LEARNING COURSE

Alternatives to POPs
Annex A

Decabromodiphenyl ether (decaBDE)

GGKP, 2024

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POPs listed in Annex A

In 2017, by decision SC-8/10, the Conference of the Parties (COP) to the Stockholm Convention amended Annex A to the Convention to list decabromodiphenyl ether (BDE-209) present in commercial decabromodiphenyl ether (c-decaBDE) with specific exemptions (vehicles parts) and its expiration dates.

Parties 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.

What is decaBDE?

C-decaBDE is an intentionally produced chemical consisting of the fully brominated decaBDE congener or BDE-209 (=90-97%), with small amounts of nona- and octa-bromodiphenyl ether.

C-decaBDE has been under scrutiny for its potential health and environmental impacts for more than a decade. Steps to restrict the use of c-decaBDE have been taken in some countries and regions, as well as by some of the major electronic companies.

decaBDE uses

As per Annex A:

Chemical	Activity	Specific exemption
Decabromodiphenyl ether (BDE-209) present in commercial decabromodiphenyl ether (CAS No: 1163-19-5)	Production	As allowed for the Parties listed in the Register
	Use	In accordance with Part IX of Annex A: • Parts for use in vehicles specified in paragraph 2 of Part IX of Annex A • Aircraft for which type approval has been applied for before December 2018 and has been received before December 2022 and spare parts for those aircraft • Textile products that require anti-flammable characteristics, excluding clothing and toys • Additives in plastic housings and parts used for heating home appliances, irons, fans, immersion heaters that contain or are in direct contact with electrical parts or are required to comply with fire retardancy standards, at concentrations lower than 10 per cent by weight of the part • Polyurethane foam for building insulation

- C-decaBDE is a general-purpose additive flame retardant compatible with a wide variety of materials
- BDE-209 is also found in products made from recycled plastics, including food contact materials
- The many uses and applications of c-decaBDE can be roughly divided into two main categories – in plastics polymers and in textiles

REF: UNEP/POPS/COP.9/INF/20-UNEP/POPS/POPRC.11/10/Add.1

decaBDE uses

Polymer group	End-use applications								
	Electronics	Wire and cable	Public buildings	Construction materials	Automotive	Aviation	Storage and distribution products	Textiles	Waterborne emulsions & coatings
Polyolefins									
Styrenics									
Engineering thermoplastics									
Thermosets									
Elastomers									
Waterborne emulsions and coatings									

REF: UNEP/POPS/COP.9/INF/20-UNEP/POPS/POPRC.11/10/Add.1

decaBDE production

- c-decaBDE is produced in high quantities worldwide
- In the past, c-decaBDE constituted 75-80% of the total global production of PBDEs
- The total global amount of c-decaBDE produced in the period 1970-2005 was between 1.1-1.25 million tonnes, similar to the scale of production of PCBs

REF: UNEP/POPS/POPRC.11/10/Add.1

Status of decaBDE under the Stockholm Convention

Specific exemption	Application	Expire date
(a) Parts for use in legacy vehicles, defined as vehicles that have ceased mass production, and with such parts falling into one or more of the following categories:	(i) Powertrain and under-hood applications such as battery mass wires, battery interconnection wires, mobile air-conditioning (MAC) pipes, powertrains, exhaust manifold bushings, under-hood insulation, wiring and harness underhood (engine wiring, etc.), speed sensors, hoses, fan modules and knock sensors; (ii) Fuel system applications such as fuel hoses, fuel tanks and fuel tanks underbody; (iii) Pyrotechnical devices and applications affected by pyrotechnical devices such as airbag ignition cables, seat covers/fabrics (only if airbag relevant) and airbags (front and side); (iv) Suspension and interior applications such as trim components, acoustic material and seat belts.	At the end of the service life of legacy vehicles or in 2036, whichever comes Earlier
(b) Parts in vehicles specified in paragraphs (a) (i)–(iv) above and those falling into one or more of the following categories:	(i) Reinforced plastics (instrument panels and interior trim); (ii) Under the hood or dash (terminal/fuse blocks, higher- amperage wires and cable jacketing (spark plug wires); (iii) Electric and electronic equipment (battery cases and battery trays, engine control electrical connectors, components of radio disks, navigation satellite systems, global positioning systems and computer systems); (iv) Fabric such as rear decks, upholstery, headliners, automobile seats, head rests, sun visors, trim panels, carpets.	At the end of the service life of vehicles or in 2036, whichever comes earlier

All uses for decaBDE other than those listed as specific exemptions **are prohibited** because alternatives are readily available.

REF: UNEP/POPS/COP.9/INF/20

Information on alternatives to decaBDE

Plastics

- An assessment by the European Union identified various alternative techniques that could replace c-decaBDE in plastics:

Intumescent systems	•Intumescent technologies cause the plastic, when heated, to swell (intumesce) into a thick, insulating char •Protects the underlying material from burning, by providing a physical barrier to heat and mass transfer
Nanocomposites	•Mesoporous silicate particles (MSP) when compounded with polymers can form a physically cross-linked polymer-particle network •By replacing a portion of the flame retardant loading with about 2 to 8% by weight MSPs, flame retardancy may be reached
Expandable graphite	•On exposure to fire, the graphite expands to over 100 times its original size producing a barrier effect. •Use of synergists is necessary to achieve the required flame retardancy
Smoke suppressants	•Lead to the formation of glassy coatings or intumescent foams or dilution of the combustible material •Of particular relevance to transportation applications of decaBDE.
Polymer blends	•Readily flammable polymers may be blended with less readily flammable polymers •Enables lower-flame retardant loadings to be used with limited impact on other technical properties

