritised for potential regulatory action because of concerns over hazardous properties. This could result in the imposition of restrictions on the manufacture, supply or use of a substance or may lead to a substance being added to the priority list for authorization.

2.4.1.3 Controlled chemicals and Substances of Very High Concern (SVHCs)

There are three groups of chemicals specifically controlled under REACH:

- The Candidate List of Substances of Very High Concern (SVHCs)¹³, last updated in January 2012.
- Annex XIV Substances¹⁴, priority SVHCs from the candidate list requiring authorization.
- Annex XVII Restricted Substances¹⁵, particular hazardous substances that have controls on how they can be supplied or used. Typically, substances belonging to this category are prohibited.

A substance can be subject to control in any or all of the groups listed above. A chemical may be classified as a Substance of Very High Concern (SVHC) if it has high associated hazards and, accordingly, meets one or more of the following criteria:

- It is carcinogenic.
- It is mutagenic.
- It is toxic for reproduction.
- It is a persistent bio-accumulative and toxic according to criteria set out in Annex XIII (PBT Substances).
- It is very persistent and very bio-accumulative according to criteria set out in Annex XIII (vPvB Substances).

Proposals to list a substance as a SVHC can come from either the European Commission or one of the EU's member states. These proposals are made public by the ECHA and if the substance is deemed to meet one or more of the above criteria it is subsequently listed as a

SVHC. The list of SVHCs is referred to as a 'Candidate List' as all of the substances placed on it are candidates for inclusion in Annex XIV of REACH. Some substances from the Candidate List will immediately be prioritised for authorization and included in Annex XIV (SVHC Authorisation List). Subsequently, these substances will be given the following:

- A 'Latest Application Date' - a specified date by which applications for use must be submitted to the ECHA.
- A 'Sunset Date' - a specified date after which the substance cannot be used or imported into the EU without prior authorization from the ECHA.

As of September 2015 there are 163 substances on the SVHC Candidate List.

2.4.1.4 Substances of Very High Concern Candidate List obligations:

Companies have legal obligations resulting from the inclusion of substances in the Candidate List of SVHCs. These obligations refer not only to the listed substances on their own or in mixtures, but also to their presence in 'articles'. Under the REACH Regulations 'articles' are defined as objects which, during production, are given a special shape, surface or design which determines its function to a greater degree than does its chemical composition.

2.4.1.5 Substances in articles:

From the date of inclusion on the Candidate List:

EU and EEA suppliers of articles which contain substances on the Candidate List in a concentration above 0.1% w/w (i.e. a particular weight of chemical contained in the overall weight of the article) have to provide sufficient information to allow safe use of the article to their customers or, upon request, to a consumer within 45 days of receipt of purchase.

From 1st June 2011:

EU and EEA producers or importers of articles have to notify the ECHA if their article contains a substance on the Candidate List. This obligation applies if the substance is present above 0.1% w/w and its quantities in the produced/imported articles are over 1 tonne in total per year. If importing or producing several articles containing the same SVHC then total tonnage must be calculated.

2.4.2 Stockholm Convention

The Stockholm Convention was created in 2004 after a series of international meetings (starting as early as 1995) demanding action on Persistent Organic Pollutants. As of May 2013, there are 179 parties to the convention (178 states and the European Union). Notable non-ratifying states include the US, Israel, Malaysia, and Iraq. The Stockholm Convention is implemented within EU legislation in REGULATION (EC) No 850/2004.

Key elements of the Convention include the responsibility for developed countries to provide new and additional financial resources and methods in order to eliminate production and use of intentionally produced POPs, eliminate unintentionally produced POPs where feasible, and manage and dispose of POP wastes in an environmentally friendly manner.

2.4.2.1 Review procedures of POPs

When the Convention was adopted, provision was made for a procedure to identify additional POPs and the criteria to be considered when doing so. The POP Review Committee (POPRC), comprising 31 experts from the five United Nations regional groups, reviews nominated chemicals in three stages.

It first establishes whether a substance fulfils POP screening criteria detailed in Annex D of the Convention, relating to its persistence, bioaccumulation, potential for long-range environmental transport (LRET), and toxicity.

If a substance is deemed to fulfil these requirements, the Committee will draft a risk profile according to Annex E to evaluate whether the substance is likely, as a result of LRET, to lead to significant adverse human health and/or environmental effects and therefore warrants global action¹⁶. Lastly, if the POPRC finds that global action is warranted, it creates a risk management evaluation, according to Annex F, reflecting socioeconomic considerations associated with possible control measures. Based on this, the POPRC decides to recommend that the substance be listed under one or more of the Annexes to the Convention.

2.4.2.2 The Annexes:

Annex A- Elimination: Countries must take measures to eliminate the production and use of the chemicals listed under Annex A. Specific exemptions for use or production are listed in the Annex and apply only to Parties that register for them. An example of this would include allowing a product containing the chemical listed to be recycled and included into a new product (providing it falls within the concentration limit).

Annex B- Restriction: Countries must take measures to restrict the production and use of the chemicals listed under Annex B in light of any applicable acceptable purposes and/or specific exemptions listed in the Annex.

Annex C- Unintentional Production: Countries must take measures to reduce the unintentional release of chemicals listed under Annex C with the goal of continuing minimization and, where feasible, ultimate elimination.

2.4.2.3 POP Screening:

As part of POP screening, many factors are assessed to distinguish a chemical's environmental impact. One criterion is long-range environmental transport (LRET) which looks at measured levels of the chemical in locations distant from the sources of its release. This relates to the potential for transfer to a receiving environment occurring via air, water or migratory species.

2.4.3 EU restriction on the use of hazardous substances directive (RoHS)

The Restriction of Hazardous Substances (RoHS) Directive (2002/95/EC) is a major piece of legislation that came into force in 2006. Its purpose is to restrict the use and import into European Union (EU) member states of six hazardous substances, found in articles such as

new electrical or electronic equipment (EEE) incorporating a flame retardant. Since 2006, a series of Commission Decision amendments have been circulated and enforced. The six restricted substances are lead (Pb), mercury (Hg), cadmium (Cd), hexavalent chromium (Cr), polybrominated biphenyls (PBB), and some polybrominated diphenyl ethers (octaBDE, pentaBDE and tetraBDE).

Within these categories three new POPs have been designated; hexabromodiphenyl ether, commercial pentabromodiphenyl ether and commercial octabromo-diphenyl ether. (commercial versions of the chemical refers to technical mixtures of different PBDE congeners).

The EU has adopted the RoHS Directive to protect employees of manufacturers and recyclers from exposure to these substances throughout the product life cycle.

Key elements of the RoHS Directive include:

- **Articles with maximum allowable concentration value in homogeneous articles of 0.1% by weight (1000ppm) for PBBs and most PBDEs:** if this concentration is exceeded, the articles are not in compliance with the EU Directive, will not be permitted to be imported into the EU, and are placed on a register of non-conforming products.
- **Standard reference materials:** developed for analytical testing of articles and materials in the supply chain.
- **An EU Declaration of Conformity:** assured through the fixing of a legible and indelible “CE” mark; governments can take action if the label is awarded improperly.

Some countries, other than those supplying articles to the EU, have adopted the concepts of the RoHS for their own national markets. The RoHS, which places the burden of proof on manufacturers inside and outside the EU, could form the basis for further development of compliance with import/export and transport regulations for additional POPs¹⁷.

2.4.3.1 The Restriction of Hazardous Substances (RoHS) Directive 2 (2002/95/EC 2011/65/EU)

The RoHS 2 directive (2011/65/EU) is an evolution of the original directive and became law on the 21st July 2011, taking effect on 2nd January 2013. It addresses the same substances as the original directive while improving regulatory conditions and legal clarity. It requires periodic re-evaluations that facilitate gradual broadening of its requirements to cover additional electronic and electrical equipment, cables and spare parts. The CE logo now indicates compliance and RoHS 2 declaration of conformity is now detailed.

2.4.3.2 Life-cycle impact assessment of brominated flame retardants (BFR)-free materials

The ban on concentrations of brominated flame retardants (BFRs) above 0.1% in plastics has had an impact on plastics recycling. As more and more products include recycled plastics, it has become critical to know the BFR concentration in these plastics, either by tracing the origins of the recycled plastics to establish the BFR concentrations, or by measuring the BFR

concentrations from samples. Plastics with high BFR concentrations are costly to handle or to discard, whereas plastics with levels below 0.1% have value as recyclable materials.

There are a number of analytical techniques for the rapid measurement of BFR concentrations. X-ray fluorescence spectroscopy can confirm the presence of bromine but it does not indicate the BFR concentration or specific molecule. Ion attachment mass spectrometry (IAMS) can be used to measure BFR concentrations in materials such as plastics. These applications could potentially be used on other products such as textiles for upholstery.

2.4.4 The Waste Electrical and Electronic Equipment (WEEE) directive

The Waste Electrical and Electronic Equipment (WEEE) directive aims to prevent the production and disposal of WEEE through reuse and recycling targets. Moreover, it is set up to improve the environmental performance of all operators involved in the life cycle of electrical and electronic (E&E) equipment. The WEEE directive requires European Union Member States to ensure that producer-financed systems are set up to separately collect, treat, recover and dispose of WEEE. The WEEE directive prescribes the removal or the separate treatment of certain substances, mixtures and components, including plastic containing **brominated flame retardants**, from any separately collected WEEE. The directive has been in force since February 2003¹⁸.

2.4.5 Water Framework Directive (WFD)

The Water Framework Directive (WFD), which entered into force in December 2000, establishes a Community framework for water protection and management. Its main focus is the establishment of a strategy for dealing with chemical pollution of water. Member States would then be obliged to carry out measures to achieve defined environmental quality standards (EQS), where it is technically feasible and not unreasonably costly to do so, and to also carry out measures for the termination or phasing out of discharges, emissions and losses to the aquatic environment.

