Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex E of the Convention

Introductory information

Name of the submitting Party/observer

NGO Observer: Environmental Health Fund on behalf of the International POPs Elimination Network (IPEN)

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Chemical name

Pentachlorobenzene
Synonyms: 1,2,3,4,5-pentachlorobenzene; benzene, pentachloro-; quintochlorobenzene; PeCB
CAS = 608-93-5
EINECS = 210-172-0

Date of submission

8 February 2007

(a) Sources, including as appropriate **(provide summary information and relevant references)**

(i) Production data:

Quantity

Location

(ii) Uses

Sources from UNECE reports

"In the original report (Van de Plassche et al 2002) several *indirect* emission pathways are described, such as:
• impurity in quintozene and HCB;
• (municipal waste) incineration of organochlorine compounds and hydrocarbon polymers in the presence of chlorine;

• in waste streams from pulp and paper mills, iron and steel mills, petroleum refineries;
• and activated sludge waste water treatment and from landfills.

However, at that time quantitative data were not available. The Canadian report "Pentachlorobenzene (QCB) and tetrachlorobenzenes (TeCBs) proposed risk management strategy" from the Chemicals Control Branch Environmental Protection Service (EPS 2005) provides qualitative and quantitative information on emission sources of pentachlorobenzene in Canada. [see discussion in reference cited below]

"The following sources are additional emission sources compared to the original report (Van de Plassche et al 2002):
• barrel burning of household waste;
• wood treatment plants and in service utility poles;
• hazardous waste incineration;
• magnesium production;
• the use in pesticides other than quintozene (see "Pesticides" in the following paragraphs);
• and solvent use."

"The following potential sources are identified:
• Chlorinated Solvents;
• Secondary Copper and Aluminium Processing;
• Chemical Manufacturing;
• Iron and Steel Mills;
• Petroleum Refineries;
• Wastewater Treatment Plants;
• Textile Mills;
• Long-Range Transport"

Belfroid, A., van der Aa, E. and Balk, F. 2005. Addendum to the risk profile of Pentachlorobenzene. Royal Haskoning report 9R5744.01/R0005/ABE/CKV/Nijm. (http://www.unece.org/env/popsxg/docs/2005/PeCB%20_def__NL.pdf)
UNECE 2005
http://www.unece.org/env/popsxg/docs/2005/EU%20pentachloorbenzeen.pdf

"...it is expected that some PeCB may enter the environment as an impurity in Quintozene… In the EU the use of quintozene will stop after June 2002. World-wide quintozene is still used. For the UN-ECE region, quintozene is manufactured without using PeCB as feedstock. For outside the UN-ECE region this is unknown."
Van de Plassche, E.J., Schwegler, A.M.G.R., Rasenberg, M. and Schouten, A. 2002. Pentachlorobenzene. Dossier prepared for the third meeting of the UN-ECE Ad hoc Expert Group on POPs. Royal Haskoning report L0002.A0/R0010/EVDP/TL
http://www.unece.org/env/popsxg/docs/2005/EU%20pentachloorbenzeen.pdf

(iii) Releases

Discharges

Chemical plant wastes containing tetrachlorobenzenzes, pentachlorobenzene, and HCB caused considerable soil contamination at a temporary waste disposal site in Hungary. The authors note that non-cancer toxic effects, "…showed marked health hazard inside the dump and small potential risk in vicinity" and conclude that further monitoring information is needed to clarify the situation.
Dura G, Laszlo E, Horvath A. Fodor Jozsef National Centre of Public Health, National Institute of Environmental Health, Budapest, Hungary. dura@oki1.joboki.hu Human health risk assessment and management in hazardous waste site contaminated by polychlorinated benzenes. Cent Eur J Public Health. 2000 Jul;8 Suppl:47-8.

"In the stack emissions from a hazardous waste incinerator we found highly significant correlations between 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalents (I-TE) and pentachlorobenzene (CI5Bz) and between I-TE and heptachlorobiphenyl (CI7B). We therefore propose to utilize these substances as indicator parameters from which I-TE values can be estimated. Since they are easier to analyze than PCDD/F the use of indicator parameters such as CI5Bz and CI7B offers the chance to monitor I-TE emissions which are limited to 0.1 ng/m3 in many European countries."
Kaune A, Lenoir D, Nikolai U, Kettrup A. GSF-Research Centre for Environment and Health, Neuherberg, FRG. Indicator parameters for PCDD/F as a possible means to monitor emissions of toxicity equivalents from waste incinerators. Cent Eur J Public Health. 1993 Dec;1(2):123-4

"1,2-DCB, 1,4-DCB, TCBs, TeCBs and QCB [pentachlorobenzene] have been identified in pulp and paper mill effluents. Effluents from iron and steel manufacturing contribute to loadings of TCBs, TeCBs and QCB, while petroleum refinery effluents have been reported to contain TeCBs and QCB."
Environment Canada, Follow-up Report on Five PSL1 Substances for Which There Was Insufficient Information to Conclude Whether the Substances Constitute a Danger to the Environment, December 2003
http://www.ec.gc.ca/substances/ese/eng/psap/assessment/PSL1_chlorobenzenes_followup.pdf

Losses

Tetrachlorobenzenes, pentachlorobenzene, and HCH isomers were measures in air and deposition at three contaminated sites in Greppin, Roitzsch, and Leipzig Germany. Average chlorobenzene concentrations in air in the gas phase and particles were 11 ng/nm3 (Leipzig), 0.17 ng/nm3 (Roitzsch), and 0.37 ng/nm3 (Greppin.) The authors state that the increased concentrations in Leipzig were due to industrial waste sites and their influence on the atmospheric environment.
Popp P, Bruggemann L, Keil P, Thuss U, Weiss H. UFZ-Centre for Environmental Research, Leipzig-Halle, Leipzig, Germany. Chlorobenzenes and hexachlorocyclohexanes (HCHs) in the atmosphere of Bitterfeld and Leipzig (Germany). Chemosphere. 2000 Sep;41(6):849-55.

