Decabromodiphenyl ether

sc-239649

Material Safety Data Sheet

Hazard Alert Code Key: EXTREME HIGH MODERATE LOW

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME

Decabromodiphenyl ether

STATEMENT OF HAZARDOUS NATURE

CONSIDERED A HAZARDOUS SUBSTANCE ACCORDING TO OSHA 29 CFR 1910.1200.

NFPA

SUPPLIER

Company: Santa Cruz Biotechnology, Inc.
2145 Delaware Ave
Santa Cruz, CA 95060
Telephone: 800.457.3801 or 831.457.3800
Emergency Tel: **CHEMWATCH: From within the US and Canada: 877-715-9305**
Emergency Tel: **From outside the US and Canada: +800 2436 2255 (1-800-CHEMCALL) or call +613 9573 3112**

PRODUCT USE

Fire retardant for high impact polystyrene, ABS polymers, adhesives, polyethylene, thermoset applications of epoxy resins and unsaturated polymers and synthetic fibers.

SYNONYMS

C12-Br10-O, (C6Br5)2, "ether, bis(phenylbromophenyl)", "benzene, 1, 1' -oxybis(2, 3, 4, 5, 6-pentabromo-", "bis-pentabromophenyl ether", "decabromobiphenyl oxide", "decabromophenyl ether", "1, 1' -oxybis(2, 3, 4, 5, 6-pentabromobenzene)", DBDPE, DBDPO, DE-83R, FR-300, "FR 300BA", FRP-53, NCI-C55287, "Berkflam B-10E", BR-55N, "Bromkal 83-10DE", "Bromkal 82-ODE", Decabrom, Saytex, "Tardex 100", fire-retardant

Section 2 - HAZARDS IDENTIFICATION

CHEMWATCH HAZARD RATINGS

		Min	Max
Flammability:	0		
Toxicity:	2		
Body Contact:	2		
Reactivity:	1		
Chronic:	2		

Min/Nil=0
Low=1
Moderate=2
High=3
Extreme=4

CANADIAN WHMIS SYMBOLS

EMERGENCY OVERVIEW

RISK

Limited evidence of a carcinogenic effect.
Harmful by inhalation, in contact with skin and if swallowed.
Irritating to eyes, respiratory system and skin.
May cause long-term adverse effects in the environment.
Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED

■ Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal or may produce serious damage to the health of the individual.

■ Digestion of PCBs and related substances can lead to nausea and vomiting, abdominal pain, loss of appetite, jaundice, liver damage, coma and death. Headache, dizziness, lethargy, depression, nervousness, loss of libido and muscle and joint pain may also occur. Symptoms and death may be delayed for months; the substance occurs in the breastmilk of women and is toxic to babies.

EYE

■ This material can cause eye irritation and damage in some persons.

■ Vapors of PCBs may be irritating and may be absorbed by the eye.

SKIN

■ Skin contact with the material may be harmful; systemic effects may resultfollowing absorption.

■ This material can cause inflammation of the skin oncontact in some persons.

■ The material may accentuate any pre-existing dermatitis condition.

■ Direct contact of the skin with liquid PCBs may result in irritation and defatting leading to dermatitis. PCBs may be absorbed by skin and as a result may be retained in body tissues.

■ Exposure to the material may result in a skin inflammation called chloracne. This is characterized by white- and blackheads, keratin cysts, spots, excessive discoloration. These mainly involve the skin under the eyes and behind the ears. The reaction may be delayed. There may also be excess hair growth, degeneration of elastic tissue as a result of sunlight, and scarring of the membrane of the penis.

■ Open cuts, abraded or irritated skin should not be exposed to this material.

■ Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.

■ Chlorinated diphenyl ethers may produced skin irritation; systemic toxicitymay occur following absorption.

INHALED

■ Inhalation of dusts, generated by the material, during the course of normalhandling, may be harmful.

■ The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage.

■ Persons with impaired respiratory function, airway diseases and conditions such as emphysema or chronic bronchitis, may incur further disability if excessive concentrations of particulate are inhaled.

■ Inhalation of vapors containing PCBs may cause respiratoryirritation, eczema and skin burns.

CHRONIC HEALTH EFFECTS

■ Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems.
There has been concern that this material can cause cancer or mutations, but there is not enough data to make an assessment.
Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems.
Many of the effects of PBB are seen after long-term exposure. The reason for this may be the pronounced accumulation of some PBB congeners and the poor ability of the body to metabolize and eliminate them. This results in a build-up of the chemical in the body overcoming compensatory mechanisms leading to adverse effects.
Two small groups of workers with occupational exposure to a mixture of PBBs or to DeBB (decabromobiphenyl) and DBBO (decabromobiphenyl ether) were identified. Lesions resembling chloracne were found in 13% of the workers exposed to the PBB mixture, such lesions were not seen in the DeBB- exposed workers. However, a significantly higher prevalence of hypothyroidism was seen in the latter group.
Overall evaluation of toxicity and carcinogenicity The only lifetime study with a PBB mixture was conducted on rats and mice in an NTP bioassay. The lowest dose tested that still produced carcinogenic effects was 0.5 mg/kg body weight per day (liver tumours in rodents). In other carcinogenicity studies, 3 mg/kg body weight per day given for 6 months resulted in a carcinogenic response. The 6-month study demonstrates that less than lifetime exposure at similar doses will also result in similar adverse effects. Effects on reproduction in subhuman primates and mink may occur at lower doses. In addition, in the 2-year NTP rat study, a daily dose of 0.15 mg/kg body weight per day and prenatal and perinatal exposure of the dam to 0.05 mg/kg body weight per day did not result in any adverse effects. Thus, the total daily intake from food, water, air, and soil should be less than 0.15 ug/kg body weight per day, extrapolating from a NOAEL (no-observed- adverse-effect level) of a positive carcinogenicity study, using an uncertainty (safety) factor of 1000, since these compounds probably produce cancer by an epigenetic mechanism.
Polybrominated diphenyl ethers may be by-products during the production of the diphenyl derivative.
Prolonged contact with chlorinated diphenyl ethers may cause skin irritation, weight loss and liver injury. Repeated absorption has produced liver damage in animals.
In a two-year animal study at dose-rates of up to 1 mg/kg/day DBDPE, no adverse effects or no dose-related deaths were noted. The same

study failed to show a significant increase in tumour incidence. The National Toxicology Program conclude that the substance showed some evidence of carcinogenicity as a lifelong feeding study at high dose rates in male and female rats produced an increased incidence of benign-tumour like changes in the liver.

Carcinogenicity bioassays (2 year) have been conducted on DBDPE in mice and rats. A significant increase in the combined incidence of hepatocellular adenomas and carcinomas was reported in mice (males) when compared to control animals, but not when compared to historical control groups. The combined incidence of thyroid gland follicular-cell adenomas and carcinomas was also increased at low and high doses, though not significantly. No significant differences in the number

of rats developing tumours, the total number of tumours or specific type of tumours were observed between treated and control animals fed up to 1 mg/kg DBDPE over 2 years. In another report, rats fed doses up to 50 g/kg of DBDPE over two years showed significant increases in the incidence of liver adenomas. However, no significant differences were identified among the groups in the incidence of hepatocellular carcinomas or acinar-cell adenomas of the pancreas.

The reproductive capacity of both female and male rats was not effected by diets containing up to 100 mg/kg/day. Foetuses showed subcutaneous oedema and delayed ossification of bones following treatment of the mother with 1000 mg of the substance in a corn oil suspension at 6-15 days gestation.

Studies in rats indicated that DBDPE was minimally absorbed (< 2%) in the gastrointestinal

tract, with the majority being excreted via faeces. Neither absorption nor elimination were affected by the dose administered. DBDPE deposits in the liver were identified to be less than 1% of the administered dose and only trace amounts were identified in kidneys, spleen, lung, brain, fat and skin.

Dietary long-term exposure in rats revealed significant increase in total bromine content of adipose tissue in response to increased dose and time of exposure. However, conclusions regarding the source of the increased bromine levels were confounded by the purity of the test substance, which also contained around 20% NBDPE and OBDPE congeners.

No information was available on metabolites in animals fed DBDPE.

Radiolabelled 14C-DBDPE studies in rats indicated that the elimination of DBDPE is a rapid process with a half-life of less than 24 h.

DBDPE is of low acute oral toxicity with LD50 in rats > 5 g/kg, with no indication of toxicity, gross pathological changes or mortality over a 14-day observation period following single dose. The acute dermal LD50 in rabbits is > 2 g/kg with no associated mortalities. No information on skin irritation was reported. The acute inhalation LC50 in rats is >48.2 mg/L; although no mortalities were reported, respiratory difficulties, eye squint and ocular discharge and increased motor activity, were observed in a 14-day inhalation study.

Application of DBDPE to the shaved skin of rabbits resulted in no irritation to intact skin and no, or only slight, irritation to abraded skin. Similarly, only transient redness and chemosis of the conjunctival membrane of rabbit eyes resulted from application of DBDPE, which resolved after 24 h.