In a report on the analysis of the most appropriate risk management options for decaBDE¹⁹ there are concerns that decaBDE has the potential to degrade to similar PBDE products that are within scope of the Water Framework Directive which may prompt Member States to take action to prevent the release of decaBDE which would be a discretionary decision of each country. OctaBDE and decaBDE are listed among the substances to be monitored, while pentaBDE is the only BFR listed as a hazardous substance. No other BFRs are listed²⁰.

2.4.6 The Voluntary Emissions Control Action Program – VECAP

The Voluntary Emissions Control Action Program (www.vecap.info) is led by the European Flame Retardants Association (EFRA), representing the three main suppliers of decaBDE to the European market, and is targeted at all European users of brominated flame retardants. This is not legislation and is a voluntary best practice followed throughout the backcoating industry. This revolutionary stewardship scheme was established in 2004 by the three main producers of flame retardants and the UK Textile Finishers Association (TFA). This was also

achieved in partnership with users in order to ensure the environmentally sound management of chemicals through the production chain.

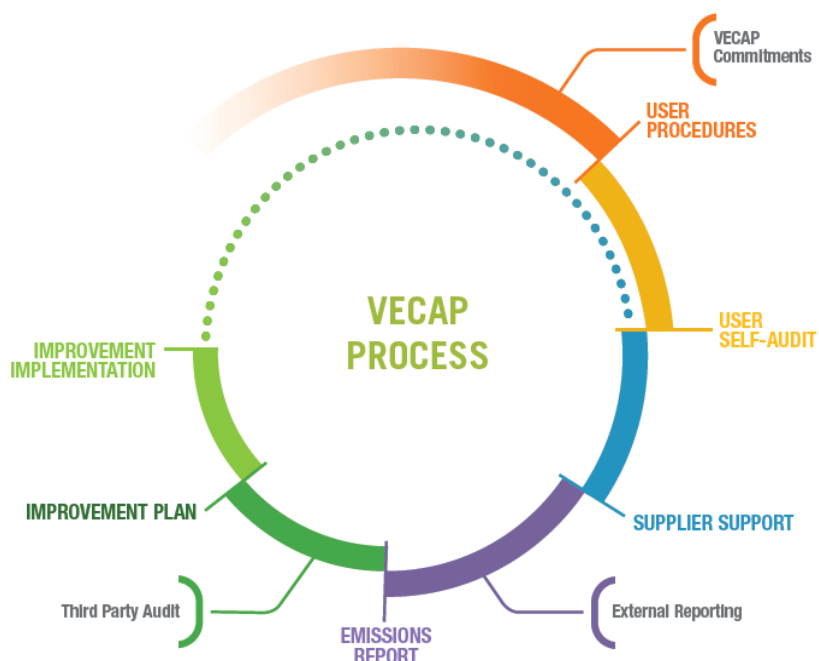


Figure 2: How VECAP works²¹

As a result of the VECAP initiative, suppliers have generated good practice advice for situations which they have identified as having a high potential for environmental release during production. However, participation in VECAP is voluntary, not all suppliers to the EU market participate, not all downstream users participate (after five years of operation, around 10% of the three main suppliers' tonnage is sold to users who are not signed up) and VECAP does not cover releases during service life or disposal/recycling of treated articles.

There is a BREF (reference document on best available techniques) for the textile industry which provides Best Available Techniques (BAT) for minimising FR chemical emissions. VECAP has effectively offered a strengthening of the BREF advice for flame retardants applied to textiles. This focuses more on emissions occurred in production as opposed to end of life, as it is claimed that this is where the biggest environmental impact occurs²².

2.4.7 The Classification, Labelling and Packaging Regulation

The Classification, Labelling and Packaging Regulation 1272/2008/EC (CLP) allows identification of hazardous chemicals and informs users about these hazards through standard symbols and phrases on packaging labels and through safety data sheets.

3. Chemicals impacted by legislation:

Referring back to the list in [Section 2.3](#) the table below indicates how the different legislations have impacted the use and production of flame retardant chemicals used in the furniture industry;

Family group	Chemical	Legislative impact
Brominated Flame Retardants	Hexabromobiphenyl (HBB)	Listed under Annex A of the Stockholm Convention.
	Pentabromodiphenyl ether (pentaBDE)	Come under the group-polybromodiphenyl ethers (PBDEs) listed under Annex A of the Stockholm Convention. Registered under REACH as SVHC's.
	Octabromodiphenyl ether (octaBDE)	
	Hexabromodiphenyl ether (hexaBDE)	
	Tetrabromodiphenyl ether (tetraBDE)	
	Decabromodiphenyl ether (decaBDE)	Registered as an SVHC under REACH with CAS No: 1163-19-5 in Sep 2010. Proposed for listing under Annex A of the Stockholm Convention, POP listing not expected until end of 2018.
	Hexabromocyclododecane (HBCD)	Registered under REACH with CAS No: 79-94-7 in Oct 2008 and listed under Annex A of the Stockholm Convention.
	Decabromodiphenyl ethane (EBP)	Ongoing REACH evaluation. Decision not expected until 2017/2018. No current impact on use or production.
	Perfluorooctane sulfonic acid (PFOS)	Listed under Annex B of the Stockholm Convention with specific exemptions in textiles, upholstery and coatings
Chlorinated Flame Retardants	Short-chained chlorinated paraffins (SCCPs)	Proposed for listing under Annex A of the Stockholm Convention.
	Tris (1,3-dichloro-2-propyl)phosphate) TDCPP	Registered under REACH with CAS No: 13674-87-8
	Tris (2-chloroethyl)phosphate (TCEP)	Listed as a SVHC under REACH with CAS No: 115-96-8 as of 2012. Likely to face restrictions for its use in children's toys, however no current impact within furniture uses in Europe ²³ .
	Pentachlorobenzene (PeCB)	Listed under Annex A and C of the Stockholm Convention
Phosphorous-based Flame Retardants	Triphenylphosphate (TPHP)	No impact (A 2009 risk evaluation of TPHP by the UK Environment Agency concluded it does not meet persistent, bio-accumulative or toxic (PBT) criteria) ²⁴ .
	Bisphenol A (bis-[diphenyl]phosphate) (BADP, BAPP, BPADP, BDP)	No impact
Nitrogen-based flame retardants	Melamine	No impact
	Melamine derivatives	No impact
	Melamine homologues	No impact

3.1 Flame Retardants currently in use and impacted by legislation

3.1.1 Decabromodiphenyl ether - DecaBDE

DecaBDE (commercial mixture c-decaBDE) is used for a wide range of applications and the role it plays in fire safety is unquestionable. DecaBDE has traditionally been a flame retardant of choice for upholstered furniture and textiles and the chemical is always used in conjunction with antimony trioxide in synthetic materials. In plastics, decaBDE is used for electrical and electronic equipment (i.e. housings of computers and TV sets).

At the time of writing this report there are no restrictions in the EU for its use in textiles and upholstered furniture²⁵.

In the US and Canada, decaBDE production and sales were voluntarily phased out at the end of 2012 by the Bromine, Science and Environmental Forum (BSEF) members except specifically for transportation and military applications. The European Court of Justice ruled in 2008 that as of 1 July 2008 decaBDE can no longer be used in electronics and electrical applications in Europe.

In May 2013, decaBDE was proposed as a candidate Persistent Organic Pollutant (POP) by Norway which resulted in the European Chemicals Agency (ECHA) publishing an intention for its restriction. Currently the UN Stockholm Convention is reviewing if decaBDE meets POP criteria.