Emissions

Incineration fly ash

This study helped develop an availability test for determining the maximum potential environmental pollutant for leaching from incinerator fly ash using pentachlorobenzene, HCB, o-terphenyl and m-terphenyl as target compounds. Using fly ash sample from a Milan, Italy municipal sold waste incinerator, they measured 31 ng/g pentachlorobenzene in fly ash. A leaching test involving extraction of compounds from fly ash with water yielded 1.1 ng/g fly ash of pentachlorobenzene.
Korenkova E, Matisova E, Slobodnik J. Environmental Institute, Okruzna 784/42, 972 41 Kos, Slovak Republic. eva.korenkova@ene.gov.on.ca Application of large volume injection GC-MS to analysis of organic compounds in the extracts and leachates of municipal solid waste incineration fly ash. Waste Manag. 2006;26(9):1005-16. 2005 Nov 22.

PVC combustion

The study tested the effect of temperature on formation of PAHs and chlorinated compounds during PVC combustion. Formation of chlorinated compounds reached a peak at 600C with low emissions at 300C and 900C. “There was a close correlation (R2 = 0.97) among polychlorinated biphenyls (PCBs), hexachlorobenzene, pentachlorobenzene, and polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (PCDD/Fs).”
Kim KS, Hong KH, Ko YH, Kim MG. Environmental Analysis Team, Korea Testing Laboratory, Seoul, South Korea. kskim@ktl.re.kr Emission characteristics of PCDD/Fs, PCBs, chlorobenzenes, chlorophenols, and PAHs from polyvinylchloride combustion at various temperatures. J Air Waste Manag Assoc. 2004 May;54(5):555-62.

(b) Hazard assessment for endpoints of concern, including consideration of toxicological interactions involving multiple chemicals **(provide summary information and relevant references)**

Carcinogenicity

Clonal growth of preneoplastic enzyme-altered foci during liver carcinogenesis was examined in initiation-promotion experiments using pentachlorobenzene (PECB) or hexachlorobenzene (HCB). “Both PECB and HCB caused a significant increase in foci volume compared with the DEN controls. HCB treatments resulted in increased proliferation of normal hepatocytes, which was not observed for PECB under the same treatment regimen. The best description of the data resulted from the model incorporating the hypothesis that PECB and HCB promoted the growth of foci via increased net growth rates of B cells.”
Ou YC, Conolly RB, Thomas RS, Xu Y, Andersen ME, Chubb LS, Pitot HC, Yang RS. Center for Environmental Toxicology and Technology, Department of Environmental Health, Colorado State University, Fort Collins 80523, USA. A clonal growth model:

time-course simulations of liver foci growth following penta- or hexachlorobenzene treatment in a medium-term bioassay. Cancer Res. 2001 Mar 1;61(5):1879-89.

"In the studies presented here, we measured the ability of 1,4-dichlorobenzene (DCB), 1,2,4,5-tetrachlorobenzene (TeCB), pentachlorobenzene (PeCB), and hexachlorobenzene (HCB) to promote glutathione S-transferase pi (GSTP1-1) positive preneoplastic foci formation in rat liver, following diethylnitrosamine (DEN) initiation. The results from these studies show that TeCB, PeCB, and HCB all promote the formation of GSTP1-1 positive foci and that DCB does not. The numbers and area of foci were greatest following HCB promotion, and TeCB and PeCB were approximately equal in their promoting ability." "Alterations in GSH and GSSG levels were similar in PeCB- and TeCB-treated animals in that GSSG levels were significantly decreased, whereas HCB and DCB did not have this effect, although HCB treatment led to a significant increase in GSH levels. We conclude that induction of CYP1A2 or CYP2B1/2 by chlorobenzene isomers may indicate promotional ability, and that this property might be exploited to predict the hepatocarcinogenicity of other chlorobenzene isomers."
Gustafson DL, Long ME, Thomas RS, Benjamin SA, Yang RS. Center for Environmental Toxicology and Technology, Department of Environmental Health, Colorado State University, Fort Collins 80523-1680, USA. Comparative hepatocarcinogenicity of hexachlorobenzene, pentachlorobenzene, 1,2,4,5-tetrachlorobenzene, and 1,4-dichlorobenzene: application of a medium-term liver focus bioassay and molecular and cellular indices. Toxicol Sci. 2000 Feb;53(2):245-52.

