Public Health England

Polybromodiphenyl ethers (Decabromodiphenyl ether)

General Information

Key Points

Fire

- Non flammable
- Degrades to lower brominated diphenyl ethers when exposed to UV light and when heated to decomposition
- In the event of a fire involving polybromodiphenyl ethers, use fine water spray and normal fire kit with breathing apparatus

Health

- Decabromodiphenyl ether (Deca-BDE) has a low acute toxicity following inhalation, ingestion or dermal exposure
- Likely targets for toxicity of lower brominated polybromodiphenyl ether (PBDEs) in humans include the liver and thyroid

Environment

- Avoid release into the environment
- Inform Environment Agency of substantial incidents

Prepared by the Toxicology Department
CRCE, PHE
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Background

Polybromodiphenyl ethers (PBDEs) are a large group of 209 compounds with similar chemical structures. In the past, three commercial PBDEs, namely penta-BDE, octa-BDE and deca-BDE, have been available in the UK for use as flame retardants. Only deca-BDE is currently commercially available since the marketing and use of penta- and octa-BDE was banned throughout the EU in 2004 due to the potential to bioaccumulate in the environment.

Deca-BDE does not occur naturally and is only produced industrially. Flame retardants such as deca-BDE are added to materials to increase their resistance to burning. Deca-BDE is used in electrical equipment, including casings for televisions, computers, audio/visual equipment and mobile phones; in textiles for furnishings and upholstery such as sofas, office chairs, curtains and in materials such as communication cables, pipes and lamp sockets.

The toxicity of PBDEs varies, with deca-BDE being the least toxic. Deca-BDE can degrade in the environment into other PBDEs such as nona- and octa-BDE, which may have greater toxicity. Such BDEs are not readily broken down in the environment and may be present at low levels in soils and sediments for several years. Lower brominated PBDEs such as penta-BDE may be present at low levels in air, sediments and food animals such as fish. Individuals may therefore be exposed by inhalation or ingestion. Higher brominated PBDEs such as deca-BDE may also be inhaled or ingested, but are much less likely to pass into the blood stream. PBDEs are not likely to be absorbed through the skin following dermal contact.

There is very little information regarding adverse health effects in humans following exposure to PBDEs. Studies in animals have shown that the toxicity of deca-BDE by all routes of exposure is low. Experimental animals exposed to lower-brominated PBDEs have shown some changes in thyroid and liver function. Some impairment of nervous system behaviour, learning and memory have also been observed.

Children exposed to PBDEs would be expected to show similar health effects to adults. Developing infants may be more susceptible to effects of PBDEs on the nervous system and thyroid than adults. Lower-brominated PBDEs accumulate in fat and breast milk and may be passed from the mother to infants during feeding.

Due to the lack of human data and the limited data in animals, it is not known whether deca-BDE causes cancer therefore the International Agency for Research on Cancer (IARC) considered it as being not classifiable (group 3).

Frequently Asked Questions

What is polybromodiphenyl ethers?

Polybromodiphenyl ethers (PBDEs) are a large group of 209 compounds with similar chemical structures. Decabromodiphenyl ether (deca-BDE) is now the only commercially available PBDE for use as a flame retardant in the EU.

How does polybromodiphenyl ethers get into the environment?

PBDEs such as deca-BDE are flame retardants which are present in many household items. Some items which may contain deca-BDE include casings of televisions, computers and audio/visual equipment, and upholstery such as sofas and curtains. These flame retardants may be released (or leach-out) in small amounts from any material which contains them as particles or dust. PBDEs are not readily broken down in the environment and may be present at low levels in soils and sediments for several years.

How will I be exposed to does polybromodiphenyl ethers?

Lower brominated PBDEs such as tetra-BDE and penta-BDE are persistent in the environment. They have been used in the past and may be present at low levels in air, sediments and food animals such as fish. Individuals may therefore be exposed to these by inhalation or ingestion. Higher brominated PBDEs such as deca-BDE may also be inhaled or ingested, but are much less likely to pass into the blood stream. PBDEs are not likely to be absorbed through the skin following dermal contact.

If there is does polybromodiphenyl ethers in the environment will I have any adverse health effects?