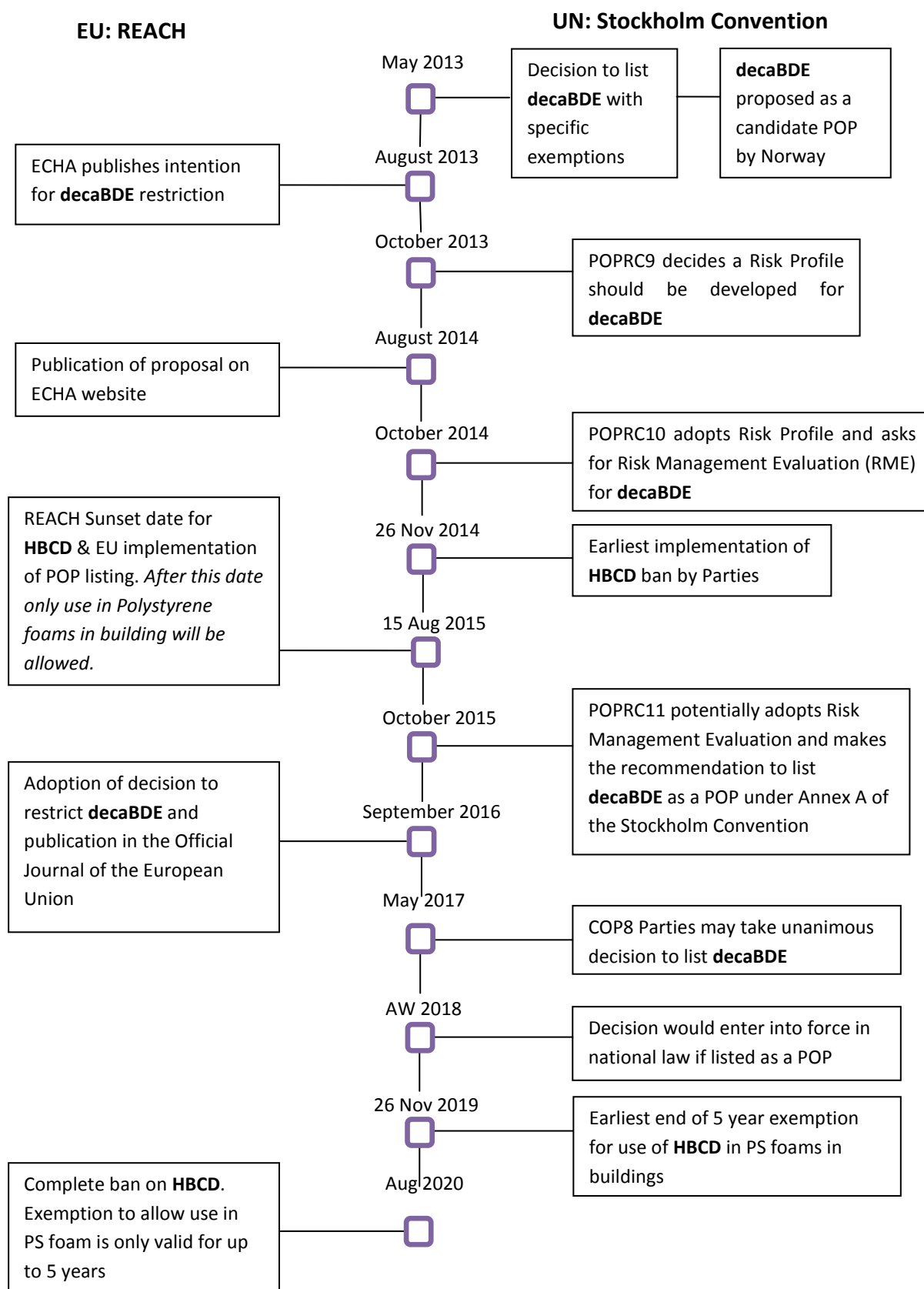
3.1.2 Hexabromocyclododecane – HBCD

Commercially available hexabromocyclododecane (HBCD) is a white solid substance which is used as an additive flame retardant on its own, or in combination with other flame retardants. The main downstream uses of HBCD are in the polymer and textile industries. It is estimated that 8%, is used in textile coating in vehicles, furniture and bed mattresses. Alternative chemicals and techniques for avoiding the use of HBCD are available for most of its uses. European industry has already started voluntary programs to manage its releases from industrial sites.

According to the Bromine Science and Environmental forum, HBCD is one of the flame retardant technologies to meet the highest levels of safety against flammability required by the legislations for furniture and other textile applications in several EU Member States. HBCD has undergone an EU Risk Assessment (RA) for environment and human health, which was initiated in 1996 and finalised in May 2008. The RA conclusions identified no risk to consumers, but due to its persistent, bio-accumulative and toxic properties, it has been identified as a potential environmental hazard²⁶.

The current estimated review schedule for HBCD and decaBDE is illustrated below. As a result, HBCD has been listed a SVHC and a POP under the Stockholm Convention.

Figure 3: Phase out timings (based on earliest estimates) for HBCD and decaBDE²⁷



3.1.3 Short-chained chlorinated paraffins (SCCPs)

Short-chained chlorinated paraffins (SCCPs) are a group of synthetic compounds mainly used in metal working fluids, sealants, flame retardants in rubbers and textiles, in leather processing and in paints and coatings. They have been proposed for listing as a POP under Annex A of the Stockholm Convention.

Very limited amounts of SCCPs are used for textile processes such as flame retardant and protective coatings now and there would not be as significant impact to the upholstery industry as decaBDE and HBCD limitations have as emissions to the environment would be lower than those from decaBDE and HBCD.

3.2 Flame Retardants previously used in the upholstery industry and impacted by legislation

3.2.1 Hexabromobiphenyl (HBB)

This chemical is listed under Annex A (Elimination) of the Stockholm Convention- taking measures to eliminate the production and use of the chemicals) and belongs to the group of polybrominated biphenyls (PBBs), similar to PBDE's these also contain bromine as the main chemical substance.

It is an industrial chemical that has been used as a flame retardant, mainly in the 1970s which is now banned for use. According to available information, hexabromobiphenyl is no longer produced or used in most countries. The chemical is highly persistent in the environment, highly bioaccumulative and has a strong possibility for long-range environmental transport. Hexabromobiphenyl is classified as a possible human carcinogen and has other toxic effects. Alternatives are available for all uses of hexabromobiphenyl. There may be traces of HBB in old product producing emissions to the environment.

3.2.2 Pentachlorobenzene (PeCB)

PeCB is listed under Annex A and Annex C of the Stockholm Convention (Elimination and Unintentional Production)-taking measures to reduce the unintentional releases of chemical). PeCB was used in dyestuff carriers, as a fungicide, a flame retardant and as a chemical intermediate. PeCB is also produced unintentionally during combustion in thermal and industrial processes. It is also present in products such as solvents and pesticides. PeCB is persistent in the environment, highly bioaccumulative and has a potential for long range environmental transport. It is moderately toxic to humans and very toxic to aquatic organisms. The production of PeCB in the UK ceased in 1991 as efficient and cost effective alternatives became available.

3.2.3 Tetrabromodiphenyl ether and pentabromodiphenyl ether (tetraBDE and pentaBDE)

These diphenyl ethers are listed under Annex A (Elimination) of the Stockholm Convention with a specific exemption for use as articles containing these chemicals for recycling in

accordance with the provision in Part IV of Annex A. PentaBDE is highly persistent in the environment, bioaccumulative and has a high potential for long-range environmental transport. Both tetraBDE and pentaBDE have been detected in humans in all regions. There is evidence of their potential for toxic effects in wildlife, including mammals.

C-pentaBDE refers to commercial pentaBDE which is a technical mixture of different PBDE congeners (minor chemical constituents) BDE-47 (tetrabromodiphenyl ether) and BDE-99 (pentabromodiphenyl ether). The term pentaBDE alone refers to isomers (molecules with the same chemical formula but different chemical structures) of pentabromodiphenyl ether.

It is estimated that between 90% and 95% of the use of c-pentaBDE was for the treatment of polyurethane (PUR) foam. These foams were mainly used in automotive and upholstery applications. Minor uses included textiles, printed circuit boards, insulation foam, cable sheets, conveyer belts, and lacquers²⁸. An approximate distribution of global c-pentaBDE use of 36% in transport, 60% in furniture and a 4% residual in other articles is considered to be reasonable and is generally consistent with analytical data for different waste streams.

Table 1: Former uses of c-pentaBDE in polymers/resins/applications and articles:

	Applications	Articles
Polyurethane (PUR)	Cushioning materials, packaging, padding, construction	Furniture, transportation, sound insulation, packaging, padding panels, rigid PUR foam construction
Textiles	Coatings	Back coatings and impregnation for carpets, automotive seating, furniture in homes and official buildings, aircraft, underground

The average content of pentaBDE in PUR foam is reported to be around 3-5wt % for upholstery, cushions, mattresses, and carpet padding used in countries with flammability standards for these applications.

3.2.4 HexaBDE and heptaBDE (also known as commercial-octaBDE/c-octaBDE)

The main former use of c-octaBDE was in acrylonitrile-butadiene-styrene (ABS) polymers, accounting for about 95% of c-octaBDE supplied in the EU and it is also listed under Annex A (Elimination) of the Stockholm Convention. The treated ABS was mainly used for housings/casings of electrical and electronic equipment (EEE). Other minor uses were high impact polystyrene (HIPS), polybutylene terephthalate (PBT), and polyamide polymers.

Other minor uses found in the literature include nylon, low density polyethylene, polyamide-polymers within the textile industry, polycarbonate, phenolformaldehyde resins, unsaturated polyesters, adhesives and coatings.

3.2.5 Perfluorooctane sulfonic acid (PFOS)

PFOS is both intentionally produced and an unintended degradation product. The current intentional use of PFOS is widespread and includes: electric and electronic parts, fire fighting

foam, photo imaging, hydraulic fluids and textiles. PFOS is still produced in several countries and has been listed under Annex B of the Stockholm Convention.

However, specific exemptions for its use include coatings for **carpets, leather and apparel, textiles and upholstery**, paper and packaging, coatings and coating additives, rubber and plastics. The chemical is only allowed in exempted finished articles with maximum concentrations up to 0.001% by weight (10mg/kg). PFOS was the key ingredient for Scotchguard, a fabric protector manufactured by 3M, and other stain repellents. In 2000 3M announced the phase out of PFOS who were the only producer of the chemical in the US at the time²⁹. In the EU, manufacture and essentially all uses of PFOS are now prohibited under a Directive (2006/122/EC) that came into force in June 2008³⁰.

4. End-of-life: Disposal and Recycling

Once an article has reached the end of its service life it can be re-used, recycled, incinerated or land filled.

The Waste Framework Directive sets the basic ideas and definitions related to waste management, such as what is waste, recycling and recovery. It gives explanation of when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products.

The Directive provides basic waste management principles and EU Member States shall apply as a priority order the following waste management hierarchy:



Figure 4: Waste Management Hierarchy according to the Waste Framework Directive

The Directive includes recycling and recovery targets to be achieved by 2020 including, 50% preparing for re-use and recycling of certain waste materials from households and other origins similar to households³¹.

The following section identifies regulatory bodies controlling the movement and management of waste containing persistent organic pollutants.

4.1 The Basel Convention on the control of transboundary movements of hazardous wastes and their disposal

The Basel Convention is a global agreement which addresses the problems and challenges posed by the movement and management of hazardous wastes, including those containing, or contaminated with, POPs. The Basel Convention uses a Prior Informed Consent (PIC) procedure to control transboundary movements of waste whereby hazardous waste cannot be shipped from one country to another without the consent of those countries involved, including countries of transit.