This study examined the tumor-promoting activity of pentachlorobenzene (PeCB) in male F344 rats. "Animals were given a single i.p. injection of diethylnitrosamine (200 mg/kg body weight) and 2 weeks later were administered 0.1 or 0.4 mmol/kg per day PeCB by gavage in a corn oil vehicle, 7 days/week. At the end of week 3, rats were subjected to a partial hepatectomy. Results showed that PeCB, at both doses, significantly increased both the number and area of glutathione S-transferase pi (GST-P) foci (>0.2 mm diameter) ($P < 0.05$). This trend was dose-dependent. In addition to increases in preneoplastic foci, liver glutathione concentrations and glutathione-associated enzymes showed significant changes in animals treated with PeCB." "Together with changes in GR and gamma-GCS expression, a decrease in GST-P foci around the central veins was significant ($P = 0.004$) at the high dose. In these animals, 26% of the foci were classified as centrilobular whereas 37 and 39% of the foci were centrilobular in the low dose and control groups, respectively. Because of the co-localized nature of the changes in glutathione-associated enzymes and the decreased incidence of centrilobular foci, our results suggest that the reduced cellular environment may ultimately play a role in negatively selecting for foci growth."
Thomas RS, Gustafson DL, Pott WA, Long ME, Benjamin SA, Yang RS. Center for Environmental Toxicology and Technology, Department of Environmental Health, Colorado State University, Fort Collins 80523-1680, USA. Evidence for hepatocarcinogenic activity of pentachlorobenzene with intralobular variation in foci incidence. Carcinogenesis. 1998 Oct;19(10):1855-62. thomas@oncology.wisc.edu

No human or animal carcinogenicity data; classified D: not classifiable as to human carcinogenicity. Supporting data: “Haworth et al. (1983) reported that pentachlorobenzene at concentrations of 0, 33.3, 333.3, 1000 and 3333.3 ppm did not produce reverse mutations in four strains of Salmonella typhimurium (TA98, TA100, TA1535 and TA1537) in the presence or absence of rat liver microsomes (S9). Similar results were reported at unspecified concentrations (presumably the same) by the same group in an abstract (Lawlor et al., 1979). Pentachlorobenzene was also negative in Chinese hamster ovary cell assays for induction of sister chromatid exchanges and chromosomal aberrations (NTP, 1991). In 13-week rat and mouse micronucleus assays, pentachlorobenzene tested negative in all exposed groups (NTP, 1991). The metabolites of pentachlorobenzene (chlorobenzene, tetrachlorophenols, tetrachlorobenzenes, trichlorophenols, trichlorobenzenes, pentachlorophenol, tetrachlorohydroquinone) were all negative for gene mutation assays in Salmonella (Haworth et al., 1983; Zeiger et al., 1988; NTP, 1991). Some of the metabolites (e.g., pentachlorophenol), have shown evidence of clastogenic activity in vitro (Galloway et al., 1987; NTP, 1991). In rat and monkey metabolism studies, Engst et al. (1976) and Rozman et al. (1979) identified pentachlorophenol (classified as B2, probable human carcinogen) and 2,3,4,5-tetrachlorophenol as major metabolites of pentachlorobenzene. Other chlorinated phenols were also identified as metabolites. Pentachlorophenol has also been identified in the urine of rabbits administered pentachlorobenzene (Kohli et al., 1976).”
US EPA, Pentachlorobenzene (CASRN 608-93-5), Integrated Risk Information System, Carcinogenicity assessment last revised 1 February 1995
http://www.epa.gov/iris/subst/0085.htm

Immunotoxicity

The study examined the effects of various organic pollutants on cytokine production in culture to test the hypothesis that POPs may contribute to the increased prevalence of allergic disease. Cells were cultured for six days in the presence of a pollutant or Dermatophagoides pteronyssinus extract, then for one day in the presence of PHA + phorbol 12-myristate 13-acetate. Pentachlorobenzene reduced the levels of IL-6 and other substances all had similar effects. All the compounds had similar effects on cells from allergic or non-allergic donors indicating that this test did not support the hypothesis.
Devos S, Van Den Heuvel R, Hooghe R, Hooghe-Peters EL. Neuroendocrine Immunology, Pharmacology Department, Medical School, Free University of Brussels (V.U.B.), Belgium. sadevos@farc.vub.ac.be Limited effect of selected organic pollutants on cytokine production by peripheral blood leukocytes. Eur Cytokine Netw. 2004 Apr-Jun;15(2):145-51.

This study examined the role of metabolism and porphyria in the immunomodulating effects of HCB and pentachlorobenzene (PCB) in female Wistar rats. “PCB caused no skin lesions and had only minor, predominantly immunosuppressive effects.”
Schielen P, Den Besten C, Vos JG, Van Bladeren PJ, Seinen W, Bloksma N. Department of Immunotoxicology, Utrecht, University, The Netherlands. Immune effects of hexachlorobenzene in the rat: role of metabolism in a 13-week feeding study. Toxicol Appl Pharmacol. 1995 Mar;131(1):37-43.