The presence of polybromodiphenyl.ethers in the environment does not always lead to exposure. Clearly, in order for it to cause any adverse health effects you must come into contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact. Following exposure to any chemical, the adverse health effects you may encounter depend on several factors, including the amount to which you are exposed (dose), the way you are exposed, the duration of exposure, the form of the chemical and if you were exposed to any other chemicals.

There is very little information regarding adverse health effects in humans following exposure to PBDEs. Studies in animals have shown that the toxicity of deca-BDE by all routes of exposure is low. Experimental animals exposed to lower-brominated PBDEs have shown some changes in thyroid and liver function.

Can polybromodiphenyl ethers cause cancer?

There is no evidence to suggest that exposure to PBDEs would cause cancer in humans. Due to the lack of human data and the limited data in animals, the International Agency for Research on Cancer (IARC) categorised deca-BDE as not being classifiable as to its carcinogenicity to humans (group 3). PBDEs are also not classified as carcinogens in the EU.

Does polybromodiphenyl ethers affect children or damage the unborn child?

Children will be affected by PBDEs in the same way as adults. Developing infants may be more susceptible to effects of PBDEs on the nervous system and thyroid than adults. There is some evidence from animal studies to suggest that exposure to lower-brominated PBDEs during development may be associated with some impairment of nervous system behaviour, learning and memory. Lower-brominated PBDEs accumulate in fat and breast milk and may

therefore be passed from the mother to infants during feeding. There is no evidence to suggest that exposure to deca-BDE can affect the health of the unborn child.

What should I do if I am exposed to polybromodiphenyl ethers?

It is very unlikely that the general population will be exposed to a level of polybromodiphenyl ethers high enough to cause adverse health effects.

Public Health England

Polybromodiphenyl ethers (Decabromodiphenyl ether)

Incident management

Key Points

Fire

- Non flammable
- When heated to decomposition emits fumes of hydrogen bromide In the event of a fire involving polybromodiphenyl ethers, use fine water spray and normal fire kit with breathing apparatus

Health

- Deca-BDE and other PBDEs have low acute toxicity following inhalation, ingestion or dermal exposure
- Deca-BDE is relatively rapidly eliminated but the lower-brominated derivatives accumulate in fat and may be present in the body for long periods

Environment

- Avoid release into the environment
- Inform Environment Agency of substantial incidents

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Hazard Identification

Standard (UK) Dangerous Goods Emergency Action Codes

<table>
<tr><td colspan="2">UN</td><td rowspan="5">Data not available</td></tr>
<tr><td colspan="2">EAC</td></tr>
<tr><td colspan="2">APP</td></tr>
<tr><td rowspan="2">Hazards</td><td>Class</td></tr>
<tr><td>Sub risks</td></tr>
<tr><td colspan="2">HIN</td></tr>
</table>

UN – United Nations number; EAC – Emergency Action Code; APP – Additional Personal Protection; HIN - Hazard Identification Number

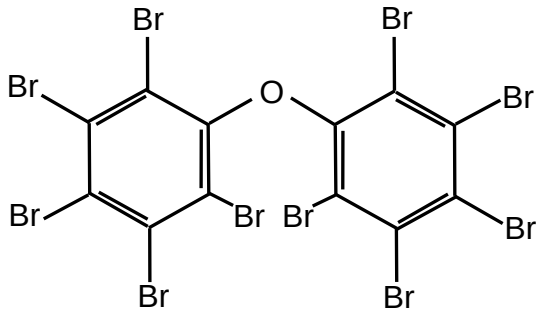
Chemical Hazard Information and Packaging for Supply Classification