A variety of samples of DBDPE were evaluated for chloracnegenic activity on the rabbit ear and found to be negative. DBPDE did not induce skin sensitisation in a human patch test.

In general, short- and long-term studies in mice and rats provided no evidence of compound-related effects on clinical, physiological or pathological parameters, with a few exceptions. Increased liver weights and pathological changes in kidneys and lungs following inhalation exposure were reported. In mice and rats, the LOAELs for orally administered DBDPE were determined to be 9 000 mg/kg bw/day and 3 350 mg/kg bw/day, respectively, obtained in 90 days studies. The NOAELs (oral) were determined to be 3 500 mg/kg bw/day and 1 100 mg/kg bw/day in mice and rats, respectively. Effects reported in 2 year oral studies included liver degeneration and fibrosis of spleen in rats and liver hypertrophy and follicular cell hyperplasia in mice. Neoplastic effects are discussed below.

DBDPE was not mutagenic in Salmonella typhimurium or Saccharomyces cerevisiae assays in the presence or absence of exogenous metabolic activation. Similarly, it was neither mutagenic in mouse lymphoma cells nor caused chromosomal aberration or sister chromatid exchanges (SCE) in Chinese hamster ovary cells. The absence of cytogenetic effects by DBDPE was also reported in bone marrow cells recovered from a reproduction study.

Human studies indicated that DBDPE is not a skin sensitiser when applied repeatedly to the skin of human volunteers, though signs of skin irritation were reported in a small group of volunteers (9 out of 50 individuals). The available epidemiological reports indicate that no adverse health effects were

observed from occupational exposure to DBDPE. However, a health assessment of workers exposed to PBB and PBDPEs revealed the prevalence of primary hypothyroidism and significant reduction in sensory and fibula motor velocities.

Thyroid nodules were also observed in 16% of workers exposed to PBB and DBDPE, with the effects reportedly dependent on the content of the mixes. No direct correlation between the effects and chemicals could be established, given that exposure to both may have occurred at the same plant

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
decabromodiphenyl ether	1163-19-5	>98
commercial product may contain varying levels of		
heptabromodiphenyl ether	68928-80-3	
nonabromodiphenyl ether	63936-56-1	
hexabromodiphenyl ether	36483-60-0	
octabromodiphenyl ether	32536-52-0	

Section 4 - FIRST AID MEASURES

SWALLOWED

■

- IF SWALLOWED, REFER FOR MEDICAL ATTENTION, WHERE POSSIBLE, WITHOUT DELAY.
- Where Medical attention is not immediately available or where the patient is more than 15 minutes from a hospital or unless instructed

otherwise:

- For advice, contact a Poisons Information Center or a doctor.
- Urgent hospital treatment is likely to be needed.
- If conscious, give water to drink.
- INDUCE vomiting with fingers down the back of the throat, ONLY IF CONSCIOUS. Lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration.

NOTE: Wear a protective glove when inducing vomiting by mechanical means.

- In the mean time, qualified first-aid personnel should treat the patient following observation and employing supportive measures as indicated by the patient's condition.
- If the services of a medical officer or medical doctor are readily available, the patient should be placed in his/her care and a copy of the MSDS should be provided. Further action will be the responsibility of the medical specialist.
- If medical attention is not available on the worksite or surroundings send the patient to a hospital together with a copy of the MSDS.

EYE

■ If this product comes in contact with the eyes:

- Wash out immediately with fresh running water.
- Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.
- If pain persists or recurs seek medical attention.
- Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

SKIN

■ If skin contact occurs:

- Immediately remove all contaminated clothing, including footwear
- Flush skin and hair with running water (and soap if available).
- Seek medical attention in event of irritation.

INHALED

■

- If fumes or combustion products are inhaled remove from contaminated area.
- Lay patient down. Keep warm and rested.
- Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.
- Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.
- Transport to hospital, or doctor, without delay.

NOTES TO PHYSICIAN

■ Treat symptomatically.

Presentation:

A: Acute symptoms related to overexposure to the PCBs and dioxins (PCDDs and PCDFs) and, presumably, other polyhalogenated polyaromatics (PHAHs) include irritation of the skin, eyes and mucous membranes and nausea, vomiting and myalgias.

B: After a latency period which may be prolonged (up to several weeks or more), chloracne, porphyria cutanea tarda, hirsutism, or hyper-pigmentation may occur. Elevated levels of hepatic transaminases and blood lipids may be found. Polyneuropathies with sensory impairment and lower-extremity motor weakness may also occur.

C: Useful laboratory studies might include glucose, electrolytes, BUN, creatinine, liver transaminase, and liver function tests, and uroporphyrins (where porphyria is suspected)

Treatment:

A: Emergency and Supportive Measures: Treat skin, eye and respiratory irritation symptomatically

B: There is no specific antidote

C: Decontamination:

- Inhalation; remove victims from exposure and give supplemental oxygen if available.
- Eyes and Skin: remove contaminated clothing and wash affected skin with copious soap and water; irrigate exposed eyes with copious tepid water or saline.
- Ingestion; (a) Prehospital: Administer activated charcoal if available. Ipecac-induced vomiting may be useful for initial treatment at the scene if it can be given within a few minutes exposure (b) Hospital: Administer activated charcoal. Gastric emptying is not necessary if activated charcoal can be given promptly.

D: Enhanced elimination: There is no known role for these procedures.

POISONING and DRUG OVERDOSE, Californian Poison Control System Ed. Kent R Olson; 3rd Edition

- If large amounts of PCB are ingested, gastric lavage is suggested.
- In the case of splashes to the eyes, a petrolatum-based ophthalmic ointment may be applied to the eye to relieve the irritating effects of PCBs.
- If electrical equipment arcs over, PCB dielectric fluids may decompose to produce hydrogen chloride (HCl), a respiratory irritant. [MONSANTO] Preplacement and annual medical examination of workers, likely to be exposed to PCBs and their congeners, is recommended; examination should emphasize liver function, skin condition, and reproductive history. [ILO]

Section 5 - FIRE FIGHTING MEASURES

Vapor Pressure (mmHg):	34.728 x 10-9 (20 C)
Upper Explosive Limit (%):	Not available.
Specific Gravity (water=1):	3.0-3.25
Lower Explosive Limit (%):	Not available

EXTINGUISHING MEDIA

■

- Foam.
- Dry chemical powder.
- BCF (where regulations permit).
- Carbon dioxide.
- Water spray or fog - Large fires only.

FIRE FIGHTING

■

- Alert Emergency Responders and tell them location and nature of hazard.
- Wear breathing apparatus plus protective gloves.
- Prevent, by any means available, spillage from entering drains or water course.
- Use water delivered as a fine spray to control fire and cool adjacent area.
- DO NOT approach containers suspected to be hot.
- Cool fire exposed containers with water spray from a protected location.
- If safe to do so, remove containers from path of fire.
- Equipment should be thoroughly decontaminated after use.

GENERAL FIRE HAZARDS/HAZARDOUS COMBUSTIBLE PRODUCTS

■ Combustion products include: carbon monoxide (CO), carbon dioxide (CO2), hydrogen bromide, other pyrolysis products typical of burning organic material.

Flame retardants may not themselves be immune from combustion but will quickly self-extinguish under fire normal conditions. Their thermal degradation products may be be required to break the combustion cycle of materials in which they are found. When materials burn they introduce flammable gases into the immediate environment, The gas flame itself is maintained by the action of high energy "radicals" (that is H+ and OH- in the gas phase) which decompose molecules to give free carbon. This free carbon may react with oxygen in air to " burn" to CO2, generating heat energy.

Halogenated flame retardants act by effectively removing the H+ and OH- radicals in the gas flame phase. This considerable slows or prevents the burning process, thus reducing heat generation and, as a result, the production of further gaseous material. The halogenated flame retardants release bromine or chlorine as free radicals (Br- or Cl- as appropriate) which react with the flammable gases to give off HBr or HCl. These then react with the high energy H+ or OH- radicals to give water and the much lower energy Br- or Cl- radicals which then become available to begin a new cycle of H+ and OH- radical removal.

Because chlorine (from chorinated retardants) is released over a wider range of temperatures than bromine, it is present in the flame zone at lower concentrations and is thus less effective.

PCBs decompose on heating to produce acrid black soot and toxic fumes of aldehydes, hydrogen chlorides (HCl), chlorides and extremely toxic polychlorinated dibenzofurans (PCDF) and polychlorinated dibenzodioxin (PCDD).

Other halogenated analogues may produce corresponding decomposition products.

FIRE INCOMPATIBILITY

■ Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids,chlorine bleaches, pool chlorine etc. as ignition may result.

PERSONAL PROTECTION

Glasses:
Chemical goggles.
Gloves:
Respirator:
Particulate

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS

■ Environmental hazard - contain spillage.