Heme synthesis

This study compared the effects of HCB and pentachlorobenzene on heme synthesis in female Wistar rats receiving either substance in the diet for 13 weeks plus or minus triacetyloleandomycin (TAO), a selective inhibitor of cytochrome P450IIIA1/2. “Rats treated with HCB (high dose) had significantly elevated levels of urinary porphyrins from the 4th week on and had a significant hepatic accumulation of porphyrins at the end of the study. Both urinary porphyrin excretion and hepatic porphyrin accumulation were greatly inhibited in rats receiving co-treatment with HCB and TAO. However, the inhibition of HCB-induced porphyria by TAO cannot be explained by a diminished formation of the highly reactive TCBQ, since rats treated with a high dose of PCB, which had a several fold higher urinary excretion of PCP and TCHQ compared to a high dose of HCB, did not develop porphyria. Instead, the present study points to the involvement of a putative reactive intermediate in the primary oxidative step in HCB-induced porphyria, since based on paired observations of individual rats, the degree of porphyria was correlated to a high degree with excretion of PCP, whereas correlation of porphyria with early excretion of TCHQ was much weaker. This finding fits well with the fact that the mechanisms of oxidation of HCB to PCP and PCB to PCP are different. Both HCB and PCB were oxidized to PCP and tetrachlorohydroquinone (TCHQ), the reduced analog of TCBQ. Cytochrome P450IIIA1/2 appears to be involved in the conversion of HCB and PCB, since co-treatment of TAO resulted in a strongly diminished urinary excretion of PCP and TCHQ. Treatment with HCB as well as PCB results in disturbances of retinoid and thyroid hormone homeostasis. These effects, which have also been reported after exposure to polychlorinated biphenyls, originate from interference of hydroxylated metabolites (notably PCP) with the plasma thyroxine transport protein, transthyretine, and since this metabolite is formed from both HCB and PCB, this results in the same toxicity for both compounds.”

den Besten C, Bennik MH, Bruggeman I, Schielen P, Kuper F, Brouwer A, Koeman JH, Vos JG, Van Bladeren PJ. Department of Toxicology, Agricultural University, Wageningen, The Netherlands. The role of oxidative metabolism in hexachlorobenzene-induced porphyria and thyroid hormone homeostasis: a comparison with pentachlorobenzene in a 13-week feeding study. Toxicol Appl Pharmacol. 1993 Apr;119(2):181-94.

Liver, kidney, thyroid toxicity

The acute toxicity of pentachlorobenzene and other chlorobenzenes was studied in rats after a single ip injection of 1, 2, or 4 mmol/kg. Effects in the kidney were observed in the form of protein droplets in the tubular epithelial cells. Pentachlorobenzene and 1,2,4-trichlorobenzene caused the most severe decrease in plasma thyroxine levels and the effect correlated well with binding to transthyretin.

den Besten C, Vet JJ, Besselink HT, Kiel GS, van Berkel BJ, Beems R, van Bladeren PJ. Department of Toxicology, Agricultural University, Wageningen, The Netherlands. The liver, kidney, and thyroid toxicity of chlorinated benzenes. Toxicol Appl Pharmacol. 1991 Oct;111(1):69-81.

This study investigated microsomal metabolism of 1,2,4-[14C]trichlorobenzene (1,2,4-TrCB) and [14C]pentachlorobenzene (PeCB). “About 10% of all metabolites became covalently bound to protein in a rather nonselective way. For 1,2,4-TrCB and PeCB a strong correlation between secondary metabolism to hydroquinones and covalent binding was established. Protein binding was completely inhibited by the addition of ascorbic acid, indicating quinone metabolites as the sole reactive species formed. Both 1,2,4-TrCB and PeCB alkylated DNA, although to a much lesser extent than protein (0.5 and 0.3% of all metabolites, respectively).” “The present study clearly demonstrates the high alkylating potency of secondary quinone metabolites derived from chlorinated benzenes and poses a need for reevaluation of the role of epoxides in the observed toxicity of these compounds.”
den Besten C, Smink MC, de Vries EJ, van Bladeren PJ. Department of Toxicology, Agricultural University, Wageningen, The Netherlands. Metabolic activation of 1,2,4-trichlorobenzene and pentachlorobenzene by rat liver microsomes: a major role for quinone metabolites. Toxicol Appl Pharmacol. 1991 Apr;108(2):223-33.

“Toxicology studies were conducted by exposing groups of F344/N rats and B6C3F1 mice of each sex to pentachlorobenzene (99%percnt; pure) in feed for 15 days or 13 weeks. Exposure concentrations were 0, 100, 330, 1,000, 3,300, or 10,000 ppm pentachlorobenzene in the 15-day studies (five animals of each sex per group per species). All rats that received 10,000 ppm and all mice that received 3,300 or 10,000 ppm died. Of the exposed rats that survived to the end of the studies, males had an accumulation of abnormal hyaline droplets in the renal cortical epithelium and males and females had centrilobular hepatocellular hypertrophy. Chemical-related lesions were not observed in exposed mice. Exposure concentrations were 0, 33, 100, 330, 1,000, or 2,000 ppm pentachlorobenzene in the 13-week studies (10 animals of each sex per group per species). No compound-related deaths occurred. Body weights of exposed rats but not of mice were lower than those of controls. In male rats, dose-related histologic lesions included renal tubular epithelial hyaline droplet formation and medullary granular casts and mineralization. This spectrum of renal lesions in male rats is consistent with the entity described as "hydrocarbon or hyaline droplet nephropathy." Exacerbation of spontaneous nephropathy characterized by renal tubular cell regeneration and homogeneous intratubular protein casts was seen in rats of each sex. Urinary protein concentration was increased in male and female rats in the 1,000- and 2,000-ppm groups; this change was especially prominent in males. Urinary glucose concentration was increased in male rats in the 330- to 2,000-ppm groups and in female rats in the 1,000 and 2,000-ppm groups. Centrilobular hepatocellular hypertrophy was observed in exposed male and female rats. Unidentified yellow-brown pigment granules were present in hepatocytes and renal tubular epithelium in exposed animals of each sex but were more prominent in females. These granules possibly contained porphyrins. The only exposure-related histologic lesion in mice of either sex was centrilobular hepatocellular hypertrophy. Significant, but not dose-related, increases of liver porphyrin concentrations were observed in exposed male rats; female rats in the 2,000-ppm group also had increased liver porphyrin concentrations. Liver porphyrin concentrations were significantly increased in the 1,000- and 2,000-ppm groups of mice of each sex. Increased sorbitol dehydrogenase concentrations in exposed rats and mice of each sex were