The Basel Convention prohibits the export of all hazardous waste from members of the EU, Organisation for Economic Co-operation and Development (OECD) and Liechtenstein to all other Parties to the Convention. This is implemented in the EU via the Waste Shipment Regulation³².

The Basel Convention Principles of Environmentally Sound Management:

Step One: Minimise the generation of hazardous wastes

Step Two: Treat and dispose of hazardous wastes as close as possible to where they are generated

Step Three: Minimise international movements of hazardous wastes

There are nine annexes within the text of the Basel Convention;

- Annex I -** Categories of wastes to be controlled
- Annex II -** Categories of waste requiring special consideration
- Annex III -** List of hazardous characteristics
- Annex IV -** Disposal operations
- Annex Va -** Information to be provided on notification
- Annex Vb -** Information to be provided on the movement document
- Annex VI -** Arbitration
- Annex VII -** Parties and other states which are members of the OECD, EC and Liechtenstein (not yet entered into force)
- Annex VII -** List A - Waste characterised as hazardous
- Annex IX -** List B - Wastes containing a controlled material (annex I) causing them to exhibit a hazardous characteristic (annex III)

Waste falls under the scope of the Basel Convention if it is within the category of wastes listed in Annex I and it exhibits one of the hazardous characteristics contained in Annex III. In other words it must both be listed and possess a characteristic such as being explosive, flammable, toxic, or corrosive.

The other way that a waste may fall under the scope of the Basel Convention is if it is defined as, or considered to be, a hazardous waste under the laws of the exporting country, the importing country, or any of the countries of transit.

The definition of the term disposal is made at the beginning of the full text of the Basel Convention within Article 2 of the preliminary statement and just refers to Annex IV, which gives a list of operations which are understood as disposal or recovery and is categorised according to methods which could lead to re-use, recycling reclamation or recovery and methods which have no possibility of secondary uses.

Annex II of the Convention lists other wastes, such as household wastes and residue that comes from incinerating household waste.

Annex IX attempts to define "commodities" which are not considered wastes and which would be excluded³³. Referring back to the chemicals in question within this report, these wastes would be wastes prepared to a 'standard' which reduces its environmental impact yet to be defined by the Basel Convention³⁴.

4.2 POPs Waste Management and POPs in material flows at end-of-life

The POPs waste management procedure written by the United Nations Environmental Programme (UNEP) includes stages of identification, capture and containment, pre-treatment (if applicable), residuals management, and post disposal monitoring. The first three phases are carried out prior to the disposal phase. Pre-treatment may be a distinct phase in advance of disposal.

In any event, the "front end" phases, pre-treatment, and residuals management can each drastically impact the approach to disposal and the related technology selection used during disposal. The main challenge for POP elimination is the identification of existing stockpiles and articles containing POPs and their disposal at end-of-life.

Large volumes of these materials are in the global recycling flow and will continue to be used in consumer articles. This is illustrated for pentaBDE (PBDE) in Figure 4. The existing reuse and recycling of materials and wastes containing POP PBDEs were the trigger for a specific exemption that allows recycle and reuse under certain conditions³⁵. Depending on whether an article falls within the low POPs content limit which is 1000ppm for the sum of POP BDEs in an article and either 100ppm or 1000ppm for HBCD which is yet to be confirmed by the Basel Convention, will impact the processing options for their disposal and destruction.

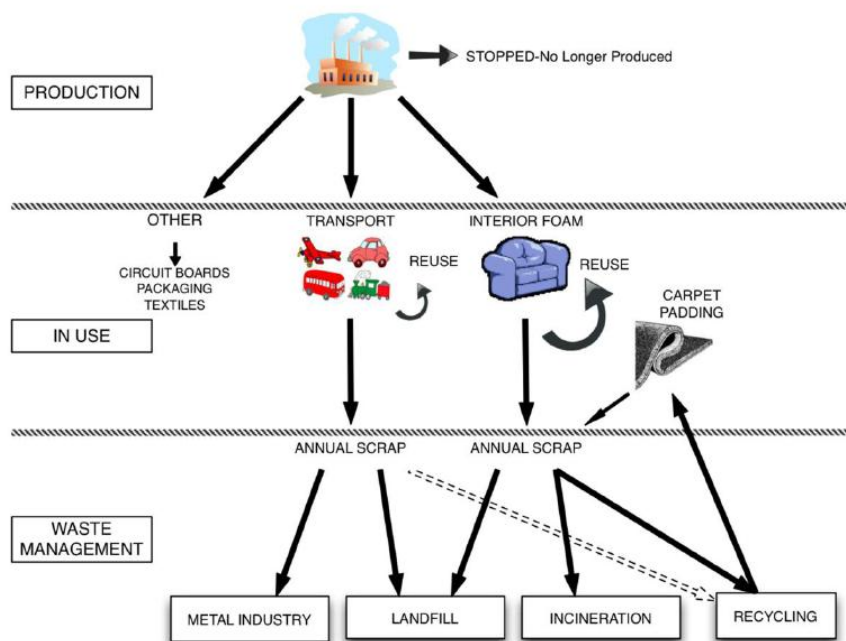


Figure 5: The Life Cycle of c-pentaBDE³⁶

4.3 Low POPs Content

The Basel Convention and Guidelines, set out provisional limits for low POPs content, and the method to review, expand and potentially revise these levels as required has been established jointly with the Stockholm Convention. No recycling is allowed above these low POP limits and Municipal Solid Waste incineration would be the appropriate method for destroying such waste³⁷.

As previously mentioned the provisional levels currently adopted and which would apply for purposes of this guidance are 1,000ppm for sum of POP BDEs; limit for HBCD TBC following more studies on its emissions and environmental impact during the degradation stage³⁸.

Impacts of proposed limit values on current recycling activities:

Recycling activities which could be impacted by the above low POP limit values are particularly the following:

- Recycling of textiles (decaBDE)
- Recycling of EPS/XPS foams (HBCD and potentially decaBDE)
- Recycling of carpets (PFOS)

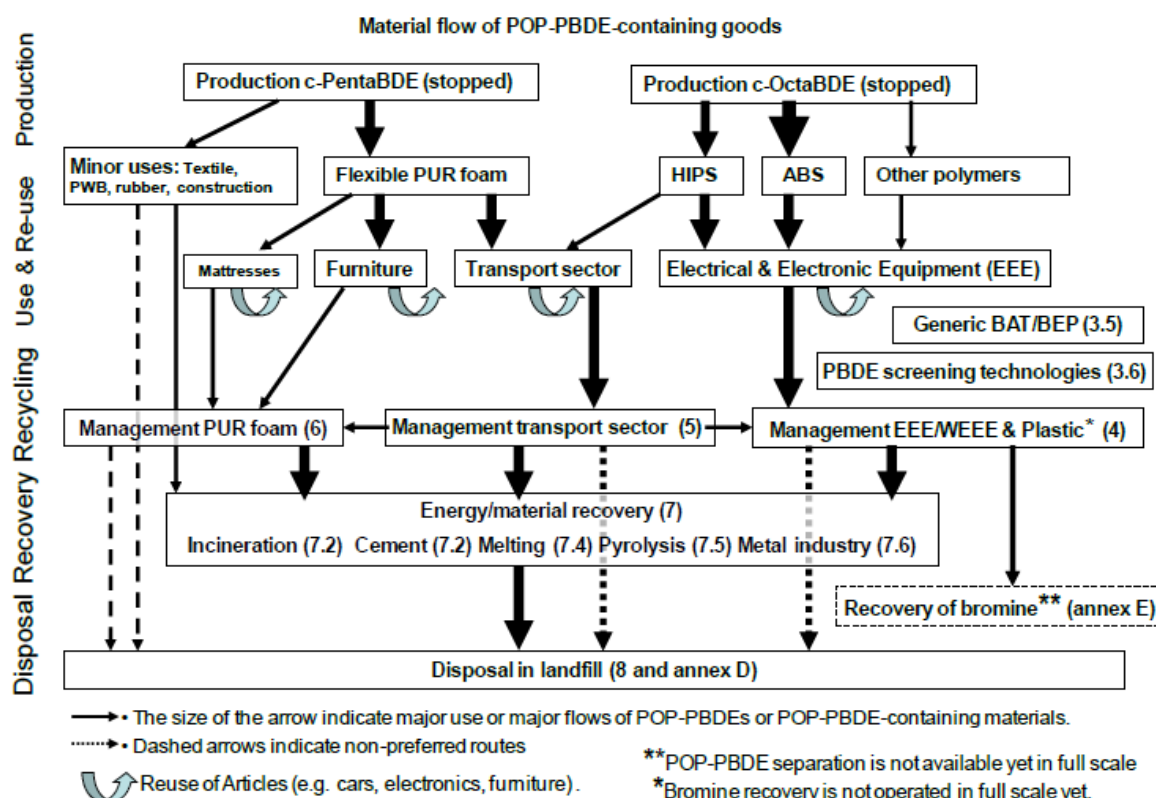


Figure 6: Structure of the guidance and mass flow for the relevant production and application of c-pentaBDE and c-octaBDE and the reuse, recycling and disposal of articles containing these substances³⁹

Land disposal options should be limited to solid waste that meets the Basel Guidelines' provisional low POPs content if considered anything but a transitional step to destruction.

Solid wastes above the low POPs content level should be pre-treated to remove remaining POPs, or make certain their potential release from the waste is minimized. Where solid waste exceeds the low POPs content level, a specific justification and risk assessment for land disposal should be provided on a case-by-case basis.

Sometimes if certain disposal techniques are not available in a country or facilities are limited, the material can be stored as a stockpile until appropriate treatments are available, or it is disposed in sanitary landfills which is the least preferred option⁴⁰.