- Clean up waste regularly and abnormal spills immediately.
- Avoid breathing dust and contact with skin and eyes.
- Wear protective clothing, gloves, safety glasses and dust respirator.
- Use dry clean up procedures and avoid generating dust.
- Vacuum up or sweep up. NOTE: Vacuum cleaner must be fitted with an exhaust micro filter (HEPA type) (consider explosion-proof machines designed to be grounded during storage and use).
- Dampen with water to prevent dusting before sweeping.
- Place in suitable containers for disposal.

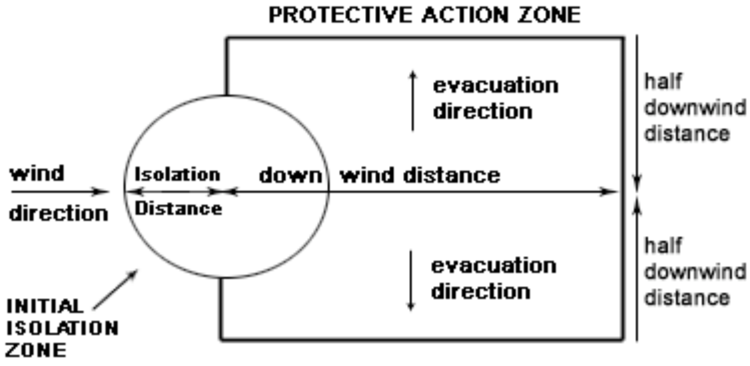
MAJOR SPILLS

■ Environmental hazard - contain spillage.

Moderate hazard.

- CAUTION: Advise personnel in area.
- Alert Emergency Responders and tell them location and nature of hazard.
- Control personal contact by wearing protective clothing.
- Prevent, by any means available, spillage from entering drains or water courses.
- Recover product wherever possible.
- IF DRY: Use dry clean up procedures and avoid generating dust. Collect residues and place in sealed plastic bags or other containers for disposal. IF WET: Vacuum/shovel up and place in labelled containers for disposal.
- ALWAYS: Wash area down with large amounts of water and prevent runoff into drains.
- If contamination of drains or waterways occurs, advise emergency services.

PROTECTIVE ACTIONS FOR SPILL



From IERG (Canada/Australia)	
Isolation Distance	15 meters
Downwind Protection Distance	50 meters

From US Emergency Response Guide 2000 Guide 171

FOOTNOTES

1 PROTECTIVE ACTION ZONE is defined as the area in which people are at risk of harmful exposure. This zone assumes that random changes in wind direction confines the vapour plume to an area within 30 degrees on either side of the predominant wind direction, resulting in a crosswind protective action distance equal to the downwind protective action distance.
2 PROTECTIVE ACTIONS should be initiated to the extent possible, beginning with those closest to the spill and working away from the site in the downwind direction. Within the protective action zone a level of vapour concentration may exist resulting in nearly all unprotected persons becoming incapacitated and unable to take protective action and/or incurring serious or irreversible health effects.
3 INITIAL ISOLATION ZONE is determined as an area, including upwind of the incident, within which a high probability of localised wind reversal may expose nearly all persons without appropriate protection to life-threatening concentrations of the material.
4 SMALL SPILLS involve a leaking package of 200 litres (55 US gallons) or less, such as a drum (jerrican or box with inner containers). Larger packages leaking less than 200 litres and compressed gas leaking from a small cylinder are also considered "small spills". LARGE SPILLS involve many small leaking packages or a leaking package of greater than 200 litres, such as a cargo tank, portable tank or a "one-tonne" compressed gas cylinder.
5 Guide 171 is taken from the US DOT emergency response guide book.
6 IERG information is derived from CANUTEC - Transport Canada.

ACUTE EXPOSURE GUIDELINE LEVELS (AEGL) (in ppm)

AEGL 1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.
AEGL 2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
AEGL 3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING

■

- Avoid all personal contact, including inhalation.
- Wear protective clothing when risk of exposure occurs.
- Use in a well-ventilated area.
- Prevent concentration in hollows and sumps.
- DO NOT enter confined spaces until atmosphere has been checked.
- DO NOT allow material to contact humans, exposed food or food utensils.
- Avoid contact with incompatible materials.
- When handling, DO NOT eat, drink or smoke.
- Keep containers securely sealed when not in use.
- Avoid physical damage to containers.
- Always wash hands with soap and water after handling.
- Work clothes should be laundered separately.
- Launder contaminated clothing before re-use.
- Use good occupational work practice.
- Observe manufacturer's storing and handling recommendations.
- Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.

Empty containers may contain residual dust which has the potential to accumulate following settling. Such dusts may explode in the presence of an appropriate ignition source.

- Do NOT cut, drill, grind or weld such containers.
- In addition ensure such activity is not performed near full, partially empty or empty containers without appropriate workplace safety authorisation or permit.

RECOMMENDED STORAGE METHODS

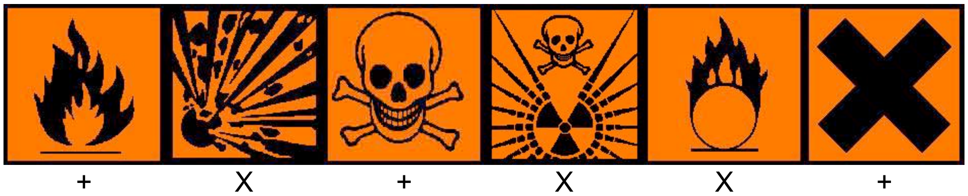
■

- Polyethylene or polypropylene container.
- Check all containers are clearly labelled and free from leaks.

STORAGE REQUIREMENTS

■ Observe manufacturer's storing and handling recommendations.

SAFE STORAGE WITH OTHER CLASSIFIED CHEMICALS



X: Must not be stored together
O: May be stored together with specific preventions
+: May be stored together

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS

Source	Material	TWA ppm	TWA mg/m³	STEL ppm	STEL mg/m³	Peak ppm	Peak mg/m³	TWA F/CC	Notes
US AIHA Workplace Environmental Exposure Levels (WEELs)	decabromodiphenyl ether (Decabromodiphenyl Oxide [a])		5						
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	decabromodiphenyl ether (POLYBROMINATED DIPHENYL ETHERS (PBDEs), LOWER BROMINATED)		0.006						
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	nonabromodiphenyl ether (POLYBROMINATED DIPHENYL ETHERS (PBDEs), LOWER BROMINATED)		0.006						
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	hexabromodiphenyl ether (POLYBROMINATED DIPHENYL ETHERS (PBDEs), LOWER BROMINATED)		0.006						
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	octabromodiphenyl ether (POLYBROMINATED DIPHENYL ETHERS (PBDEs), LOWER BROMINATED)		0.006						
Canada - Nova Scotia Occupational Exposure Limits	octabromodiphenyl ether (Particles (Insoluble or Poorly Soluble) [NOS] Respirable particles)		3						See Appendix B current TLV/BEI Book
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	octabromodiphenyl ether (Particulates Not Otherwise Classified (PNOC))		10						
Canada - British Columbia Occupational Exposure Limits	octabromodiphenyl ether (Particles (Insoluble or Poorly Soluble) Not Otherwise Classified (PNOC))		10 (N)						
US - Washington Permissible exposure limits of air contaminants	octabromodiphenyl ether (Particulates not otherwise regulated - Total particulate)		10		20				
US - Washington Permissible exposure limits of air contaminants	octabromodiphenyl ether (Particulates not otherwise regulated - Respirable fraction)		5		10				

Canada - Nova Scotia Occupational Exposure Limits	octabromodiphenyl ether (Particles (Insoluble or Poorly Soluble) [NOS] Inhalable particles)	10	See Appendix B current TLV/BEI Book

The following materials had no OELs on our records

- heptabromodiphenyl ether: CAS:68928-80-3

MATERIAL DATA

DECABROMODIPHENYL ETHER:
HEPTABROMODIPHENYL ETHER:
HEXABROMODIPHENYL ETHER:
NONABROMODIPHENYL ETHER:
OCTABROMODIPHENYL ETHER:

■ It is the goal of the ACGIH (and other Agencies) to recommend TLVs (or their equivalent) for all substances for which there is evidence of health effects at airborne concentrations encountered in the workplace.

At this time no TLV has been established, even though this material may produce adverse health effects (as evidenced in animal experiments or clinical experience). Airborne concentrations must be maintained as low as is practically possible and occupational exposure must be kept to a minimum.

NOTE: The ACGIH occupational exposure standard for Particles Not Otherwise Specified (P.N.O.S) does NOT apply.