attributed to mild hepatocyte injury. Minimal thyroid follicular cell hypertrophy was also present in male and female rats in the 1,000 and 2,000-ppm groups. Free thyroxin and total thyroxin concentrations were significantly decreased in exposed male and female rats; these data indicate moderate hypothyroxinemia in exposed animals. Hematologic findings in exposed rats included decreased hematocrit, hemoglobin concentration, erythrocyte count (males), mean corpuscular hemoglobin, mean erythrocyte volume, and mean corpuscular hemoglobin concentration; these findings are consistent with a mild-to-moderate anemia that is microcytic (decreased mean cell volume), hypochromic (decreased mean corpuscular hemoglobin concentration, females), and poorly regenerative (slight-to-no change in reticulocyte counts). The no-observed effect levels (NOELs) for histologic lesions were 33 ppm for male rats and 330 ppm for female rats. The NOEL for histologic lesions in female mice was 100 ppm. An NOEL was not reached for male mice. Synonyms: 1,2,3,4,5-Pentachlorobenzene; quintochlorobenzene." McDonald M. National Toxicology Program USA, NTP technical report on the toxicity studies of Pentachlorobenzene in F344/N Rats and B6C3F1 Mice (Feed Studies) (CAS No. 608-93-5). Toxic Rep Ser. 1991 Jan;6:1-48.

"Oral LD50 values for pentachlorobenzene (QCB) in rats were 1125, 1080, and 940 mg/kg for adult males, adult females, and weanling females, respectively. The oral LD50 values in mice were 1175 mg/kg for males and 1370 mg/kg for females. Clinical signs of toxicity included tremors and narcosis. Dermal application of 2500 mg/kg did not produce clinical signs in rats. In subchronic studies weanling male rats were fed 0, 125, or 1000 ppm QCB for 100 days and weanling females fed 0, 125, 250, 500, or 1000 ppm for 180 days. No clinical signs of toxicity or effects on growth were observed in these rats throughout the exposures. QCB accumulated in adipose tissues at approximately 1.5-2.2 times the dietary concentrations. Porphyrin measurements were made only in females. Terminal values for urinary uro-and coproporphyrin and accumulation of liver porphyrins were not remarkably different in control and QCB-treated groups. In groups fed 1000 ppm, the WBC was increased and red blood cell indices were generally decreased compared to controls. The rats were pair-bred with untreated partners after 67 days of treatment. Fertility and fecundity were unaffected in either sex; however, suckling pups of QCB-treated mothers fed 250 ppm or more developed tremors and at 1000 ppm most died before weaning. Adrenal weights in males and kidney weights in both sexes were increased in adults fed 1000 ppm. In groups fed 250 ppm or more liver/body weight ratios were increased in both adults and in weanling offspring of QCB-treated dams. Hepatocellular enlargement was particularly evident in the 500 and 1000 ppm groups. In the kidneys of adult males, more numerous and larger foci of tubular atrophy and lymphocytic infiltration were seen at 1000 ppm than were seen in controls and dose-related increases in hyaline droplet formation occurred at 125 and 1000 ppm."
Linder R, Scotti T, Goldstein J, McElroy K, Walsh D. Acute and subchronic toxicity of pentachlorobenzene. J Environ Pathol Toxicol. 1980 Nov;4(5-6):183-96.

Aquatic

Time-dependent toxicity of pentachlorobenzene and fluoranthene was measured in Hyalella azteca, Chironomus tentans, and Diporeia spp. "Pentachlorobenzene LR50 values were less variable among species and ranged from 1.20 micromol x g(-1) at 4 d to

0.81 micromol x g(-1) at 10 d for C. tentans, 5.0 micromol x g(-1) at 20 d and 2.75 micromol x g(-1) at 28 d for Diporeia spp., and 1.51 micromol x g(-1) at 4 d and 0.71 micromol x g(-1) at 28 d for H. azteca."
Schuler LJ, Landrum PF, Lydy MJ. Fisheries and Illinois Aquaculture Center, Department of Zoology, Southern Illinois University at Carbondale, Carbondale, Illinois 62901-6511, USA. Comparative toxicity of fluoranthene and pentachlorobenzene to three freshwater invertebrates. Environ Toxicol Chem. 2006 Apr;25(4):985-94