Classification	Data not available
Risk phrases	
Safety phrases	

Globally Harmonised System of Classification and Labelling of Chemicals (GHS) *

Hazard Class and Category	Data not available
Hazard Statement	
Signal Words	

Physicochemical Properties

CAS number	1163-19-5
Molecular weight	959
Empirical formula	$C_{12}Br_{10}O$
Common synonyms	Deca-BDPE; Deca-BDE; Deca-brominated diphenyl ether; Decabromodiphenyl oxide; Bis(Pentabromophenyl) ether; Bromkal 82-0DE; Berkflam B 10E; BR 55N; FR 300BA; FRP 53
State at room temperature	Solid, powder
Volatility	Vapour pressure negligible at 21°C
Specific gravity	3.0 (water = 1)
Flammability	Non-flammable
Lower explosive limit	Not applicable
Upper explosive limit	Not applicable
Water solubility	Not soluble in water at 25°C. Soluble in benzene and toluene
Reactivity	Degraded by UV light
Reaction or degradation products	When heated to decomposition it emits toxic fumes of hydrogen bromide.
Odour	Odourless
Structure	

References[a,b,c,d]

[a] Hazardous Substance Data Bank (HSBD). Entry for Decabromobiphenyl ether, 2012. (accessed 02/2013).
[b] The Merck Index (14th Edition). Entry 7563: Polybrominated Biphenyls, 2006.
[c] The Dictionary of Substances and their Effects. Ed. S Gangolli. Second Edition, Volume 6, 1999.
[d] International Programme on Chemical Safety (IPCS): Bis(Pentabromophenyl) ether International Chemical Safety Card: 1689. 2008, WHO: Geneva.

Threshold Toxicity Values

EXPOSURE VIA INGESTION		
ppm	**mg m^{-3}**	**SIGNS AND SYMPTOMS**
-	-	Data not available

Published Emergency Response Guidelines

Emergency Response Planning Guideline (ERPG) Values

	Listed value (ppm)	Calculated value (mg m^{-3})
ERPG-1*	Data not available	
ERPG-2**		
ERPG-3***		

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.
** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.
*** Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.

Acute Exposure Guideline Levels (AEGLs)

Interim values

	ppm				
	10 min	**30 min**	**60 min**	**4 hr**	**8 hr**
AEGL-1†	Data not available				
AEGL-2††					
AEGL-3†††					

† The level of the chemical in air at or above which the general population could experience notable discomfort.
†† The level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape.
††† The level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

Exposure Standards, Guidelines or Regulations

Occupational Standards

WEL	LTEL(8 hour reference period): No guideline value specified
	STEL(15 min reference period): No guideline value specified

Public Health Guidelines

DRINKING WATER QUALITY GUIDELINE	No guideline value specified
AIR QUALITY GUIDELINE	No guideline value specified
SOIL GUIDELINE VALUE AND HEALTH CRITERIA VALUES	No guideline value specified

WEL – Workplace exposure limit; LTEL - Long-term exposure limit; STEL – Short-term exposure limit

Health Effects

Major Route of Exposure[(a)]

- Exposure via inhalation, ingestion and dermal exposure

Immediate Signs or Symptoms of Acute Exposure[(a)]

- Deca-DBE and other PBDEs have low acute toxicity following inhalation, ingestion or dermal exposure

[a] Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological profile for polybrominated biphenyls and polybrominated diphenyl ethers, 2004.

Decontamination and First Aid

Important Notes

- Ambulance staff, paramedics and emergency department staff treating chemically-contaminated casualties should be equipped with Department of Health approved, gas-tight (Respirex) decontamination suits based on EN466:1995, EN12941:1998 and prEN943-1:2001, where appropriate.
- Decontamination should be performed using local protocols in designated areas such as a decontamination cubicle with adequate ventilation.

Dermal Exposure[(a)]

- Remove patient from exposure.
- Any particulate matter adherent to skin should be removed and the patient washed with soap and water under low pressure for at least 10-15 minutes.
- Pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears.
- Other measures as indicated by the patient's clinical condition.

Ocular Exposure[(b)]

- Remove patient from exposure.
- Remove contact lenses if present and immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10-15 minutes.
- Patients with corneal damage or those whose symptoms do not resolve rapidly should be referred for urgent ophthalmological assessment.

Inhalation

- Remove patient from exposure.
- Ensure a clear airway and adequate ventilation.
- Give oxygen to symptomatic patients.
- Apply other supportive measures as indicated by the patient’s clinical condition.

Ingestion[(a)]

- Give oxygen to symptomatic patients.
- Apply other supportive measures as indicated by the patient’s clinical condition.