REF: UNEP/POPS/COP.9/INF/20-UNEP/POPS/POPRC.11/INF/6

Information on alternatives to decaBDE

Plastics

Additionally, c-decaBDE can be replaced by:

Alternative materials	• Halogen-free polyketone and high performance thermoplastics such as polysulphone, polyaryletherketone (PAEK), or polyethersulphone (PES) plastics are inherently fire-resistant and could replace polymers typically treated with c-decaBDE.
Product design strategies	• Separating the high-voltage components that need greater ignition protection from the low-voltage components; • Reducing the operating voltage requirements, therefore reducing the need for fire-resistant enclosure materials; • Separating the power supply from the product, which reduces the fire retardancy requirements of the electronic enclosure; • Shielding power supplies with metal to eliminate the need for additive flame retardants
Chemical alternatives	• Decabromodiphenyl ethane (DBDPE) • Bisphenol A bis (diphenyl phosphate) (BDP/BAPP) • Resorcinol bis (diphenylphosphate) (RDP) • Ethylene bis (tetrabromophthalimide) (EBTBP) • Magnesium hydroxide (MDH) • Triphenyl phosphate (TPP) • Aluminium trihydroxide (ATH) • Red phosphorous

REF: UNEP/POPS/COP.9/INF/20

Information on alternatives to decaBDE

Textile products that require anti-flammable characteristics

Substitution of c-decaBDE in textiles is not straightforward due to the complexity of the end-products and the wide array of possible substitution approaches

Alternative fibres	• Natural fibres are easier to chemically flame retard than synthetics (leather, wool). Several non-halogenated c-decaBDE chemical substitutes are available: ammonium polyphosphates, dimethylphosphono (N-methylol) propionamide, phosphonic acids, tetrakis (hydroxymethyl) phosphonium urea ammonium salt.
Fire barriers	• Fire barriers are made from inherently fire-resistant fibres. Moreover, many of these fibres are made from non-halogen materials. Some barriers can also be made from blends of inexpensive fibres and expensive inherently fire-resistant fibres. • Plastic films have also been used as barriers (neoprene).
Intumescent systems	• Include use of expandable graphite impregnated foams, surface treatments, and some barrier technologies.
Chemical alternatives	• Aluminum trihydroxide (ATH) • Magnesium hydroxide (MDH) • Tris(1,3-dichloro-2-propyl) phosphate (TDCPP) • Ethylene bis(tetrabromophthalimide) (EBTBP) • 2,2'-oxybis[5,5-dimethyl-1,3,2-dioxaphosphorinane] 2,2'-disulphide • Tetrabromobisphenol A bis (2,3-dibromopropyl ether) (TBBPA) (only in polymer applications); • Red phosphorous • Decabromodiphenyl ethane (DBDPE)

REF: UNEP/POPS/COP.9/INF/20

Information on alternatives to decaBDE

Polyurethane foam for building insulation

A variety of insulation materials are used in buildings, each having some advantages for specific applications determining its use, and many with general application.

Expanded and extruded polystyrene (EPS/XPS)	• Major insulation used in a variety of installations for the entire building envelope.
Stone wool	• The structure and density of the product can be adapted to its precise final usage. Inorganic rock or slag is the main components (typically 98%) of stone wool. The remaining 2% organic content is generally a thermosetting resin binder.
Glass wool	• Is a subgroup of the mineral wool; glass wool products usually contain 95% to 96% inorganic material.
Phenolic foams	• Insulation is made by combining phenol-formaldehyde resin with a foaming agent.
Natural fibre-based insulation materials	• Environment friendly building techniques. They are available as loose insulation fill, as insulation batts or/and as rolls.
Chemical alternatives	• EU restriction proposal identified six chemical alternatives: magnesium hydroxide (MDH); Aluminum trihydroxide (ATH); Ethylene bis(tetrabromophtalimide) (EBTBP); Substituted amine phosphate mixture (P/N intumescent systems); Red phosphorous; Decabromodiphenyl ethane (DBDPE).

REF: UNEP/POPS/COP.9/INF/20

Benefits of adopting alternatives

- A positive impact on human health and the environment can be expected from a global reduction or elimination of decaBDE.
- The most positive effect would possibly be on the indoor environment and public health; with decaBDE levels in dust being reduced and ultimately eliminated by ending the use in indoor textiles and equipment.
- Eliminating or restricting the use of decaBDE will also lead to better protection of worker health, particularly in developing countries where personal protection equipment is limited, and will also reduce human and environmental exposure to toxic degradation products.
- Elimination of decaBDE would benefit agriculture as well as human and wildlife health by ending further widespread dispersal of a POP substance to soil.
- The socio-economic costs of implementing a ban and/or restriction on the use of decaBDE are considered small and outweighed by the benefits of an elimination/regulation.
- Elimination of decaBDE is consistent with sustainable development plans that seek to reduce emissions of toxic chemicals and links chemical safety, sustainable development and poverty reduction.

REF: UNEP/POPS/POPRC.11/10/Add.1

Final remarks

- c-decaBDE is still produced in high quantities worldwide.
- There are several alternatives for the different uses of decaBDE.
- The implementation of decaBDE alternatives has various benefits (human health, environmental impact, socio-economic benefit).