"For QCB [pentachlorobenzene], where no measurements were made, effect concentrations were extrapolated using the measured molar effect concentrations determined for each of the other CBzs. The EqP estimates for benthic organisms were within the range reported for *Hexagenia* spp. and *Tubifex tubifex* by Day *et al*. (1995) for 1,4-DCB and 1,2,4,5-TeCB (Table 5). Measured effects concentrations for 1,2-DCB and 1,2,3-TCB were higher than the EqP estimates. Based on these results, the EqP results were taken to be the conservative CTV_{SED} for 1,2-DCB (1382 µg/g OC), 1,4-DCB (1005 µg/g OC), TCBs (1637 µg/g OC), TeCBs (2846 µg/g OC) and QCB (2500 µg/g OC) for freshwater benthos (Table 9)." "The measured LOECs reported by Doe *et al*. (1995) for marine benthos were taken to be the CTV_{SED}s for 1,2-DCB (1127 µg/g OC) and TeCBs (1582 µg/g OC). The median LOEC for QCB, based on the molar estimates reported by Doe *et al*. (1995), was taken to be the CTV_{SED} (3080 µg/g OC) (Table 9). The EqP value was used as the CTV_{SED} for 1,4-DCB (4999 µg/g OC) and TCBs (504 µg/g OC) (Table 9) in marine systems."
Environment Canada, Follow-up Report on Five PSL1 Substances for Which There Was Insufficient Information to Conclude Whether the Substances Constitute a Danger to the Environment, December 2003
http://www.ec.gc.ca/substances/ese/eng/psap/assessment/PSL1_chlorobenzenes_followup.pdf

Pentachlorobenzene toxicity to Chironomus tentans was positively correlated with temperature when tested at 10C, 20C, and 30C. Body residues of pentachlorobenzene remained constant at all temperatures through uptake increased at 20C and 30C. Temperature had a greater effect on chlorpyrifos and m-parathion toxicity than pentachlorobenzene and the authors hypothesize that this may be due to accelerated biotransformation to more toxic metabolites.
Lydy MJ, Belden JB, Ternes MA. Department of Biological Sciences, Wichita State University, 1845 N. Fairmount, Wichita, Kansas 67260, USA. Effects of temperature on the toxicity of m-parathion, chlorpyrifos, and pentachlorobenzene to Chironomus tentans. Arch Environ Contam Toxicol. 1999 Nov;37(4):542-7.

This study measured the effect of pentachlorobenzene and other halobenzenes on growth rate reduction in the mosquito fish (Gambusia affinis) at sub-lethal levels. Pentachlorobenzene reduced growth rate at concentrations as low as 0.10 mumol/L. The aqueous concentrations of the halobenzenes causing growth rate reduction of 50% and 10% were 0.067 – 3.4 mumol/L and 0.0042 – 0.32 mumol/L. These values correspond to 5 – 8% and 0.1 – 3.9% of the LC50 values. "The lipid-based internal concentrations that

gave 50 and 10% growth rate reductions were 8.3-27 and 0.5-1.6 mmol kg-1, respectively."
Chaisuksant Y, Yu Q, Connell DW. Faculty of Environmental Sciences, Griffith University, Nathan, Queensland, Australia. Effects of halobenzenes on growth rate of fish (Gambusia affinis). Ecotoxicol Environ Saf. 1998 Feb;39(2):120-30.

This study examined the effect of 0.095 ppm pentachlorobenzene exposure for 5 days on the morphology and fatty acids of the diatom, Cyclotella meneghiniana. An increase in lipid volume was the most significant morphological change. "The C18:1 and C20:5 fatty acids were most variable with exposure to pentachlorobenzene. Results suggest that at sublethal doses, lipophilic toxicants exert effects that are biphasic. That is, immediately measurable effects are observed in the cells that include increases in storage products and changes in membranous organelles. Long-term effects are postulated to be the result of mobilization of lipophilic toxicants that have partitioned into lipid stores and are more available when lipids are metabolized. Although pentachlorobenzene has a higher octanol/water partition coefficient, it appears to exert fewer cellular changes than any trichlorobenzene isomer."
Sicko-Goad L, Evans MS, Lazinsky D, Hall J, Simmons MS. Effects of chlorinated benzenes on diatom fatty acid composition and quantitative morphology. IV. Pentachlorobenzene and comparison with trichlorobenzene isomers. Arch Environ Contam Toxicol. 1989 Sep;18(5):656-68.

(c) Environmental fate **(provide summary information and relevant references)**

Chemical/physical properties

The study examined surface soil samples from Teide Mountain in the Canary Islands at elevations of 10 and 3400 feet above sea level for PCBs, DDTs, HCHs, HCB, and pentachlorobenzene. "…the log-transformed TOC-normalized concentrations of most PCBs, HCB, and pentachlorobenzene exhibit a good correlation with the reciprocal of average annual atmospheric temperatures also showing a temperature dependence for their distribution in the high mountain system."
Ribes A, Grimalt JO, Torres Garcia CJ, Cuevas E. Temperature and organic matter dependence of the distribution of organochlorine compounds in mountain soils from the subtropical Atlantic (Teide, Tenerife Island). Department of Environmental Chemistry, Institute of Chemical and Environmental Research (ICER-CSIC), Barcelona, Catalonia, Spain. Environ Sci Technol. 2002 May 1;36(9):1879-85.