DECABROMODIPHENYL ETHER:
HEPTABROMODIPHENYL ETHER:
HEXABROMODIPHENYL ETHER:
NONABROMODIPHENYL ETHER:
OCTABROMODIPHENYL ETHER:

■ Sensory irritants are chemicals that produce temporary and undesirable side-effects on the eyes, nose or throat. Historically occupational exposure standards for these irritants have been based on observation of workers' responses to various airborne concentrations. Present day expectations require that nearly every individual should be protected against even minor sensory irritation and exposure standards are established using uncertainty factors or safety factors of 5 to 10 or more. On occasion animal no-observable-effect-levels (NOEL) are used to determine these limits where human results are unavailable. An additional approach, typically used by the TLV committee (USA) in determining respiratory standards for this group of chemicals, has been to assign ceiling values (TLV C) to rapidly acting irritants and to assign short-term exposure limits (TLV STELs) when the weight of evidence from irritation, bioaccumulation and other endpoints combine to warrant such a limit. In contrast the MAK Commission (Germany) uses a five-category system based on intensive odour, local irritation, and elimination half-life. However this system is being replaced to be consistent with the European Union (EU) Scientific Committee for Occupational Exposure Limits (SCOEL); this is more closely allied to that of the USA.

OSHA (USA) concluded that exposure to sensory irritants can:

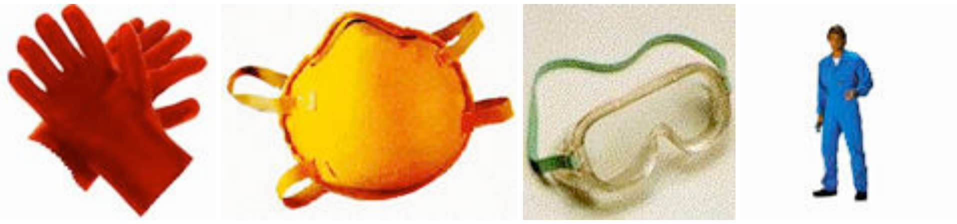
- cause inflammation
- cause increased susceptibility to other irritants and infectious agents
- lead to permanent injury or dysfunction
- permit greater absorption of hazardous substances and
- acclimate the worker to the irritant warning properties of these substances thus increasing the risk of overexposure.

DECABROMODIPHENYL ETHER:
OEL STEL (Russia): 3 mg/m3
CEL TWA: 5 mg/m3 (compare WEEL-TWA*)

While the material is relatively innocuous a Workplace Environmental Exposure Level (WEEL) guide has been established by AIHA to take into account the small particle size and relative insolubility of the substance which precludes treatment as a nuisance particulate.

HEPTABROMODIPHENYL ETHER:
CEL TWA: 5 mg/m3 (compare WEEL-TWA for decabromodiphenyl oxide)
NONABROMODIPHENYL ETHER:
CEL TWA: 5 mg/m3 (compare WEEL-TWA for decabromodiphenyl oxide)
HEXABROMODIPHENYL ETHER:
CEL TWA: 5 mg/m3 (compare WEEL-TWA for decabromodiphenyl oxide)
OCTABROMODIPHENYL ETHER:
CEL TWA: 5 mg/m3 (compare WEEL-TWA for decabromodiphenyl oxide)

PERSONAL PROTECTION



Consult your EHS staff for recommendations

EYE

■

- Safety glasses with side shields.
- Chemical goggles.
- Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. DO NOT wear contact lenses.

HANDS/FEET

■ Suitability and durability of glove type is dependent on usage. Important factors in the selection of gloves include: such as:

- frequency and duration of contact,

- chemical resistance of glove material,
- glove thickness and
- dexterity

Select gloves tested to a relevant standard (e.g. Europe EN 374, US F739).

- When prolonged or frequently repeated contact may occur, a glove with a protection class of 5 or higher (breakthrough time greater than 240 minutes according to EN 374) is recommended.
- When only brief contact is expected, a glove with a protection class of 3 or higher (breakthrough time greater than 60 minutes according to EN 374) is recommended.
- Contaminated gloves should be replaced.

Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturiser is recommended.

Experience indicates that the following polymers are suitable as glove materials for protection against undissolved, dry solids, where abrasive particles are not present.

- polychloroprene
- nitrile rubber
- butyl rubber
- fluorocaoutchouc
- polyvinyl chloride

Gloves should be examined for wear and/ or degradation constantly.

OTHER

■

- Overalls.
- P.V.C. apron.
- Barrier cream.
- Skin cleansing cream.
- Eye wash unit.

■

- Respirators may be necessary when engineering and administrative controls do not adequately prevent exposures.
- The decision to use respiratory protection should be based on professional judgment that takes into account toxicity information, exposure measurement data, and frequency and likelihood of the worker's exposure - ensure users are not subject to high thermal loads which may result in heat stress or distress due to personal protective equipment (powered, positive flow, full face apparatus may be an option).
- Published occupational exposure limits, where they exist, will assist in determining the adequacy of the selected respiratory . These may be government mandated or vendor recommended.
- Certified respirators will be useful for protecting workers from inhalation of particulates when properly selected and fit tested as part of a complete respiratory protection program.
- Use approved positive flow mask if significant quantities of dust becomes airborne.
- Try to avoid creating dust conditions.

RESPIRATOR

■

Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
10 x PEL	P1	-	PAPR-P1
	Air-line*	-	-
50 x PEL	Air-line**	P2	PAPR-P2
100 x PEL	-	P3	-
		Air-line*	-
100+ x PEL	-	Air-line**	PAPR-P3

* - Negative pressure demand ** - Continuous flow

Explanation of Respirator Codes:

Class 1 low to medium absorption capacity filters.

Class 2 medium absorption capacity filters.

Class 3 high absorption capacity filters.

PAPR Powered Air Purifying Respirator (positive pressure) cartridge.

Type A for use against certain organic gases and vapors.

Type AX for use against low boiling point organic compounds (less than 65ºC).

Type B for use against certain inorganic gases and other acid gases and vapors.

Type E for use against sulfur dioxide and other acid gases and vapors.

Type K for use against ammonia and organic ammonia derivatives

Class P1 intended for use against mechanically generated particulates of sizes most commonly encountered in industry, e.g. asbestos, silica.

Class P2 intended for use against both mechanically and thermally generated particulates, e.g. metal fume.

Class P3 intended for use against all particulates containing highly toxic materials, e.g. beryllium.

The local concentration of material, quantity and conditions of use determine the type of personal protective equipment required.

Use appropriate NIOSH-certified respirator based on informed professional judgement. In conditions where no reasonable estimate of exposure can be made, assume the exposure is in a concentration IDLH and use NIOSH-certified full face pressure demand SCBA with a minimum service life of 30 minutes, or a combination full facepiece pressure demand SAR with auxiliary self-contained air supply. Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

ENGINEERING CONTROLS

■

- Local exhaust ventilation is required where solids are handled as powders or crystals; even when particulates are relatively large, a certain proportion will be powdered by mutual friction.

- Exhaust ventilation should be designed to prevent accumulation and recirculation of particulates in the workplace.
- If in spite of local exhaust an adverse concentration of the substance in air could occur, respiratory protection should be considered. Such protection might consist of:

(a): particle dust respirators, if necessary, combined with an absorption cartridge;
(b): filter respirators with absorption cartridge or canister of the right type;
(c): fresh-air hoods or masks

- Build-up of electrostatic charge on the dust particle, may be prevented by bonding and grounding.
- Powder handling equipment such as dust collectors, dryers and mills may require additional protection measures such as explosion venting.

Air contaminants generated in the workplace possess varying "escape" velocities which, in turn, determine the "capture velocities" of fresh circulating air required to efficiently remove the contaminant.

Type of Contaminant:	Air Speed:
direct spray, spray painting in shallow booths, drum filling, conveyer loading, crusher dusts, gas discharge (active generation into zone of rapid air motion)	1-2.5 m/s (200-500 f/min.)
grinding, abrasive blasting, tumbling, high speed wheel generated dusts (released at high initial velocity into zone of very high rapid air motion).	2.5-10 m/s (500-2000 f/min.)

Within each range the appropriate value depends on:

Lower end of the range	Upper end of the range
1: Room air currents minimal or favorable to capture	1: Disturbing room air currents
2: Contaminants of low toxicity or of nuisance value only	2: Contaminants of high toxicity
3: Intermittent, low production.	3: High production, heavy use
4: Large hood or large air mass in motion	4: Small hood-local control only

Simple theory shows that air velocity falls rapidly with distance away from the opening of a simple extraction pipe. Velocity generally decreases with the square of distance from the extraction point (in simple cases). Therefore the air speed at the extraction point should be adjusted, accordingly, after reference to distance from the contaminating source. The air velocity at the extraction fan, for example, should be a minimum of 4-10 m/s (800-2000 f/min) for extraction of crusher dusts generated 2 meters distant from the extraction point. Other mechanical considerations, producing performance deficits within the extraction apparatus, make it essential that theoretical air velocities are multiplied by factors of 10 or more when extraction systems are installed or used.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL PROPERTIES

Solid.
Does not mix with water.
Sinks in water.