This document from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced in this document.

TOXBASE – http://www.toxbase.org (accessed 02/2013)

[a] TOXBASE: Skin decontamination – irritants, 2012

[b] TOXBASE: Eye irritants, 2002.

Public Health England

Polybromodiphenyl ethers (Decabromodiphenyl ether)

Toxicological Overview

Key Points

Kinetics and metabolism

- Higher-brominated PBDEs (such as deca-BDE) are unlikely to undergo significant absorption. They may be metabolised to lower brominated products, and are excreted mainly in the faeces
- Lower-brominated PBDEs are likely to be absorbed orally and accumulate in body tissues such as fat and be retained for many years

Health effects of acute exposure

- The acute toxicity of PBDEs is low, following inhalation, ingestion and dermal contact

Health effects of chronic exposure

- Animal studies suggest that the main target organs following repeated exposure are the liver and thyroid. Deca-BDE has much lower toxicity than penta- or octa-BDE
- Evidence of carcinogenicity of deca-BDE in animal studies is equivocal. PBDEs do not have mutagenic properties
- Animal studies suggest that deca-BDE does not have any significant toxicity to the reproductive system

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Toxicological Overview

Summary of Health Effects

Polybromodiphenyl ethers (PBDEs) are a large group of 209 compounds with similar chemical structures. Deca-, octa- and penta- brominated diphenyl ethers (BDEs) have been used in the past as flame retardants in a variety of consumer products. However, only deca-BDE is currently commercially available since the marketing and use of penta- and octa-BDE was banned throughout the EU in 2004 on the basis of the potential for the lower-brominated derivatives to bioaccumulate in the environment. Therefore most of the data in this report predominantly refers to deca-BDE and to a lesser extent to penta- and octa-BDE.

There are very few data regarding the kinetics and metabolism of PBDEs in humans. Higher brominated PBDEs (such as deca-BDE) are unlikely to undergo oral absorption. Any absorbed deca-BDE is likely to be relatively rapidly eliminated, mainly in the faeces [1]. Lower-brominated PBDEs are likely to accumulate in body tissues such as fat and be retained for many years [2]. PBDEs are not likely to be absorbed through the skin following dermal contact [2, 3].

There are very few data relating to adverse health effects in humans from acute exposure to PBDEs. Data from animal studies suggest that PBDEs have low acute toxicity and that deca-BDE is much less likely than the lower-brominated PBDEs to cause adverse health effects [2]. Data from rodent studies indicate that the key target organ for toxicity following repeated exposure to PBDEs is the liver. Penta- and octa-BDE are considerably more hepatotoxic than deca-BDE. Penta- and octa-BDE have been shown to induce liver cytochrome P-450 enzymes and to produce effects on the thyroid [1].

Deca-BDE and penta-BDE did not produce any overt fetotoxicity or teratogenicity in developmental toxicity studies in animals, whereas with octa-BDE there was some evidence of low fetotoxicity at doses producing no maternal toxicity. Single doses of penta-BDE given shortly after birth have been reported to produce neurobehavioural effects (delayed habituation behaviour) at 60 and 120 days of age [1].

The International Agency for Research on Cancer (IARC) has concluded that, based on the lack of human data and the limited evidence of carcinogenicity in animals, deca-BDE is not classifiable as to its carcinogenicity to humans (group 3) [4]. Deca-BDE is not classified as a carcinogen in the EU. No carcinogenicity data are available on the lower-brominated PBDEs [1]. PBDEs do not possess any mutagenic potential [1].

Kinetics and Metabolism

There are very few data regarding the kinetics and metabolism of PBDEs in humans.

Data from animal studies indicate that higher-brominated PBDEs (such as deca-BDE) are unlikely to undergo significant absorption following oral administration with less than 10% being absorbed [1], whilst lower brominated PBDEs such as penta- and octa-BDE are readily absorbed and are likely to accumulate in body tissues such as fat and be retained for many years. No studies were found regarding absorption in humans following inhalation exposure [2]. PBDEs are not likely to be absorbed through the skin.