Persistence

"The half-lives of 1,2-DCB, 1,4-DCB, TCBs and TeCBs in soil have been estimated to be approximately 8 months, while QCB's [pentachlorobenzene's] half-life in soil has been estimated to be 2 years. Additionally, TeCBs and QCB are subject to atmospheric transport from its source to remote areas and, therefore, are considered persistent in air. All of the CBzs of interest in this report therefore meet the criteria for persistence as defined in the Persistence and Bioaccumulation Regulations of CEPA 1999 (Government

of Canada, 2000) due to the persistence of these compounds in sediment and soil. The higher chlorinated products, TeCBs and QCB also are persistent in air."
Environment Canada, Follow-up Report on Five PSL1 Substances for Which There Was Insufficient Information to Conclude Whether the Substances Constitute a Danger to the Environment, December 2003
http://www.ec.gc.ca/substances/ese/eng/psap/assessment/PSL1_chlorobenzenes_followup.pdf

How are chemical/physical properties and persistence linked to environmental transport, transfer within and between environmental compartments, degradation and transformation to other chemicals?

The study examined the dechlorination of HCB in municipal waste incineration fly ash and model fly ash. A pathway of dechlorination observed at 260C – 300C converted HCB into pentachlorobenzene which degraded to 1,2,3,5-tetrachlorobenzene followed by 1,3,5-trichlorobenzene, and ultimately 1,3-dichlorobenzene. "The relative percentual distribution of the dehalogenated products depends on the temperature, but not on the initial amount of water vapor or copper metal. On the other hand, the initial amount of copper substantially affects the conversion of the dehalogenation as well as the molar ratio of Cu_3Cl_3 to HCl in the equilibrium mixture."
Bures M, Pekarek V, Karban J, Fiserova E. Institute of Chemical Process Fundamentals, Czech Academy of Sciences, Rozvojova 135, 165 02 Praha 6, Czech Republic. Dehalogenation potential of municipal waste incineration fly ash. II. Comparison of dehalogenation pathways of fly ash and model fly ash with thermodynamic calculations. Environ Sci Pollut Res Int. 2003;10(2):121-5.

"Pentachlorobenzene (PeCB) and 1,2,3,4-tetrachlorobenzene (TeCB) were evaluated as oral chemical biomarkers when administered to coyotes (Canis latrans) during the period of 31 January to 10 August 1994. Three coyotes each received 100 mg of PeCB and three received 100 mg of TeCB, each in a mineral oil formulation. Three additional coyotes received only the mineral oil carrier. Muscle and adipose tissues, blood serum, and fecal samples were evaluated by capillary gas chromatography with electron capture detection for 120 days following administration. Residues of PeCB were detected in serum, feces, and adipose and muscle tissues for 120 days post-treatment; TeCB residues were detected in feces and serum at 1 and 8 days post-treatment and in adipose tissue at 30 days post-treatment. Residues of TeCB were not detected in muscle tissue at any point in the study."
Kimball BA, Windberg LA, Furcolow CA, Roetto M, Johnston JJ. U.S. Department of Agriculture, Denver Wildlife Research Center, Denver Federal Center, Colorado 80225, USA. Two new oral chemical biomarkers for coyotes. J Wildl Dis. 1996 Jul;32(3):505-11.

The metabolites of HCB and pentachlorobenzene (PCBz) were examined in urine after 13 weeks of dietary exposure in rats. "Both HCB and PCBz are oxidized to pentachlorophenol (PCP) and tetrachlorohydroquinone (TCHQ), which were the only two mutual metabolites formed." "PCBz is more extensively metabolized to the major metabolites 2,3,4,5-tetrachlorophenol (TCP), mercaptotetrachlorophenol (MTCP) and the

glucuronide of pentachlorothiophenol (PCTP), and the minor metabolites methylthiotetrachlorophenol (MeTTCP), hydroxytetrachlorophenyl sulphoxide (HTCPS), and bis(methylthio)-trichlorophenol (bis-MeTTriCP). The biotransformation of HCB and PCBz was modulated by selective inhibition of cytochrome P450IIIA in rats which received combined treatment of HCB or PCBz with triacetyloleandomycin (TAO). Rats receiving this diet had a strongly diminished excretion of both PCP and TCHQ, as compared to rats fed HCB or PCBz alone, indicating the involvement of P450IIIA in the oxidation of both compounds. However, the excretion of 2,3,4,5-TCP was not diminished by co-treatment of rats with PCBz and TAO, indicating that: (i) the oxidation of PCBz to PCP and 2,3,4,5-TCP does not proceed via a common intermediate; and (ii) oxidation of PCBz to 2,3,4,5-TCP is not mediated by P450IIIA. Co-treatment of rats with PCBz and TAO had a differential effect on the excretion of sulphur-containing metabolites, resulting in a decrease in the excretion of PCTP glucuronide, whereas no change was observed in the excretion of MTCP, as compared to rats receiving PCBz alone."
den Besten C, Bennik MM, van Iersel M, Peters MA, Teunis C, van Bladeren PJ. Department of Toxicology, Agricultural University, Wageningen, Netherlands. Comparison of the urinary metabolite profiles of hexachlorobenzene and pentachlorobenzene in the rat. Chem Biol Interact. 1994 Feb;90(2):121-37.