State	Divided solid	Molecular Weight	959.22
Melting Range (°F)	554- 582.8	Viscosity	Not Applicable
Boiling Range (°F)	Not available	Solubility in water (g/L)	Immiscible
Flash Point (°F)	Not Available	pH (1% solution)	Not applicable
Decomposition Temp (°F)	Not Available	pH (as supplied)	Not applicable
Autoignition Temp (°F)	Not available	Vapor Pressure (mmHg)	34.728 x 10-9 (20 C)
Upper Explosive Limit (%)	Not available.	Specific Gravity (water=1)	3.0-3.25
Lower Explosive Limit (%)	Not available	Relative Vapor Density (air=1)	>1
Volatile Component (%vol)	Nil @ 38 C.	Evaporation Rate	Non Volatile

APPEARANCE

White to off-white powder with slight odour; largely insoluble in water. Solubilities: water 20-30 ppb; cottonseed oil 600ppm; acetone 0.5 g/100 ml; benzene 0.48 g/100ml; chlorobenzene 0.6 g/100 g; o-xylene 0.87 g/100 g; methylene bromide 0.49 g/100 g. Commercial DBDPE product is reported to comprise >=97% DBDPE, ~3% NBDPE and < 1% OBDPE.

Environmental Fate Overall, it has been determined that varying the physico-chemical properties of logKow, water solubility and vapour pressure over a wide range had little effect on distribution to the aquatic and terrestrial compartments. However, a much larger effect was noticed in the atmospheric compartment. Release to the environment will be slow and diffuse over the life of products containing PBFRs. Where released to the environment, some PBFRs are expected to be stable, both microbially and abiotically. When released to land, they should bind strongly to the organic component of soils and be immobile. In the event of release to water, movement from the water column is likely to be rapid with the compounds partitioning to sediments and biota, where bioaccumulation is expected from the commercial pentabromo diphenyl ether compounds (tetra- to hexa-). Bioaccumulation is not anticipated with octabromodiphenyl ethers (OBDPE) and decabromodiphenyl ether (DBDPE) while hexabromocyclododecane (HBCD) has the potential to bioaccumulate. A relatively high bioconcentration factor for tetrabromobisphenol A (TBBPA) is balanced by rapid excretion and the compound has not been found in environmental biological samples. Components of commercial pentabromodiphenyl ether (PeBDPE) may volatilise to the atmosphere from water. It is speculated that they may bind to atmospheric particles with the potential to undergo long-range atmospheric transport.

Material	Value

Section 10 - CHEMICAL STABILITY

CONDITIONS CONTRIBUTING TO INSTABILITY

■

- Presence of incompatible materials.
- Product is considered stable.
- Hazardous polymerization will not occur.

STORAGE INCOMPATIBILITY

■ Avoid reaction with oxidizing agents.

For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

decabromodiphenyl ether

TOXICITY AND IRRITATION

■ unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

TOXICITY	IRRITATION
Oral (rat) LD50: >2000 mg/kg	Nil Reported [Ethyl Corporation]

■ Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. Industrial bronchitis, on the other hand, is a disorder that occurs as result of exposure due to high concentrations of irritating substance (often particulate in nature) and is completely reversible after exposure ceases. The disorder is characterised by dyspnea, cough and mucus production.

The primary health concerns revolve around the potential of polybrominated fire retardants (PBFRs) to act as carcinogens, endocrine disruptors and neurodevelopmental toxicants based on data for some members of this class of chemicals. In addition, their structural similarities to the polychlorinated diphenyl ethers (PCDEs), nitrofen and polychlorinated biphenyls (PCBs) lends further support to concerns for health effects exerted by these chemicals.

Three PBFRs, the penta-, octa- and decabromodipheyl ethers (BDPE)s, have been and remain of significant commercial interest.

Nonetheless, the field of PBFRs is expanding and a diverse range of these chemicals are now available . Emphasis on the health effects of PBFRs is directed to certain chemical compounds within this class, namely decabromodipehyl ether (DBDPE), pentabromodipheyl ether (PeBDPE), octabromodiphemyl ether (OBDPE) and hexabromocyclododecane (HBCD). Also discussed are the polybrominated biphenyls (PCBs) and tris(2,3-dibromopropylphosphate (TDBPP), though no longer used, due to their significant adverse health effects.

The PBFRs are a structurally diverse group of chemical compounds, some of which share similarities in chemical structure while others vary significantly. Pharmacokinetic studies are limited for most of the chemicals . However, the available information indicates that some brominated flame retardants such as tetrabromodiphenyl ether (TBDPE), HBCD, TDBPP and PBBs are readily absorbed via the gastrointestinal tract. Data available for the polybrominated diphenyl ethers (PBDPE)s and PBBs indicate that the degree of gastrointestinal absorption is inversely proportional to the level of bromination. Dermal absorption has also been reported for TDBPP.

They are generally of low acute toxicity with no or slight and transient irritation to the skin and eyes of experimental animals. Inhalation studies in animals revealed that exposure to PBDPEs caused transient respiratory difficulties.

Like the PBDPEs, tetrabromobisphenol A (TBBPA) and its derivatives have low acute and repeated dose toxicity. They are neither skin or eye irritants nor skin sensitisers in experimental animals. Reversible respiratory effects were reported following inhalation exposure.

With a few exceptions, mutagenicity studies indicate that the majority of the PBRs are neither mutagenic to microbial or eukaryotic organisms nor genotoxic in experimental in vivo and in vitro systems. TBDPE and HBCD caused an increase in the recombination frequency in some cell lines.

Of the commercially and commonly used PBFRs, penta- and tetra-bromodiphenyl ethers appear to be of greatest significance where health effects are concerned.

Evidence indicates that the liver, and possibly the thyroid, are the organs most sensitive to these chemicals. According to available data, they are endocrine disruptors and neurodevelopmental toxicants in experimental animals. Whether neurodevelopmental effects are a consequence of changes in thyroid hormone levels or are caused by direct neurotoxicity remain to be elucidated. The absence of clinical, physiological and biochemical correlates precludes any conclusions as to the nature of the mechanisms involved. PeBDPE has been classified as a hazardous chemical, Harmful- Danger of Serious Damage to Health by Prolonged Exposure in Contact with Skin and if Swallowed. A similar toxicity profile is apparent for TBDPE. OBDPE is another chemical of concern due to its adverse effects on reproduction in experimental animals.

The two other groups with significant adverse health effects are TDBPP and PBBs. Although both have relatively low acute toxicity in experimental animals, evidence for carcinogenicity, endocrine disruption and reproductive effects exists. Little human data is available, however, epidemiological reports and follow up studies indicate that PBDPE, TDBPP and PBBs are absorbed and can be detected in the serum, adipose tissue and breast milk of directly and/or indirectly exposed individuals. The available evidence indicates that, in some countries, levels of these chemicals are increasing in animal and human tissues (including breast milk), which suggests they are bioaccumulative and persistent. Thyroid effects appear to be the major adverse health effect, with hypothyroidism seen in animals (e.g. OBDPE and PeBDPE, HBCD and PBB) and humans (e.g. DBDPE and deca-BB), although some PBFRs (e.g. DBDPE, TDBPP, HBCD and PBB) elicit carcinogenic effects in animal studies.

Blooming potential: Blooming is defined as the migration (or more appropriately, diffusion) of an ingredient (e.g., plasticiser or flame retardant) in rubber or plastic material to the outer surface after curing. It is sometimes incorrectly referred to as "leaching" or "degassing". Diffusion is generally considered to be a slow process. Blooming has been identified as a source of potential exposure (human and environmental) to PBFRs, particularly for low molecular weight additive PBFRs.

It is generally accepted that "reactive", PBFRs such as TBBPA (and derivatives) and esters of acrylic (propenoic) acid, which are directly incorporated into polymers (e.g., polyester or epoxy resins) via chemical reaction (i.e., covalent binding) have a low or negligible blooming potential, although such chemicals can also be used as non-reactive (i.e., additive) ingredients.

So-called "additive" PBFRs (e.g., PBDPEs, PBBs, HBCD) are more likely to be subject to blooming, as these compounds are not chemically bound to the polymer backbone. Additive PBFRs reside within the polymer matrix as discrete molecules, but may be subject to weak Van der Waals and electrostatic interaction both between PBFR molecules and with the polymer backbone. High molecular weight polymeric additive flame retardants such as brominated polystyrene are more likely to remain within the matrix due to the slow rate of diffusion. Other PBFRs may undergo both reactive and/or additive reactions with polymer matrices e.g., tetrabromophthalic anhydride and brominated polystyrenes. Increased temperature is also associated with an increase in the rate of PBFR migration. Release of PBFRs or degradation products may occur at high temperatures during thermal processing or recycling e.g. PBDPEs emissions have been reported during thermal recycling activities.

The substance is classified by IARC as Group 3:

NOT classifiable as to its carcinogenicity to humans.

Evidence of carcinogenicity may be inadequate or limited in animal testing.