The low POP content of the Stockholm Convention is independent from the determination of hazardous waste under the Basel Convention. Provisions of the Stockholm Convention complement the provisions for the management of hazardous wastes under the Basel Convention to form a comprehensive regime to manage wastes consisting of, containing or contaminated with POPs.

Wastes consisting of, containing or contaminated with POP-BDEs above **1000 mg/kg** according to the Stockholm Convention must be disposed of in such a way that the POP content is destroyed or irreversibly transformed, or otherwise disposed of in an environmentally sound manner.

Wastes consisting of, containing or contaminated with POP-BDEs below **1000 mg/kg** should be disposed of in accordance with pertinent national legislation and international rules, standards and guidelines, including the specific technical guidelines developed under the Basel Convention.

Currently the Stockholm and Basel Conventions are discussing how this affects determination of disposal for waste containing decaBDE and HBCD. The content level for classification as hazardous waste is under review. In no case should the POPs content exceed the level allowable consistent with international best practice⁴¹.

4.3.1 Waste management for manufacturers and retailers

The first phase in waste management involves gathering comprehensive data of existing and potential POPs stockpiles and wastes. Potential wastes include:

- POPs-contaminated equipment
- products either still in use or which might be identified in the future e.g. PUR foams, finished products (sofas and mattresses in warehouses)
- POPs-containing fabrics.

An inventory of production and use of POPs, and the location of current and potential stockpiles and waste form the starting point for the National Implementation Plan (NIP) development.

Any identified POPs stockpiles and waste should be captured and contained in a secure manner, in order to immediately prevent release of POPs into the environment. Containment is particularly important as there may be a significant delay between classification of POPs stockpiles and wastes, and the availability of financial resources for disposal.

Capture and containment involves securely packaging materials as required at their current locations, characterising the waste via an itemised inventory, and protecting it against release during handling and storage. Packaging or containerization may also involve clean up and packaging of surface site contamination and isolation of consumables used in the packaging process. If the material is to remain at its original location, it may be necessary to provide secondary containment and security; however, it will often be transported to a centralised secure transitional storage site. All practices, procedures and standards for these activities, including training and occupational health and safety provisions, should be established in national hazardous waste regulations and these regulations should be benchmarked against international standards. This usually refers to the chemical in its raw state as opposed to in a finished article such as upholstery or textiles⁴².

Ideally, the NIP baseline inventory includes precise locations, existing physical condition and potential risks if released. The inventory should also quantify POPs-containing products in use. Baseline POPs inventories are often less detailed than this and may require further data collection. In turn, this is often dependent on developing institutional capacity and legislative and regulatory tools to formalize identification and registration of POPs for control purposes. It also may require getting hold of analytical capability to support waste identification and

prioritization. Therefore, additional refinement of the POPs inventory which includes supporting information may be needed before moving forward with the disposal phase, which will vary from country to country.

Regardless of the complexity, the Global Environmental Facility (GEF) support for disposal should depend upon a reasonably accurate definition of the quantities of POPs targeted for disposal, their characteristics, their location, the viability of accessing them, and a forecast of future disposal requirements in regards to time and quantity. This will require critical assessment of the inventories as part of determining a disposal strategy and technology selection.

4.3.2 How to conduct a POP-PBDEs inventory

The national focal point of the Stockholm Convention or national project coordinator could be responsible for initiating the inventory process. The existing Steering Committee on POPs that was formed for the original NIP development could be re-established for updating the NIP and involved in the planning of the inventory. The inventory process is not intended to be conducted in an entirely linear fashion. The inventory team may need to repeat activities in earlier steps depending how the inventory proceeds and which sectors are involved.

4.3.4 Identification systems for POPs in a national POPs inventory

When developing an inventory at a national level, POPs identified as substances, in mixtures, or in articles could be labelled to keep the information on identified POPs, especially in articles, readily available and accessible so that the information linked to the article does not get lost.

Determining what type of information is provided, how it is used, and how the information on identified articles is kept readily available and accessible, (so it does not disappear), depends on the nature and the specific properties of the articles identified when setting up an inventory.

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS), which is the best-known systematic labelling approach for chemicals, including POPs, is being implemented more and more throughout the world. Although it is a voluntary system, many governments have integrated its principles into national legislation, at least for industrial chemicals and, in some countries, for pesticides. Application of the basic concepts of the GHS within the EU Member State regulations is legally binding. A number of useful approaches for labelling of specific POPs in articles based on specific compositions have been advanced⁴³.

4.4 Specific best available techniques for managing flexible polyurethane foam which contains POP PBDEs

Flexible polyurethane foam (FPF) is used in residential and commercial upholstered furniture as well as in vehicles. It is an extremely technical material with a multitude of end uses and performance attributes deriving from a range of formulations and manufacturing processes.

If an aged couch, pillow or vehicle contains POP-PBDEs, human exposure could be relevant and reuse would not be recommended. Parties discovering relevant POP-PBDEs in such articles in use or reuse might need to assess if further steps for the protection of human health are necessary. Recycling of furniture and mattresses containing PUR foam requires consideration of key factors such as geographic origin and time of production to help determine the likely presence of PBDEs.

For flexible PUR foam categories known to partly contain POP-PBDE impacted material, screening for bromine could be implemented to separate the POP-PBDE-containing materials. Such separation can be at the stage of collection or in the facility recycling the foam⁴⁴. Revenue from the sale of materials being recycled has been estimated as quite low and there is consequently a need for service charges to make these options viable. Local authorities and third sector organisations may charge for collections or in some cases benefit from grant funding to help establish these types of services⁴⁵.

While the separation of POP-PBDE/BFR-containing polymers by separation of BFR-containing fractions has developed to full scale for Waste Electrical and Electronic Equipment (WEEE) plastics, there is no information on such separation for materials such as PUR foam. For larger polyurethane foam items like furniture and mattresses, the same screening methods used for WEEE plastic items could be applied with handheld X-Ray fluorescence or sliding spark spectroscopy. A screening study, possibly supported by the government, could reveal if such an approach is practical.

Whatever the best solution it is clear that the identification and handling of equipment and wastes containing brominated diphenyl ethers is considered a challenge⁴⁶.

4.4.1 POP-PBDEs in reuse, recycling and waste flows

This section takes c-pentaBDE as an example of a POP which has gone through waste management to understand how other POPs could be managed at end-of-life and what considerations should be made during the disposal and treatment stages.

The main uses for c-pentaBDE were in PUR foam used in the transport sector (e.g. cars, buses, trains etc.) and furniture (e.g. couches, seats, cushions etc.), with limited use in mattresses and some other uses. The reuse and recycling of these major material flows needs to be addressed by using an inventory. C-pentaBDE (and other flame retardants) is more likely to be present in furniture and mattresses within countries where there is rigorous fire safety legislation such as the UK and the USA. Whilst some of these chemicals may no longer be in use there will be a residual presence when old products start to enter the waste stream.

This does not mean that they will not be present in furniture in other countries, as furniture may have been exported from the UK and there may be cases where the country requires additional fire protection for contract furniture.

PUR foams containing pentaBDE and other flame retardants in furniture, transport, end-of-life vehicles and mattresses are partly recycled into new articles by processes such as carpet rebond and regrounding when the material has a concentration of chemicals below the low POPs limit. The resulting new articles need to be captured by the inventory. While the majority of PUR foam scraps are processed into carpet rebond (in the US market), scrap can also be shredded and used as packaging and stuffing for pillows, pet bedding, insulation and stuffed toys. Foam scraps might also be used for some furniture cushioning, sound insulation, gymnastic mats, or school bus seats⁴⁷.

Taking this into account and applying this methodology to potential future POPs, products containing decaBDE within the low POP limit could be recycled in the same way and used for new products which are recorded in an inventory to trace the chemical through the supply chain.

4.4.1: Material recovery options from furniture products

As mentioned above, mattresses containing flame retardants could also be monitored for the presence of POP-PBDEs/BFRs. If POP-PBDEs are detected, they could be excluded from recycling or be screened and separated if the concentration of chemicals in the material is over the low POPs limit.

A review of mattresses recycling by the International Sleep Products Association summarises some of the key issues with materials recovery of mattresses;

- The economics of recycling are finely balanced and, at the moment, the value of recovered mattress materials alone cannot sustain a mattress disposal operation. Finding a sustainable income source to supplement the scrap revenue is therefore key to a successful operation (e.g. fees from consumers, retailers, manufacturers, or municipalities equal to the “tipping fee” that a landfill would otherwise have charged had the mattress instead been dumped at the landfill).
- Low tech manual dismantling appears to be more efficient than more automated approaches, although new technologies are under development. A manual approach using relatively low skilled manual labourers equipped with box cutters is the preferred approach at present.

This low tech approach described above could be adopted for recycling facilities dismantling both mattresses and sofas. By separating the cover fabrics from the rest of the fillings, POPs containing material can be sent to facilities with the means to appropriately manage them. If incineration is the chosen method of destruction, this filtering process would also reduce the demand on these sites.

According to the Stockholm Convention the key recommendation for the short-term management on the elimination of brominated diphenyl ethers from the waste stream in

countries in a position to do so (especially developed countries) is to establish and apply screening techniques and to separate materials containing brominated diphenyl ethers in order to stop these materials from being recycled. In detail, the recommendations which impact manufacturers and retailers are:

- To begin establishing national control schemes for recycling of waste potentially containing brominated diphenyl ethers and to implement effective screening and separation techniques for material containing brominated diphenyl ethers, and following the implementation of effective screening and separation techniques, to stop the recycling of articles containing brominated diphenyl ethers.
- Safe storage of materials and articles which contain BDEs where screening and separation is not possible
- Stopping the export of waste materials containing BDEs with the exception of the purpose for environmentally sound disposal
- To assess occupational exposures of staff which work in facilities where articles and wastes potentially containing BDEs are stored, sorted, treated recycled recovered or disposed of⁴⁸.