Studies in various countries (Sweden, Canada, USA, UK) have indicated that PBDEs can be detected in human breast milk. Detailed studies in Sweden reported that levels increased over the period of 1972-1997, with the main compounds measured being tetra- and penta-BDE, together with small amounts of hexa-BDE. Deca-BDE was not detected [1].

Studies in experimental animals have demonstrated that many lower-brominated PBDEs such as penta-BDE are not readily metabolised. Limited information indicates that deca-BDE is metabolised to lesser brominated phenolic products [1].

The primary route of excretion for all PBDEs in animals is thought to be in the faeces, although it is unclear what proportion of this is unabsorbed material. Distribution studies with deca-BDE in rats have demonstrated that it is poorly absorbed and rapidly excreted in the faeces. There are few data regarding the bioaccumulation or route of elimination in humans. [1, 2].

Sources and Route of Human Exposure

Exposure of the general public to low levels of deca-BDE may occur via ingestion or inhalation, although uptake is likely to be insignificant. In contrast, uptake of penta-BDE may occur via the consumption of fish or cow's milk containing trace amounts of these compounds. Skin contact with treated textiles is unlikely to give rise to significant uptake since PBDEs are poorly absorbed through the skin. Small amounts of lower PBDEs may be present in the air hence exposure may also occur through inhalation [2, 3].

Exposure to deca-BDE may occur in occupational settings, although the potential for inhalation is expected to be very minimal, since the vapour pressure is extremely low. However, small inhalable particles and dust containing PBDEs may be produced when grinding solids and appropriate protective equipment is recommended in areas of potential exposure [3].

Individuals may be environmentally exposed to different forms of PBDEs than those initially released from the source due to transformation and differential partitioning in the environment and food animals [2]. For example, deca-BDE released from polymers or plastics may degrade to lower-brominated PBDEs, such as tetra-BDE or penta-BDE [2].

Health Effects of Acute / Single Exposure

Human Data

General toxicity

There are very few data relating to adverse health effects in humans from acute exposure to deca-BDE [2, 3].

Inhalation

No data were available regarding acute exposure of humans to deca-BDE by inhalation.

Ingestion

No data were available regarding acute exposure of humans to deca-BDE by ingestion.

Dermal / ocular exposure

No evidence for skin sensitisation was found in a study of 200 human subjects to determine the skin sensitisation potential of deca-BDE [3].

Animal and In-Vitro Data

Inhalation

The toxicity of deca-BDE following acute inhalation in experimental animals is low [3]. In a study in which male and female Spartan rats were administered a single dose of either 2 mg L^{-1} or 48.2 mg L^{-1} commercial deca-BDE by inhalation for 1 hour, all of the animals survived. In the 2 mg L^{-1} group the only effects seen during the observation period were respiratory difficulties in one animal and a slight ocular discharge in another. All other rats appeared normal. In the higher dose group, increased motor activity and eye squint were observed up to day 4. Respiratory difficulties were noted in 4 of the rats on different days post exposure and eye squint and ocular discharge were seen in a few of the rats between days 7 and 11 post exposure. However, all of the animals appeared normal on day 14 [3].

Rats exposed to extremely high concentrations of aerosolised dust of penta-BDE (200,000 mg m^{-3}), octa-BDE (60,000 mg m^{-3}) or deca-BDE (48,200 mg m^{-3}) for 1 hour, showed transient signs of respiratory distress, including tachypnoea and dyspnoea [2].

Ingestion

Intragastric intubation of a single dose of a commercial preparation of deca-BDE to female Sprague-Dawley rats in the range of 126 to 2000 mg kg^{-1} body weight (bw) in 10 % corn oil caused no adverse toxicity and no gross pathological changes up to 14 days post-exposure [3]. In another study, no adverse health effects were reported in male rats up to 14 days after exposure to a single dose of up to 5 g kg^{-1} bw deca-BDE in corn oil by gavage [3].

Studies in rodents indicate that the penta-, octa- and deca- derivatives all have low acute toxicity with LD_{50} values of greater than 2 to 5 g kg^{-1} bw. No overt signs of toxicity were seen at these very high doses [1].