CARCINOGEN

Decabromodiphenyl oxide	International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs	Group	3
Polybrominated biphenyls	International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs	Group	2B
Decabromodiphenyl ether (DBDPE)	ND	Carcinogenicity	C
Decabromodiphenyl ether (DBDPE)	ND	Carcinogen Category	C
POLYBROMINATED BIPHENYLS	US Environmental Defense Scorecard Recognized Carcinogens	Reference(s)	P65
POLYBROMINATED BIPHENYLS	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	P65
DECABROMODIPHENYL OXIDE	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	IRIS
BROMINE COMPOUNDS (ORGANIC OR INORGANIC)	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	P65-MC
Nonabromodiphenyl ether	ND	Carcinogenicity	D
Nonabromodiphenyl ether	ND	Carcinogen Category	D
Hexabromodiphenyl ether	ND	Carcinogenicity	D
Hexabromodiphenyl ether	ND	Carcinogen Category	D
ORGANIC BROMINE COMPOUNDS	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	P65-MC
Octabromodiphenyl ether	ND	Carcinogenicity	D
Octabromodiphenyl ether	ND	Carcinogen Category	D

Section 12 - ECOLOGICAL INFORMATION

Refer to data for ingredients, which follows:
NONABROMODIPHENYL ETHER:
HEXABROMODIPHENYL ETHER:
OCTABROMODIPHENYL ETHER:
DECABROMODIPHENYL ETHER:

■ On the basis of available evidence concerning either toxicity, persistence, potential to accumulate and or observed environmental fate and behaviour, the material may present a danger, immediate or long-term and /or delayed, to the structure and/ or functioning of natural ecosystems.

HEPTABROMODIPHENYL ETHER:
NONABROMODIPHENYL ETHER:
HEXABROMODIPHENYL ETHER:
OCTABROMODIPHENYL ETHER:
DECABROMODIPHENYL ETHER:

■ DO NOT discharge into sewer or waterways.

■ PBBs are solids with a low volatility that decreases with increasing bromine number. PBBs are virtually insoluble in water, soluble in fat, and slightly to highly soluble in various organic solvents; solubility also decreases with increasing bromine number. These compounds are relatively stable and chemically unreactive, though highly brominated PBB mixtures are photodegraded with reductive debromination upon exposure to ultraviolet radiation (UVR). The products of the experimental thermal decomposition of PBBs depend on the temperature, the amount of oxygen present, and a number of other factors. Investigations into the pyrolysis of FireMaster BP-6 in the absence of oxygen (600-900 C) have shown that bromobenzenes and lower brominated biphenyls are formed, but no polybrominated furans. In contrast, pyrolysis in the presence of oxygen (700-900 C) yielded some di- to heptabromodibenzofurans. In the presence of polystyrene and polyethylene, higher levels were found. Pyrolysis of FireMaster BP-6 with PVC at 800 C yielded mixed bromochlorobiphenyls. There is no information on the nature of the products of incineration of PBB-containing material. Little is known about the toxicities of brominated and brominated/chlorinated dioxins and furans, but they are estimated to be of about the same order as those of chlorinated dioxins and furans.

Most of the PBB congeners found in commercial flame retardants are lipophilic, persistent, and bioaccumulating. These compounds are biomagnified in environmental food webs and pose a threat, especially to organisms in the higher levels of these webs. Furthermore, some PBB products are precursors to toxic polybrominated dibenzofurans in combustion processes.

The principal known routes of PBBs into the aquatic environment are from industrial waste discharge and leachates from industrial dumping sites into receiving waters and from erosion of polluted soils. PBBs are almost insoluble in water and are primarily found in sediments of polluted lakes and rivers.

The hydrophobic properties of PBBs make them easily adsorbed from aqueous solutions onto soils. Preferential adsorption of PBB congeners was noted, depending on the characteristics of the soil (e.g., organic content) and the degree and position of bromine substitution.

PBBs are stable and persistent, lipophilic, and only slightly soluble in water; some of the congeners are poorly metabolized and therefore accumulate in lipid compartments of biota. Once they have been released into the environment, they can reach the food chain, where they are concentrated. PBBs have been detected in fish from several regions. Ingestion of fish is a source of PBB transfer to mammals and birds.

Degradation of PBBs by purely abiotic chemical reactions (excluding photochemical reactions) is considered unlikely. The persistence of PBBs under field conditions has been reported Mixtures of PBBs appear to be fairly resistant to microbial degradation. Neither uptake nor degradation of PBBs by plants has been recorded. In contrast, PBBs are easily absorbed by animals and though they have been found to be very persistent in animals, small amounts of PBB metabolites have been detected. The main metabolic products were hydroxy-derivatives, and, in some cases, there was evidence of partially debrominated PBBs. No investigation of sulfur-containing metabolites analogous to those of PCBs have been reported.

The bioaccumulation of PBBs in fish has been investigated. Bioaccumulation of PBBs in terrestrial animals has been investigated in avian and mammalian species. Data were obtained through field observations, evaluation of the Michigan disaster and through controlled feeding studies. Generally, the accumulation of PBBs in body fat depended on the dosage and duration of exposure. Bioaccumulation of individual PBB congeners has been found to increase with degree of bromination up to at least tetrabromo biphenyls. Higher brominated congeners can be expected to accumulate to an even greater extent. However, no information is available for decabromobiphenyl; it is possible that it is poorly absorbed. Brominated dibenzofurans or partially debrominated PBBs have been reported as products of the thermal decomposition of PBBs. Their formation depends on several variables (e.g., temperature, oxygen).

In vitro-metabolism studies showed that structure-activity relationships exist for the metabolism of PBBs. PBBs could be metabolized by PB (phenobarbital)-induced microsomes only if they possessed adjacent non-brominated carbons, meta and para to the biphenyl bridge on at least one ring. Metabolism by MC (3-methylcholanthrene)-induced microsomes required adjacent non-brominated ortho and meta positions on at least one ring of lower substituted congeners and higher bromination appeared to prevent metabolism. Hydroxylated derivatives as major in vitro- and in vivo-metabolism products of lower brominated biphenyls have been identified in vertebrates. The metabolic yield was relatively low. The hydroxylation reaction probably proceeds via both arene oxide intermediates and by direct hydroxylation.

Polybrominated biphenyl ethers: Although decabromobiphenyl and, possibly, other PBBs are still produced commercially, alternative chemicals have been introduced to replace them as flame retardants, in particular polybrominated biphenyl ethers (oxides) (PBBO),

Decabromobiphenyl ether (DBBO) for example, appears to be a much less toxic material than PBBs. However, DBBO is said to have a tendency to degrade to lower brominated biphenyl oxides. It is possible that these lower order compounds may pose environmental problems similar to those of the lower brominated PBBs In addition, on pyrolysis, PBBOs produce larger amounts of dioxins and furans than PBBs and so may themselves have to be replaced by other compounds.

- For polybrominated fire retardants (PBFRs):

Environmental Fate: Overall, it has been determined that varying the physico-chemical properties of logKow, water solubility and vapour pressure over a wide range had little effect on distribution to the aquatic and terrestrial compartments. However, a much larger effect was noticed in the atmospheric compartment. Release to the environment will be slow and diffuse over the life of products containing PBFRs. Where released to the environment, some PBFRs are expected to be stable, both microbially and abiotically. When released to land, they should bind strongly to the organic component of soils and be immobile. In the event of release to water, movement from the water column is likely to be rapid with the compounds partitioning to sediments and biota, where bioaccumulation is expected from the commercial pentabromo diphenyl ether compounds (tetra- to hexa-). Bioaccumulation is not anticipated with octabromodiphenyl ethers (OBDPE) and decabromodiphenyl ether (DBDPE) while hexabromocyclododecane (HBCD) has the potential to bioaccumulate. A relatively high bioconcentration factor for tetrabromobisphenol A (TBBPA) is balanced by rapid excretion and the compound has not been found in environmental biological samples. Components of commercial pentabromodiphenyl ether (PeBDPE) may volatilise to the atmosphere from water. It is speculated that they may bind to atmospheric particles with the potential to undergo long-range atmospheric transport.

Atmospheric Fate: The polybrominated diphenyl ethers (PBDPE) commercial products have low vapour pressures, that decrease with increasing bromination. They may be considered slightly to very slightly volatile. Accordingly, PBDPE compounds with a higher level of bromination, when released to land, are more likely to bind to soils than volatilise. Whether other highly brominated flame retardants of low vapour pressure have the same fate, cannot be determined due to the lack of sufficient data. However, this may not be the case where release is to water as the substances have very low water solubilities.

PeBDPE has a rate constant of 1.27 x 10-12 cm3/molecule.sec for reaction with atmospheric hydroxyl radicals. Using the accepted global average atmospheric concentration of hydroxyl radicals as 5 x 105 molecules/cm3, an atmospheric half-life of around 12.6 days can be estimated. This is of sufficient time for long-range atmospheric transport to occur. PeBDPE has been identified in air samples from Swedish background sites on the island of Gotland and in the Scandinavian mountain range. Similarly, HBCD levels up to 5.7 pg/m3 were measured in Sweden during 1990 and 1991 at locations far from known point sources.

Air concentrations of tri- and hexa-BDPE in the range of 7.1 to 53 pg/m3 near metal recycling plants in Taiwan and Japan, and of tetra- and penta-BDPE (combined) in the range 1 to 8 pg/m3 and HBCD of 5.3 to 6.1 pg/m3 in Swedish air samples have been reported.