4.5 The End of Life Vehicle (ELV) Directive

The End of Life Vehicles Directive is a directive of the European Union addressing the end of life for automotive products, which involves the disposal of vehicle seating. Currently PUR foams used for seating contain POP PBDEs which are shredded and recycled under the exemption of the Stockholm Convention. There are best available technique guides to explain how to handle the recycling process. This approach might also be applicable to POP containing PUR foams in furniture.

5. Flame retardants currently in use and impacted by waste and disposal legislation

Waste and disposal legislation would impact products containing the following;

Family group	Chemical	Legislative impact
Brominated Flame Retardants	Decabromodiphenyl ether (decaBDE)	Registered as an SVHC under REACH with CAS No: 1163-19-5 in Sep 2010. Proposed for listing under Annex A of the Stockholm Convention, POP listing possible but not yet confirmed and if listed would not be expected until end of 2018.
	Hexabromocyclododecane (HBCD)	Registered under REACH with CAS No: 79-94-7 in Oct 2008 and listed under Annex A of the Stockholm Convention. POP listing confirmed
Chlorinated Flame Retardants	Short-chained chlorinated paraffins (SCCPs)	Proposed for listing under Annex A of the Stockholm Convention. POP listing possible but not yet confirmed. If listed the potential listing date is not yet known

5.1. Waste management considerations of decaBDE

DecaBDE is present in plastics, foams, textiles and several waste streams. Member states are currently implementing several legislative measures to reinforce waste management. Due to the potential for decaBDE to be listed as a POP, it is important for retailers and manufacturers to be aware of their likely future responsibilities should POPs legislation take effect.

These include:

- 1. Prevention:** measures taken before a substance, material or product has become waste in order to reduce waste quantities.
- 2. Preparing for re-use:** any recovery operation through which products or components that do not constitute a waste are used again for the same purpose for which they are initially created.
- 3. Recycling:** any recovery operation through which waste materials are re-processed into products, materials or substances for their original or other purposes.
- 4. Other recovery, energy recovery:** any operation, the principle result of which is waste that serves a useful purpose.

5.2 Waste textiles and furniture

There is some uncertainty around the situation regarding the management of textile waste in Europe. Textile and furniture waste is **NOT** specifically covered by current waste legislation, and therefore no consistent EU monitoring takes place meaning that statistics are not widely available.

According to an ECHA support document to a REACH Annex XV Dossier on decaBDE there is currently no mechanism to identify upholstered items that contain decaBDE in the UK.

With regards to textiles, the main focus appears to be on clothes which can easily be re-used if they are in good condition. Unfortunately, no specific waste collection scheme exists for textiles and furniture in the UK and, as such, detailed statistics about their subsequent destinations are unknown.

The demand for decaBDE will have remained the same since 2008 for the textile industry (including textiles used for upholstery) up until 2012. Since then it is expected that the demand would have fallen significantly, because, according to personal consultation, textile finishers in the UK are already moving away from decaBDE after its designation as an SVHC⁴⁹.

5.3 DecaBDE in waste textiles

The Reach Annex XV dossier acknowledges a 2002 EU Risk Assessment Report⁵⁰, suggesting that upholstery accounts for three quarters of the total UK textiles usage of decaBDE. This includes upholstered furniture and furnishings for domestic and contract use plus transport applications.

This makes it almost impossible to calculate the likely presence of decaBDE containing furniture and furnishings within the waste stream.

Estimates could be made based on overall household waste statistics (21% incinerated and 33% land filled) but these might be flawed as they would assume that furniture and furnishings waste breakdowns are exactly the same as other household waste which may not be the case.

The following table published by the Health and Safety Executive shows estimates of annual emissions in the EU emanating from decaBDE throughout its full life cycle.

Emissions occur to air, water and soil during manufacture and use but by far the greatest emissions occur at the disposal phase.

Table 2: Summary of release estimates of decaBDE during it various life stages in ESR Risk Assessment Reports

Scenario	Continental	Data Source
Polymers- service life-volatile loss	0.95 to air	ECB, 2007a (unchanged from ECB 2004)
Polymers- service life-particulate loss	0.13 to air 31.8 to surface water 95.9 to industrial/urban soil	ECB, 2007a (unchanged from ECB 2004)
Textiles- formulation of backcoatings	1.51 to air 73.6 to waste water	ECB, 2007a
Textiles- application of backcoatings	1.05 to air 76.1 to waste water	ECB, 2007a
Textiles- Service life-leaching loss	18.8 to waste water	ECB, 2007a (unchanged from ECB 2004)
Textiles- disposal-particulate loss	37.5 to air 9340 to surface water 28125 to industrial/urban soil	ECB, 2007a (unchanged from ECB 2004)

6. Waste Management considerations of hexabromocyclododecane (HBCD)

Available assessments estimate the environmental emissions of HBCD during production and chemical use to be small, compared to the releases from HBCD containing articles and waste (EC 2008)⁵¹. Releases from processing of polystyrene foams are expected to be much lower than those associated with the application of HBCD containing back coatings for textiles.

According to ECHA, there are some releases of HBCD from products and articles but the extent of these is highly uncertain⁵². HBCD in textiles could possibly lead to contamination of surface-water during washing of the fabric.

HBCD has been used in products which can be used for long periods of time, such as those which have a service life of over 10 years. The long service-life of these products means that

there remains potential for HBCD releases to the environment both during use and once products enter the waste stream.

Wastes will contain variable concentrations of HBCD depending on initial quantities in the product, and releases occurring during its use and in the waste phase. The extent of emissions during the service life of an HBCD containing product will clearly impact hugely on concentration levels once a product reaches its end of life stage.

Table 3: Typical concentration level of HBCD for various applications (The concentrations of HBCD used for flame-retardant textiles are much higher than in PS foam production)⁵³.

Flame-retarded material	HBCD Content (mg/kg)
Expanded Polystyrene (EPS)	5000-10000
Extruded Polystyrene (XPS)	8000-25000
Textile back-coating	10000-15000
Textiles	22000-43000

The provisional definition of low POP content for HBCD is [1000 mg/kg]⁵⁴

HBCD is often contained in additive formulations like back coatings on textiles which are more likely to migrate from the material over time due to leaching, compared to when it is molecularly bonded to the material as seen with foams.

Substance flow analyses and evaluations have shown that the largest releases are during the waste phase in the life cycle of HBCD containing products, and the main fraction of HBCD-containing waste is identified as insulation products. Below shows estimated releases of HBCD to the environment based on consumption figures from 2006 supplied by the HBCD Industry Users Group⁵⁵. The data for textile coating uses estimates from 2007.

Table 4: Estimated releases of HBCD to the environment from textile coating uses – EU Statistics

		Wastewater (kg/y)	Surface water (kg/y)	Air (kg/y)
Releases during service life	Textiles during use	21.4	5.4	26.8
	From washing textiles	2.1	0	2.1
Professional Uses	Textile coating	1130	283	1413
Use of HBCD in formulations	Polymer dispersion in textiles	44	11	56.4

In particular, there is little information on the quantity of HBCD landfill discharges. However, given the low water solubility of the substance, it is expected that leaching from the surfaces of polymer products will be limited as evidence (see Table 5) indicates that there would have been emissions throughout its service life to reduce the overall concentration of HBCD in the product at the end-of-life waste stage.

7. Labelling systems

7.1 Labelling for POPS

There is currently no compulsory labelling scheme for products containing POPS in the EU and anything that would be put into effect would be best practice.

However, the identification of products and articles that contain POPs would assist in their environmentally sound management (ESM). The labelling of such products and articles would ensure that information on POPs content is clearly indicated and circulated along the supply chain to stakeholders who can then apply appropriate management measures. Such a system, whilst beneficial in terms of ESM, would have to address many difficult situations such as:

- stakeholders may be located in different countries due to the globalized nature of the supply chains of products and articles
- Use of recycled foams and textiles containing POPs such as PUR crumb foams in mattresses
- Labelling is not future proof another chemicals could be added to the POPs listing. As such future waste stream would still contain unlabelled POP containing product
- Future proofing would require that all chemicals in a product need to be included in a label but this has massive implications would prove impractical.

If a POPs labelling system were to be adopted it would require that the following issues be taken into consideration:

- What is the aim, objective, and content of the system?
- What will be labelled?
- How will the POPs be labelled (what information is required on the label, for whom is it labelled, how is it done technically)?
- How can the system be enforced?
- What resources are needed for implementation by the producer, user, and government?

Based on the above, the following labelling considerations could be subject to attention for POP chemicals in their raw formulations and within products:

- **POPs as substances and in mixtures:** Companies implement and adapt the Global Harmonised System (GHS), which would also apply to products (substances and mixtures) that contain impurities of these POPs.
- **POPs in articles:** the system could include different options including a combination of legally binding obligations to label certain articles and voluntary activities by industry.

The proposed labelling systems would require different parts of the supply chain to implement different parts of the systems. For example exporters could either avoid the use of POPs during manufacture or implement a labelling system that informs users and importers about the presence of the POPs in mixtures and articles. Importers could implement the same labelling systems, raise awareness among users, and enforce the labelling system. The

labelling system would allow for the identification of POPs in mixtures and articles along the whole supply chain. The implementation could proceed on a step-by-step basis with easy to implement approaches.