Mild impairments in spontaneous motor behaviour, learning and memory were observed in mice that were exposed to single low doses (concentration unknown) of penta-BDE, hexa-BDE and deca-BDE during prenatal or early postnatal periods and tested later in life [2, 5].

In acute oral studies, rats administered 10-100 mg kg^{-1} bw penta-BDE or octa-BDE had an increase in cytochrome P450 activity which was associated with perturbations of thyroid hormones, liver enlargement and histopathological changes in the thyroid. Deca-BDE did not induce such changes at doses up to 100 mg kg^{-1} bw [1].

Dermal / ocular exposure

Deca-BDE is not an irritant to the skin or eyes of rabbits and it is not thought to cause chloracne [3].

Health Effects of Chronic / Repeated Exposure

Human Data

General toxicity

There are very few data relating to adverse health effects in humans following repeated exposure to deca-BDE.

Inhalation

No adverse health effects were detected in workers occupationally exposed to a mixture of polybutyl terephthalate and deca-BDE for 13 years [3].

A health assessment of workers occupationally exposed to deca-BDE and polybrominated biphenyls (PBBs) showed a greater incidence of hyperthyroidism than expected and significant reductions in sensory and fibula motor velocities. No other neurological or dermatological effects were observed. However, it was not clear whether these effects were due to exposure to deca-BDE or were due to the PBBs to which the individuals were concurrently exposed, as deca-DBE was not detected in the serum of workers [3].

Ingestion

No data were available regarding repeated oral exposure of humans to deca-BDE [2].

Genotoxicity

No data were available regarding the genotoxicity of deca-BDE in humans [4].

Carcinogenicity

No data were available regarding the carcinogenicity of deca-BDE in humans.

Based on the lack of human data and the limited evidence of carcinogenicity in animals, the IARC considered deca-BDE to be not classifiable as to its carcinogenicity to humans (group 3) [4]. The U.S. EPA has classified lower-brominated PBDEs are not being classifiable as to human carcinogenicity [2].

Reproductive and developmental toxicity

No data were located regarding adverse reproductive or developmental effects in humans following exposure to deca-BDE. [2].

Animal and In-Vitro Data

Inhalation

No data were available regarding adverse health effects following chronic inhalation exposure to deca-BDE.

Ingestion

No histopathological changes in the gastrointestinal tract were reported in mice or rats given deca-BDE (<8000 and 9500 mg kg^{-1} bw day^{-1} respectively) for 13 weeks. Rats given dietary doses of deca-BDE (2240 mg kg^{-1} bw day^{-1}) for 103 weeks had forestomach lesions and 7780 mg kg^{-1} bw day^{-1} caused stomach ulcers in mice [2].

Intermediate and chronic exposure studies in rats indicate that the liver is the key target organ for PBDE toxicity.

Repeated dietary studies have shown that adverse liver effects were more severe in rats and mice when administered lower doses of lower-brominated PBDEs (octa-BDE and penta-BDE) compared with deca-BDE [2].

Exposure to deca-BDE at 94-97% purity for 103 weeks caused hepatic lesions including neoplastic nodules in rats at above 1,120 mg kg^{-1} bw day^{-1}, and thrombosis and degeneration at above 2,240 mg kg^{-1} bw day^{-1}. Centrilobular hypertrophy and granulomas were observed in mice at above 3,200 mg kg^{-1} bw day^{-1} [2].

Based on the available data from repeated dose studies, penta-BDE was considered the most toxic of the PBDEs with a lowest observable adverse effect level (LOAEL) of 0.6 mg kg^{-1} bw^{-1} day^{-1} based on liver toxicity, compared to 7.2 mg kg^{-1} bw day^{-1} and 1,120 mg kg^{-1} bw day^{-1} for octa-BDE and deca-BDE, respectively [1].

Genotoxicity

Deca-BDE did not induce reverse mutations in the Ames test using *Salmonella typhimurium* (strains TA 98, TA100, TA1535 and TA 1537) either with or without activation. It did not induce gene mutations in mouse lymphoma cells or induce sister chromatid exchanges or chromosomal aberrations in Chinese hamster ovary CHO cells [2, 4]. Cytogenic examination of bone marrow cells showed no increase in chromosomal aberrations in maternal or neonatal rats following oral exposure to deca-BDE at up to 100 mg kg^{-1} bw day^{-1} for 90 days [2]. Deca-BDE does not have any mutagenic potential [1].