Aquatic fate: Reports of PBDPEs detected in fish in the northern hemisphere show that aquatic exposure does occur, which may be attributed to local industries. For example, in Virginia, USA, muscle tissue of several fish species contained PBDPEs. While the sample area was not heavily industrialised, it is home to considerable furniture manufacturing activities. In Sweden, fish with detectable PBDPEs and HBCD concentrations were caught downstream of textile industries and sewage treatment plants.

There is little information available on the abiotic degradation of PBDPEs in aqueous solutions. Ethers are not likely to hydrolyse readily in the normal environmental pH range. PeBDPE is reported to be hydrolytically stable under conditions found in the environment.

It is apparent from measured or computed values of the Henry's Law Constant that most of the PBDPEs and HBCD can be considered moderately volatile. The highly brominated compounds may be expected to be less volatile, with the three most highly brominated substances being considered only very slightly volatile from water. This is supported by the long half-lives of volatilisation (from rivers and lakes) for DBDPE, HBCD and TBBPA. This suggests that where release occurs to water and the compounds do not fully partition to sediments or biota, the PBFRs, particularly those with relatively low levels of bromination, may volatilise to the atmosphere and thereby be available for atmospheric transport.

Terrestrial fate: When released to soils, PBFRs may generally be considered to bind strongly and be immobile. Leaching from soil is unlikely to occur. The results show that sorption tendencies increase as the level of bromination increases. This indicates that mobility, albeit very limited, is likely to be greater with the lower brominated compounds.

Degradation: Reductive dehalogenation of PBDPE occurs under some conditions. Although environmental breakdown to lower congeners is also a possibility, no anaerobic biodegradation of DBDPE was seen in sediment for up to 2 years. TBBPA has been shown to partly degrade under both aerobic and anaerobic conditions in a range of soil types and in sediment water. After 64 days approximately 35 to 80% of TBBPA remained in soil under aerobic conditions, with 40 to 90% remaining under anaerobic conditions, with the highest levels measured in sandy loam and lowest in silty loam. A sequential anaerobic/aerobic soil study demonstrated complete degradation of TBBPA after 45 days to the non-brominated bisphenol A, which was resistant to further degradation. The phenolic groups of TBBPA may be methylated in the environment and the resulting metabolite is potentially more lipophilic. This compound has been found in sediment, fish and shellfish. HBCD has been tested and found not ready biodegradable. The biodegradation of HBCD was examined after exposure of samples to bacterial medium for 5, 7 and 15 days. Some biodegradation was indicated.

Bioaccumulation: The bioaccumulation of a commercial PeBDPE product containing TBDPE, PeBDPE (2 isomers) and HBDPE (2 isomers) was studied in carp. An overall log BCF of 4.16 was estimated. The BCF for 2-propenoic acid (pentabromophenyl) methyl ester in carp was measured to be a maximum of 12 at any level (0.2 ppm, 2 ppm) over an 8-week period.

Studies indicate that as bromination levels increase beyond HBDPE, PBDPEs show a decreasing tendency for bioaccumulation . Tetra- and penta-BDPEs, in particular, have a high potential for bioaccumulation. Monitoring data from the Baltic and elsewhere suggest the presence of high concentrations of these compounds higher up in the food chain. Where OBDPE and DBDPE are concerned, no significant bioaccumulation has been demonstrated in fish and BCF varied between about 5 and less than 50. This is due to low uptake. OBDPE and DBDPE are larger molecules and, consequently, are less readily absorbed than PeBDPE.

Studies with aquatic invertebrates and vertebrates with TBBPA indicate bioconcentration factors (BCF) ranging from 20 up to 3200 depending on the test conditions and organisms. Although the BCFs are high, studies indicate that in some species TBBPA is rapidly excreted. Methylated TBBPA have been detected in 2/19 samples of fish and shellfish in Japan.

Environmental effects: While there is a distinct lack of data for avian toxicity, biomagnification in fish eating birds may occur particularly for the tetra- and penta-BDPE, which have been detected in fish as well as in fish eating birds. Due to the very low solubility of the highly used PBDPEs, namely penta-and deca-BDPE, toxicity to aquatic organisms is difficult to determine. Acute toxicity in fish up to the limit of solubility has not been observed. Some chronic effects may occur, but these appear to be limited.

Aquatic invertebrates and algae appear susceptible to PBDPEs based on the limited data available, and PBDPEs may be considered highly toxic to these organisms.

There is only one acute effect available for daphnia following exposure to commercial PeBDPE and evidence suggests the effect may have been physical rather than toxic, so conclusions are uncertain. Based on two test results, TBBPA can be described as moderately to highly toxic to aquatic invertebrates.

Sediment testing conducted as a result of the initial risk assessment conducted on PeBDPE in the EU demonstrated a lack of toxicity to three sediment dwelling organisms. No adverse biological effects resulted from the increased TBBPA body burden in a single sediment organism study.

Based on the commercial PeBDPE, PBDPEs are not toxic to soil micro-organisms, earthworms or plants.

Physical properties: PBDPEs are stable compounds with high boiling points ranging between 310 C and 425 C and low vapour pressures in the range 6.5 x 10-6 to 4.5 x 10-5 Pa at 20 to 25 C. They exhibit poor solubility in water (0.0001 to 0.01 mg/L) and in most organic solvents, with n-octanol/water partition coefficients (log Pow) between 4 and 10. No formal fat solubility studies were available for assessment, but pharmacokinetic studies indicate significant differences between congeners e.g., <1% DBDPE was identified in fatty tissue, whereas the majority of TBDPE was retained in adipose tissue.

The chemical stability of the polybromobiphenyls (PBBs) is dependent, in part, on the degree of bromination and the specific substitution patterns. In general, the highly brominated PBBs are more rapidly degraded by UV radiation. Their solubility in water is low and decreases with increasing bromination. Melting points, where determined, range from a low of 72 C to a high of 380 C. Like the PBDPEs, the PBBs have low vapour pressures.

Thermal degradation: Considerable laboratory experimentation has gone into the investigation of the thermal degradation, pyrolysis and combustion products of PBFRs, mainly because of concern that polybromodibenzo-dioxins (PBDD) and -furans (PBDF) might be formed. Close analogies have been drawn with the formation under similar conditions of polychlorodibenzo- dioxins and -furans from organochlorine substances and with the toxicity of these derived "dioxins". Neither the commercial flame retardant DBDPE, nor plastic materials incorporating it, contain measurable amounts of the highly toxic polybromodibenzo-dioxin and -furan contaminants. Partial combustion of the material containing the flame retardant (and usually also antimony trioxide) produced polybromodibenzo-dioxins and -furans, but these were mainly heavily brominated and congeners with the substitution pattern of most concern - 2,3,7,8 -were minor components of the congener mixture. Analysis of 2-propenoic acid (pentabromophenyl) methyl ester; tris (tribromoneopentyl) phosphate and TBBPA bis (2,3-dibromopropyl) ether for contamination of polybrominated p-dibenzodioxins and dibenzofurans indicated that the PBDD/PBDF levels were below the level of quantification specified by US EPA Toxic Substances Control Act (TSCA) 40 CFR 766.27.

Yields of mixed polybromodibenzofuran congeners as high as 90% could be realised by the pyrolysis of neat bromodiphenyl ethers, and lesser yields when the flame retardants were incorporated into polystyrene or polyethylene. Gas-phase pyrolysis of a number of PBFRs, including polybrominated diphenyl ethers, has demonstrated the formation of bromobenzenes, bromophenols and dioxins and furans at intermediate temperatures. However, these were destroyed when the thermal degradation reactions were carried out at 800 C. Similar experiments with decabromodiphenyl and tetrabromobisphenol A showed the presence in the pyrolysates of polybrominated dibenzo-dioxins and -furans, the latter in greater amounts. Only small proportions of these products had the 2,3,7,8-tetrasubstitution pattern, which is associated with the greatest toxicity. Formation of the dioxins and furans was greatest at 600 C. Similar results were reported for thermal degradations conducted in a device, which simulated the operation of a municipal waste incinerator.

■ May cause long-term adverse effects in the aquatic environment.

■ Do NOT allow product to come in contact with surface waters or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment wash-waters.

Wastes resulting from use of the product must be disposed of on site or at approved waste sites.

■ Toxic to aquatic organisms.