The labelling system must be practical, effective, enforceable, and easy to implement, and consider the socio-economic impact on companies. The difficulties faced by trying to implement a new labelling system include gaining international recognition, policing (monitoring and enforcement could be facilitated by monitoring a company's self-inspection scheme, or through the use of financial incentives), costs to the industry and trying to achieve consistency across all industry sectors.

Implementing a scheme such as Eco-Mobilier which is currently adopted in France could be used to account for any potential disposal costs incurred at the end of-life stage, right at the beginning of the supply chain (see Annex A) using codes which correspond to the product. It also passes on an environmental awareness and responsibility to anyone manufacturing or importing furniture. This would help account for the costs fronted by the industry for such a scheme.

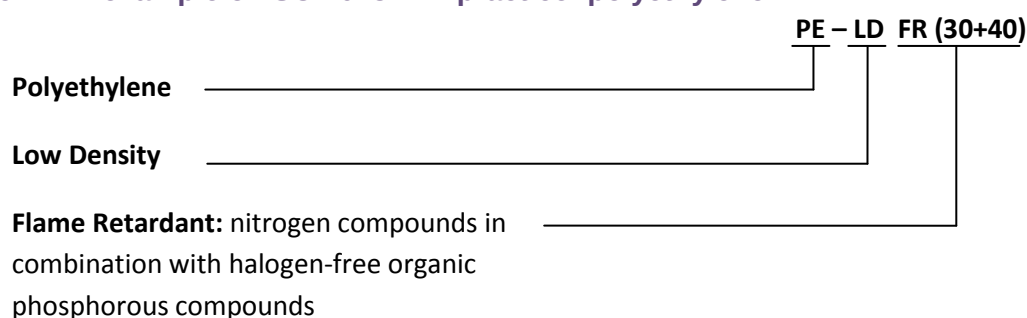
Benefits for developing and following a labelling scheme would include a way of showing a company's environmental focus towards production and waste. Retailers and manufacturers would also save costs of quarantining any stock impacted by new chemical restrictions, as a result of being able to identify the exact amount of products containing particular chemicals as opposed to using production timeframes.

7.2 Requirements of ISO 1043-4:1999 - Plastics. Symbols and abbreviated terms. Flame retardants

Should legislation require that flame retardants only are identified within furniture and furnishings (at this stage there appear to be no plans in the public domain to this effect), the method used for plastics could be adopted and adapted.

It uses a method of writing symbols with the abbreviated term "FR" with one or more succeeding code numbers representing the type of flame retardant used.

Figure 7: An example of ISO 1043-4 in practice- polyethylene⁵⁶



The labelling approach demonstrated in ISO 1043-4, 1999 provides uniform symbols for flame retardants added to plastic materials throughout the supply chain and is especially relevant for recycling of materials.

Key elements include:

- It provides voluntary industrial guidelines harmonized for industry worldwide through the International Organization for Standards (ISO) standard.
- It involves industry markings (in effect a “label”) with the use of code numbers, e.g. code-18 is pentaBDE and octaBDE; code-20 is polybrominated biphenyls (hexabromodiphenyl).
- Code markings apply to chemical contents >1% by weight for flame retardants
- The government is not involved.

8. Conclusions

Flame retardants continue to be important to the UK furniture and furnishings industry as they ensure that current high levels of fire resistance performance are maintained thus minimising deaths and injuries attributable to combustion of its products.

The chemical nature of flame retardants has led to many of them being assessed for their potentially hazardous nature, particularly in relation to them being Persistent Organic Pollutants (POPs)

The status of flame retardants currently in use is as follows:

DecaBDE will most likely be listed as a POP under Annex A of the Stockholm Convention, prohibiting its use for flame retardants. HBCD will only be allowed for use in PS foams in buildings, until mid 2020. After this there is a complete ban on its use for all applications. Short-chained chlorinated paraffin's are currently under review and meet the POPs criteria so will more than likely also be listed as a POP in the near future.

Technologies which are yet to pose an environmental threat are decabromodiphenyl ethane (EBP), phosphorous-based flame retardants and melamine-based flame retardant technologies. Other technologies which are currently being developed can be found in the FIRA report '*Alternative Flame Retardants for use in Upholstered Furniture*'.

Other flame retardants are no longer used but these may still find their way into the waste stream. These include pentaBDE, octaBDE, hexaBDE, tetraBDE, perfluorooctane sulfonic acid, pentachlorobenzene and chlorinated-tris.

Furniture and upholstery is unlikely to contain FRs in w/w concentrations high enough to warrant the need for manufacturers and retailers having to comply with the requirements of Stockholm convention and POPs irrespective of the nature of the chemicals within the product.

However, this position may change and it is important that industry is aware of issues that may impact in the future, especially if legislation is adopted such as the WEEE Directive (Waste Electrical and Electronic Equipment recycling) whereby concentration is assessed by component parts, which would have greater implications. Furniture and furnishings waste in the UK (including its potentially hazardous properties due to the presence of certain flame retardant chemicals) is a topic yet to be fully researched to the same level as for plastics and electronic equipment. At this stage, there is no clear handling precedent for sorting this waste.

Currently there are ongoing restrictions and increasing environmental pressure surrounding popular chemicals used throughout the industry, and manufacturers are finding alternatives which are less persistent at the degradation stage such as decabromodiphenyl ethane (EBP), which is seen to be a good substitute for deca-BDE.

There are currently no regulatory restrictions for EBP however a REACH substance evaluation has been ongoing since May 2014. Industry is aware that regulations can become stricter and more chemicals can be added to restriction lists so it is important for manufacturers to consider as many new available technologies as possible.

Whilst there are no specific rules and processes for furniture and furnishings waste management this could change, particularly in relation to the waste management of POPs-containing material. Encouraging re-use and recycling through new technologies (e.g. PUR foams in carpet rebond) for low POP limit products would contribute towards the evolution of a circular economy within the furniture industry.

More investigation into how flame retardants degrade and leach into the environment would help identify the most important starting points for trying to improve how waste is managed and what challenges need to be overcome by new re-use and recycling technologies.

Diversion from normal landfill sites would mean that incineration facilities may not be able to cope with a sudden increase of waste in which case other disposal options such as controlled hazardous landfills would need to be considered. These disposal methods are more expensive than normal landfill and this would need to be paid for by someone in the supply chain

Whilst stricter amendments to existing regulations are not guaranteed it is clear that environmental pressures will continue to grow. Self regulation is often less painful than enforced legislation and industries will need to begin to investigate practical solutions to the traceability, monitoring and management of their products and potentially hazardous chemicals such as flame retardants.

Labelling and supply chain of custody processes will help with the control of products and their components. These systems need to be devised so that they are practical, not cost prohibitive and engage the whole supply chain. Re-use and recycling technologies need to be developed to help reduce the tonnes of waste currently being sent to landfill and for incineration. Incineration is currently the only treatment option for POPs or wastes containing or contaminated with POPs that destroys these persistent pollutants and prevents them from (re-)entering the environment.

The addition of decaBDE to Annexes A or B of the Stockholm Convention will incur costs to Government and regulators, as there will be a requirement to assess the potential on-going sources/emissions to the environment after it has been disposed, in order to fully understand its environmental impact.

9. Annexes

Annex A. Case Study- Éco-Mobilier

The creation of a new regulatory obligation for manufacturers, importers, and distributors of furniture in France: taking responsibility for furniture end-of-life.'

In France, the 2010 National Commitment for the Environment law stipulates that “any natural or legal person manufacturing, importing, or introducing furnishings to the French market shall assume responsibility for collecting and processing the waste resulting from said products at their end-of-life.” An implementation decree dated 6 January 2012 regarding the management of furnishings waste explains the obligations resulting from the law for industries within this sector. It is a matter of applying the principles of “expanded producer responsibility (EPR)” to the furniture sector. In order to fulfil this obligation, a dedicated eco-organisation, Éco-mobilier, was created by distributors and manufacturers. This shows an example of how disposal costs can be successfully introduced throughout the supply chain to the end consumer so it does not impact manufacturing and retail furniture industry.

It has been state-approved, since 1 January 2013, and is intended for all furniture related companies conducting business in France, in order to organize the collection, recycling and recovery of household furniture. All firms active on this market in France must be a part of Éco-mobilier. When they sell goods on the market, in particular because they import foreign products, they must assign each product an eco-contribution, similar to a tax with its own product code. Starting on 1 May 2013, the eco-contribution must be displayed on each piece of furniture and billed to consumers.

Like the WEEE sector (in particular for appliances), an eco-contribution paid by the consumer must be applied to all furniture items, according to a national scale. This eco-contribution scale covers the following three categories; seating, bedding, and furniture.

This eco-contribution shall be calculated by the importer in order to be added to the price and invoiced in addition to the product price, to be followed in the same manner throughout the distribution chain, from the manufacturer/importer to the end customer.

Such eco-contribution shall then be paid by the importer to Éco-mobilier in order to finance and organize collecting and recycling of used furniture.

All furnishing falling into one of the following categories are relevant;

1. Living/family room/dining room furniture	6. Kitchen Furniture
2. Occasional Furniture	7. Bathroom Furniture
3. Bedroom Furniture	8. Garden Furniture
4. Bedding	9. Seating
5. Office Furniture	10. Technical, sizes and contract furnishings

Decorative items, toys, or products covered by other EPR regulations (WEEE, textiles...) are not relevant. If the product is relevant, an eco-contribution must be applied when it is sold in France. The eco-contribution shall be calculated as follows:

- For **furniture**: the eco-contribution shall be determined by **product weight**
- For **bedding**: the eco-contribution shall be calculated **according to size**
- For **seating**: the eco-contribution shall be defined based on the **number of seats**

Given the manufacturers', importers', and distributors' obligation to determine the eco-contribution to be applied to each product sold and to report such sales each quarter to Éco-mobilier, it is essential that customers further along the supply chain have information regarding;

- For furnishings: the majority material by weight and the furniture's weight;
- For bedding: the size, majority material (by weight), weight;
- For seating: the number of seats and weight.