Penta-BDE has given negative results in 4 studies to investigate its ability to induce gene mutation in *S. typhimurium* and in one study in *Saccharomyces cerevisiae*. A cytogenic study in human peripheral blood lymphocytes also gave negative results. Penta-BDE has not been tested for genotoxicity *in vivo*. However, the *in-vitro* data indicate that it does not have any mutagenic potential [1].

Octa-BDE has also given negative results in 4 studies for gene mutation in *S. typhimurium* and in one study in *S. cerevisiae*. Negative results were also obtained in studies to investigate unscheduled DNA synthesis in human fibroblasts, sister chromatid exchange in

CHO cells or chromosome aberrations in human peripheral blood lymphocytes. These data indicate that octa-BDE does not have any significant mutagenic potential [1].

Carcinogenicity

Carcinogenicity bioassay data are available for deca-BDE from dietary studies in mice and rats. In a 103 week study in mice, an increase in hepatocellular adenomas or carcinomas was seen at the lowest dose level (3200 mg kg^{-1} bw day^{-1}) but not at the higher dose (6650 mg kg^{-1} bw day^{-1}). Thyroid gland follicular cell adenomas were reported in male mice at both levels. There was no evidence of carcinogenicity in female mice.

In a 103 week study in the rat there was a dose dependent increase in neoplastic liver nodules, which was significantly greater than the controls, in males administered 1120 mg kg^{-1} bw day^{-1} and in both sexes given 2240 mg kg^{-1} bw day^{-1}. The recent EU comprehensive risk assessment of deca-BDE (under the Existing Substance Regulation) noted that the evidence for carcinogenicity of deca-BDE from those bioassays was equivocal [1, 6].

IARC has concluded that there was limited evidence for the carcinogenicity of deca-BDE in experimental animals [4].

No data are available on the carcinogenicity of lower-brominated PBDEs such as penta-BDE or octa-BDE [2].

Reproductive and developmental toxicity

In a one generation reproductive study in which male and female Sprague-Dawley rats were administered up to 100 mg kg^{-1} bw deca-BDE in the diet for 60 days prior to mating, and throughout gestation and lactation, no signs of toxicity were observed in either the adult rats or neonates during the study or at necropsy [3].

A study in which rats were exposed to low-doses of penta-BDE during development has suggested a permanent impairment of spermatogenesis, however, no effect on fertility was observed [5].

Deca-BDE and penta-BDE did not produce adverse effects in routine developmental toxicity studies. In a dietary study in rats using deca-BDE or penta-BDE, no developmental effects were seen following administration of doses up to 100 mg kg^{-1} bw day^{-1} 200 mg kg^{-1} bw day^{-1}, respectively, from 60 days prior to mating until weaning [1].

In contrast, octa-BDE has been shown to produce fetal toxicity in rats and rabbits. In the recent EU risk assessment, 2 mg kg^{-1} bw day^{-1} was identified as the lowest no observable adverse effect level (NOAEL) in rabbits, with slight fetotoxicity being observed at 5 mg kg^{-1} bw day^{-1} [1, 6].

Non-routine studies on specific congeners of penta-BDE have been reported to cause neurobehavioural changes in mice following a single oral administration on post natal day 3, 10 or 19. Neurobehavioural effects were detected at 60 and 120 days of age. The main effect noted was delayed habituation behaviour which was found to occur at the lowest dose tested, 0.6 – 0.8 mg kg^{-1} bw [1].

References

[1] Committee on Toxicity of Chemicals in Food Consumer Products and the Environment (COT) (2004). COT Statement on Brominated Flame Retardants in Fish from the Skerne-Tees Rivers System.

[2] Agency for Toxic Substances and Disease Registry (ATSDR) (2004). Toxicological Profile for Polybrominated Biphenyls and Polybrominated Diphenyl Ethers. US Department of Health and Human Services. Atlanta, US.

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