DECABROMODIPHENYL ETHER:

■ Half- life Soil - High (hours):	8760
■ Half- life Soil - Low (hours):	4320
■ Half- life Air - High (hours):	3686

■ Half- life Air - Low (hours):	369
■ Half- life Surface water - High (hours):	8760
■ Half- life Surface water - Low (hours):	4320
■ Half- life Ground water - High (hours):	17520
■ Half- life Ground water - Low (hours):	8640
■ Aqueous biodegradation - Aerobic - High (hours):	8760
■ Aqueous biodegradation - Aerobic - Low (hours):	4320
■ Aqueous biodegradation - Anaerobic - High (hours):	35040
■ Aqueous biodegradation - Anaerobic - Low (hours):	17280
■ Photooxidation half- life air - High (hours):	3686
■ Photooxidation half- life air - Low (hours):	369

HEPTABROMODIPHENYL ETHER:
NONABROMODIPHENYL ETHER:
HEXABROMODIPHENYL ETHER:
OCTABROMODIPHENYL ETHER:

Ecotoxicity

Ingredient	Persistence: Water/Soil	Persistence: Air	Bioaccumulation	Mobility
decabromodiphenyl ether	HIGH	HIGH	LOW	LOW
heptabromodiphenyl ether	HIGH		LOW	LOW
nonabromodiphenyl ether	HIGH		LOW	LOW
hexabromodiphenyl ether	HIGH		LOW	LOW
octabromodiphenyl ether	HIGH		LOW	LOW

Section 13 - DISPOSAL CONSIDERATIONS

Disposal Instructions

All waste must be handled in accordance with local, state and federal regulations.
¦ Puncture containers to prevent re-use and bury at an authorized landfill.
Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.
A Hierarchy of Controls seems to be common - the user should investigate:

- Reduction
- Reuse
- Recycling
- Disposal (if all else fails)

This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. Shelf life considerations should also be applied in making decisions of this type. Note that properties of a material may change in use, and recycling or reuse may not always be appropriate.
DO NOT allow wash water from cleaning equipment to enter drains. Collect all wash water for treatment before disposal.
Due to their environmental persistence and potential health hazards, PCBs and dioxins cannot be disposed of in landfills or dumped at sea. The only environmentally acceptable method of disposal of PCBs and dioxins is by high temperature incineration. However this option is costly and uncertain. Currently, most PCB and dioxin wastes must be stored in an approved manner until satisfactory arrangements can be made for their disposal. All wastes and residues containing PCBs and/or dioxins (e.g. wiping clothes, absorbent materials, used disposable protective gloves, contaminated clothing, etc.) should be collected, placed in proper containers, labelled and disposed of in the manner prescribed by government regulations. Regulations may require the compulsory reporting of all spills.

- Recycle wherever possible.
- Consult manufacturer for recycling options or consult Waste Management Authority for disposal if no suitable treatment or disposal facility can be identified.
- Dispose of by: Burial in a licensed land-fill or Incineration in a licensed apparatus (after admixture with suitable combustible material)
- Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.

Section 14 - TRANSPORTATION INFORMATION

DOT:

Symbols:	None	Hazard class or Division:	9
Identification Numbers:	UN3152	PG:	II

Label Codes:	9	Special provisions:	IB8, IP2, IP4, T3, TP33
Packaging: Exceptions:	155	Packaging: Non-bulk:	204
Packaging: Exceptions:	155	Quantity limitations: Passenger aircraft/rail:	100 kg
Quantity Limitations: Cargo aircraft only:	200 kg	Vessel stowage: Location:	A
Vessel stowage: Other:	95	S.M.P.:	Severe

Hazardous materials descriptions and proper shipping names:
Polyhalogenated biphenyls, solid or Polyhalogenated terphenyls, solid

Air Transport IATA:

ICAO/IATA Class:	9	ICAO/IATA Subrisk:	None
UN/ID Number:	3152	Packing Group:	II
Special provisions:	A11		

■ Air transport may be forbidden if this material is flammable, corrosive or toxic gases may be released under normal conditions of transport.

Shipping Name: POLYHALOGENATED BIPHENYLS, SOLID(CONTAINS DECABROMODIPHENYL ETHER)

Maritime Transport IMDG:

IMDG Class:	9	IMDG Subrisk:	P
UN Number:	3152	Packing Group:	II
EMS Number:	F-A , S-A	Special provisions:	203 305 958
Limited Quantities:	1 kg		

Shipping Name: POLYHALOGENATED BIPHENYLS, SOLID or POLYHALOGENATED TERPHENYLS, SOLID(contains decabromodiphenyl ether)

Section 15 - REGULATORY INFORMATION

REGULATIONS

ND

Ingredient	CAS	% de minimus concentration
nonabromodiphenyl ether	63936-56-1	(0.1)
hexabromodiphenyl ether	36483-60-0	(0.1)
octabromodiphenyl ether	32536-52-0	(0.1)

decabromodiphenyl ether (CAS: 1163-19-5) is found on the following regulatory lists;

"Canada Domestic Substances List (DSL)","Canada National Pollutant Release Inventory (NPRI)","International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs","International Chemical Secretariat (ChemSec) REACH SIN* List (*Substitute It Now!) 1.0","OECD Representative List of High Production Volume (HPV) Chemicals","OSPAR List of Substances of Possible Concern","US - California Air Toxics ""Hot Spots"" List (Assembly Bill 2588) Substances for which emissions must be quantified","US - California Toxic Air Contaminant List Category IV","US - Maine Chemicals of High Concern List","US - Minnesota Hazardous Substance List","US - New Jersey Right to Know Hazardous Substances","US - Pennsylvania - Hazardous Substance List","US AIHA Workplace Environmental Exposure Levels (WEELs)","US EPA Carcinogens Listing","US EPA High Production Volume Program Chemical List","US EPA Master Testing List - Index I Chemicals Listed","US EPA Master Testing List - Index II Chemicals Removed","US EPA Voluntary Children's Chemical Evaluation Program (VCCEP)","US EPCRA Section 313 Chemical List","US List of Lists - Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112(r) of the Clean Air Act","US Toxic Substances Control Act (TSCA) - Inventory","US TSCA Section 12(b) - List of Chemical Substances Subject to Export Notification Requirements","US TSCA Section 4 - HDD/HDF - Chemicals Required to Be Tested","US TSCA Section 4/12 (b) - Sunset Date/Status","US TSCA Section 8 (a) - Preliminary Assessment Information Rules (PAIR) - Reporting List","US TSCA Section 8 (d) - Health and Safety Data Reporting"

Regulations for ingredients

heptabromodiphenyl ether (CAS: 68928-80-3) is found on the following regulatory lists;

"Canada Domestic Substances List (DSL)","US Toxic Substances Control Act (TSCA) - Inventory","US TSCA Section 12(b) - List of Chemical Substances Subject to Export Notification Requirements","US TSCA Section 5(a)(2) - Significant New Use Rules (SNURs)"

nonabromodiphenyl ether (CAS: 63936-56-1) is found on the following regulatory lists;

"Canada Domestic Substances List (DSL)","US EPA Carcinogens Listing","US Toxic Substances Control Act (TSCA) - Inventory","US TSCA

Section 12(b) - List of Chemical Substances Subject to Export Notification Requirements","US TSCA Section 5(a)(2) - Significant New Use Rules (SNURs)"

hexabromodiphenyl ether (CAS: 36483-60-0) is found on the following regulatory lists;

"Canada Domestic Substances List (DSL)","US - Maine Chemicals of High Concern List","US EPA Carcinogens Listing","US Toxic Substances Control Act (TSCA) - Inventory","US TSCA Section 12(b) - List of Chemical Substances Subject to Export Notification Requirements","US TSCA Section 5(a)(2) - Significant New Use Rules (SNURs)"

octabromodiphenyl ether (CAS: 32536-52-0) is found on the following regulatory lists;

"Canada Domestic Substances List (DSL)","International Chemical Secretariat (ChemSec) REACH SIN* List (*Substitute It Now!) 1.0","OECD Representative List of High Production Volume (HPV) Chemicals","OSPAR List of Substances of Possible Concern","US - Maine Chemicals of High Concern List","US EPA Carcinogens Listing","US EPA High Production Volume Program Chemical List","US EPA Master Testing List - Index I Chemicals Listed","US EPA Master Testing List - Index II Chemicals Removed","US EPA Voluntary Children's Chemical Evaluation Program (VCCEP)","US Toxic Substances Control Act (TSCA) - Inventory","US TSCA Section 12(b) - List of Chemical Substances Subject to Export Notification Requirements","US TSCA Section 4 - HDD/HDF - Chemicals Required to Be Tested","US TSCA Section 4/12 (b) - Sunset Date/Status","US TSCA Section 5(a)(2) - Significant New Use Rules (SNURs)","US TSCA Section 8 (a) - Preliminary Assessment Information Rules (PAIR) - Reporting List","US TSCA Section 8 (d) - Health and Safety Data Reporting"

Section 16 - OTHER INFORMATION

LIMITED EVIDENCE

- Cumulative effects may result following exposure*.

* (limited evidence).

Denmark Advisory list for selfclassification of dangerous substances

Substance	CAS	Suggested codes
heptabromodiphenyl ether	68928- 80- 3	Xn Carc3; R40
nonabromodiphenyl ether	63936- 56- 1	Xn Mut3; R68
hexabromodiphenyl ether	36483- 60- 0	R52/53
octabromodiphenyl ether	32536- 52- 0	Xn Mut3; R68

- Classification of the mixture and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:
www.chemwatch.net/references.

- The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

Issue Date: Aug-3-2009

Print Date:Jul-24-2010