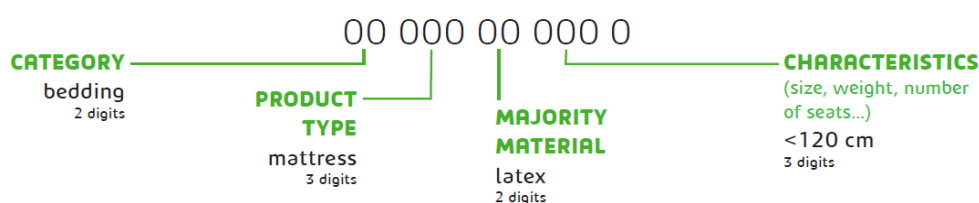
In practice, this would be the format for the table to be filled-out by foreign manufacturers for manufacturer, importer, or distributor customers in France:

Product Reference	Product Description	Majority Material (by weight)	Characteristics (size, no of seats, weight)	Weight (for bedding and seating)
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Éco-Mobilier coding system:

Each manufacturer, importer, or distributor in France must assign an Éco-mobilier product code to any furnishings sold. This 11-digit code is a nomenclature created by Éco-mobilier in order to classify furnishing based on their characteristics, a regulatory obligation from the French agency responsible for the environment (ADEME) and by Éco-mobilier.

In order to determine these product codes required for reporting, you must consult the simulator available on the Éco-mobilier website. As an illustration, here is how the product code is presented:



This code shall provide for quarterly sales reports, specifying, for each product code, the number of units sold and the total weight sold⁵⁷.

SEATING

Eco-contribution before tax per furnishing item*

PRODUCT TYPE				
Chair**	€0,167			
Seating with 2 or more seats, unpadded, including deck chairs		€0,836	€0,836	
Height-adjustable swivel chair	€0,418			
Structureless chair (with textile or padding)	€0,418	€3,344	€ 5,853	
Articulated/electric chair	€2,926	€5,435	€8,361	
Non-convertible chair with padded seat and back equipped with cushions	€1,254	€3,344	€5,853	
Convertible (bench seat, sofa-bed, and Z-bed)	€2,090	€4,181	€7,525	€2,090
Seat part, seat member, and textile or padding, specific to a given furniture item (pad, cushion...)	€0,042			

* The eco-contribution scale is applicable for the year 2013

** Chair (1-place seat, with a back, no armrest), chair with armrests but no seat and back padded or equipped with cushions, stool, and foot-rest, excluding height-adjustable swivel chairs.

-  Seating for 1
-  Seating for 2
-  Seating for more than 2 or corner sofa
-  Structure without mattress

Figure 8: Éco-Mobilier contribution for seating items

The Eco-furniture program brings together everyone throughout the supply chain from distributors and furniture manufacturers, to local communities, the actors of the social and solidarity economy as well as the operators of collection and sorting, recycling industry, consumer and environmental protection associations. Funded by the eco-participation on new furniture, the Eco-furniture program, approved by the Ministry of ecology, promotes the reuse and recycling of used furniture.

The Eco-furniture program works on making individuals aware of the issues at the end of life of furniture including the recovery of used furniture by distributors and providing monitored public waste facilities. Eco-furniture offers professional solutions which are simple and suitable to dispose of used furniture and furnishing materials waste.

Annex B: Regulations and chemicals matrix

REACH	Evaluation of all chemical substances placed in the EU market	1. Shall not be manufactured, used or placed on the market as a substance, as a constituent of other substances, or in mixtures after [date of entry into force], if the concentration is equal or greater than 0.1 % by weight. 2. Articles or any parts containing the chemical in concentrations equal to or greater than 0.1 % by weight shall not be placed on the market.	DecaBDE registered under CAS No 1163-19-5 for evaluation (restriction to potentially be adopted Sept 2016) HBCD listed in Annex XIV under CAS No 3194-55-6
Stockholm Convention	Global treaty to protect human health and the environment and from chemicals which remain intact in the environment for long periods, and have harmful impacts on human health or on the environment.	1. Prohibits and/or eliminates the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex A to the Convention. 2. Restricts the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex B to the Convention. 3. Reduces or eliminates releases from unintentionally produced POPs that are listed in Annex C to the Convention. 4. Ensures that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner.	Risk Management Evaluation developed for decaBDE. Proposal to list decaBDE under Annex A, B and C (screening criteria fulfilled). Listing estimated May 2017 Decided, in accordance with paragraph 9 of Article 8 of the Convention, to recommend listing HBCD in Annex A to the Convention with specific 5 year exemptions for production and use in expanded polystyrene and extruded polystyrene in buildings
Basel Convention	An international treaty to reduce movements of hazardous waste between nations and specifically to prevent transfer of hazardous waste from developed to less developed countries.	1. Reduces hazardous waste generation and promotes environmentally sound management of hazardous wastes, wherever the place of disposal. 2. Restricts the use of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management. 3. A regulatory system applying to cases where transboundary movements are permissible.	HBCD falls under scope of the Convention, due to listing as POPs.
VECAP	A system for efficient management of chemicals, evolved from its original concept of a tool to control emissions during handling and use of BFRs.	Recommended best practice guides to manage chemical emissions throughout production storage and transport. See http://www.vecap.info/ for detailed information.	DecaBDE and HBCD emissions currently being monitored along with EBP

Annex C: Labelling requirements of articles based on the system applied for asbestos-containing products

An example of a chemical labelling system is the requirement for the labelling of articles containing asbestos in the EC from 1983 until 1999 when the use of asbestos was totally banned. The system could be adapted for POPs and FR chemicals yet to be banned. The requirement could be for regulated articles, when marketed by the manufacturer, to bear a specific label. The content of the label could be as follows:

- **Minimum label size:** for example, 5 cm high and 2.5 cm wide.
- **Top part of label abbreviation:** “POP” in white on a black background.
- **Bottom part of label text if a POP:** “Warning: contains x.x % of [name of the POP], a persistent organic pollutant; and indicates the measures to reduce releases from waste: “Requires environmentally sound waste management” as well as “Follow waste treatment instructions” in white and/or black on a red background. If labelling takes the form of direct printing on the products, a single colour contrasting with the background colour could be sufficient.
- **Label on package:** a label firmly affixed to the packaging, or a (tie-on) label securely attached to the package, or direct printing of the packaging.
- **Label of unpacked products:** a label firmly affixed to the product containing a POP, or a (tie-on) label securely attached to such product or direct printing on the products.
- If this is not reasonable, for example, due to smallness of size of the product, the unsuitable nature of the product’s properties, or certain technical difficulties, the labelling requirement could be fulfilled by means of a hand-out with the required information.
- Resources and requirements for implementation of this approach could include:
- **Manufacturer:** identifies the POPs and labels the article.
- **Government:** provides awareness raising and training, and monitors the obligation to label. The system requires efficient monitoring by customs to identify unlabelled imported articles and the control of manufacturers in manufacturing Parties producing the regulated articles.

All manufactured articles that contain a regulated POP could, in principle, use this approach.

Proposed labelling system of an article containing a FR chemical:

Manufacturers would be able to record which chemicals their products contained in order to be prepared for any future phase outs of existing flame retardants. Using the labelling system developed for the management of POPs as a basis, this system could indicate the essential information needed to prepare for sound disposal methods that could be potentially associated to upholstery in the future. Information could include;

- Name of the FR chemical used
- % of chemical content
- Information relevant for the manufacturer/retailer
- Batch number
- Production Date

Details for the label related to how the product has been FR treated:

- **Minimum label size:** for example, 5 cm high and 2.5 cm wide.
- **Top part of label abbreviation:** "FR treated" in white on a black background.
- **Bottom part of label text:** "Notice: cover fabric consists of x.x % of [name of the main chemicals in the flame retardant] Fillings contain x.x% of [name of the main chemicals in the flame retardant], in black on a white background. If labelling takes the form of direct printing on the products, a single colour contrasting with the background colour could be sufficient. Labels should be permanently affixed to the product.
- **CAS Number:** the CAS number of the fire retardant/s used should list the relevant CAS numbers to trace to individual chemical composition
- **Batch number and production date:** Batch numbers and production dates would be key information to determining the age of the product at the disposal stage and which chemicals had currently been phased out and the time of manufacture.

Annex D: Bibliography

Annex D.1: Further Reading

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- Service Request SR 14: Support to an Annex XV Dossier on Bis-(pentabromophenyl) ether (DecaBDE). July 2014
- Survey and technical assessment of alternatives to decabromodiphenyl ether (decaBDE) in textile applications, S. Posner, Sundbyberg, September 2004
- WRAP Report: Technologies for sorting end of life textiles

Annex D.2 List of standards and legislation listed in the document

- REACH (Registration, Evaluation, Authorisation, and restriction of Chemicals)
<http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02006R1907-20150601&from=EN>
- Stockholm Convention
http://www.pops.int/documents/convtext/convtext_en.pdf
- EU Restriction on the use of hazardous substances directive (RoHS)
<http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32011L0065&from=EN>
- The Waste Electrical and Electronic Equipment (WEEE) directive
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:en:PDF>
- Water Framework Directive
<http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32000L0060&from=EN>
- The Classification, Labelling and Packaging Regulation
<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:EN:PDF>

- The Basel Convention on the control of transboundary movements of hazardous wastes and their disposal
<http://www.basel.int/Portals/4/Basel%20Convention/docs/text/BaselConventionText-e.pdf>
- The Waste Framework Directive
<http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008L0098&from=EN>

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