The absorption, metabolism, and accumulation of pentachlorobenzene was investigated under conditions of ad libitum feeding (AD) or restricted diet (RD) of 25 or 50% of AD for 15 days. Pentachlorobenzene (15 mg) was orally administered on the seventh day. "Daily fecal weight and the total amount of PECB excreted into feces were decreased by RF, indicating an increase in PECB absorption due to its prolonged retention in the gastrointestinal tract. However, the amount of PECB excreted was only 4.8% of the dose given to the AD group, and 2.1 and 2.4% of that given to the 50 and 25% restricted diet groups, respectively." "On day 8, PECB in liver, kidney, brain, and fat tissue were also lower in the restricted diet groups; the PECB levels in such tissue in the 25 and 50% restricted diet groups were 10-40 and 5-11% of that in the AD group, respectively. These results indicate that PECB metabolism was increased by RF. As PECB is lipophilic, it is most likely that the fat tissue mass, which was markedly decreased by RF, contributed to the enhancement of PECB metabolism. The mechanism seemed to be as follows: as fat tissue mass accumulating PECB decreased, the concentration of PECB in the liver increased, thus the amount of PECB metabolites formed was increased."
Umegaki K, Ikegami S, Ichikawa T. National Institute of Health and Nutrition, Tokyo, Japan. Effects of restricted feeding on the absorption, metabolism, and accumulation of pentachlorobenzene in rats. J Nutr Sci Vitaminol (Tokyo). 1993 Feb;39(1):11-22.

"Some of the CBzs [chlorobenzenes] of interest (TeCBs and QCB [pentachlorobenzene]) have been reported in lake sediments from both temperate regions and the Canadian Arctic (Eisenreich *et al*., 1989; Muir *et al*., 1995, 1996; Allen-Gil *et al*., 1997; Rawn *et al*., 2000a, 2000b). Movement of organic compounds to Arctic regions via long-range transport and deposition has been the focus of much study in recent 8 years. Muir *et al*. (1996) reported that maximum CBz (represented by Σ[QCB + hexachlorobenzene]) concentrations were observed in lake sediments dated to the lat 1970s and 1980s, approximately 5–10 years later than maximum concentrations in Lake Ontario. These

results are consistent with the cold condensation hypothesis, which explains the movement of organics to remote northern regions (Wania and Mackay, 1993). Allen-Gil *et al*. (1997) reported TeCBs (Σ[1,2,3,4-TeCB + 1,2,4,5-TeCB]) and QCB levels in surface slices of sediment cores collected in Arctic U.S. lakes (mean concentrations: 0.41 ng/g dw and 0.10 ng/g dw, respectively). Total TeCBs (Σ[1,2,3,4-TeCB + 1,2,4,5-TeCB]) concentrations detected in Yukon lake sediments ranged from below the MDL (<0.03 ng/g dw) to 0.54 ng/g dw, and QCB levels ranged from below detection levels (<0.03 ng/g dw) to 1.55 ng/g dw (Rawn *et al*., 2000b)."
Environment Canada, Follow-up Report on Five PSL1 Substances for Which There Was Insufficient Information to Conclude Whether the Substances Constitute a Danger to the Environment, December 2003
http://www.ec.gc.ca/substances/ese/eng/psap/assessment/PSL1_chlorobenzenes_followup.pdf

Bio-concentration or bio-accumulation factor, based on measured values
(unless monitoring data are judged to meet this need)

The bioconcentration of pentachlorobenzene and six other compounds was determined in carp below their water solubilities with and without a dispersant. "The bioconcentration factors (BCFs) of the compounds were on the order of 10(2)-10(4). The BCF values remained in the range of 15-49% for all the compounds, whether or not a dispersant was present, i.e., the BCF values in the presence of an organic solvent or a surfactant at a concentration below the critical micelle concentration were not significantly smaller than the BCF values in the absence of the solvent or surfactant. This result indicates that the dispersants had no influence on the evaluation of the bioconcentration potential of these test substances."
Yakata N, Sudo Y, Tadokoro H. Chemicals Evaluation and Research Institute-Japan, Kurume Laboratory, 3-2-7 Miyanojin, Kurume, Fukuoka 839-0801, Japan. yakata-naoaki@ceri.jp Influence of dispersants on bioconcentration factors of seven organic compounds with different lipophilicities and structures. Chemosphere. 2006 Sep;64(11):1885-91. 2006 Mar 9

POPs and mercury were measured in sediment and animals near an industrial wastewater treatment plant in Sumgayit, Azerbaijan. Turtle tissues contained elevated levels of pentachlorobenzene even though this substance was not elevated in the sediment sample.
Swartz CD, Donnelly KC, Islamzadeh A, Rowe GT, Rogers WJ, Palatnikov GM, Mekhtiev AA, Kasimov R, McDonald TJ, Wickliffe JK, Presley BJ, Bickham JW. Department of Veterinary Anatomy and Public Health, Texas A&M University, College Station, TX 77843, USA. Chemical contaminants and their effects in fish and wildlife from the industrial zone of Sumgayit, Republic of Azerbaijan. Ecotoxicology. 2003 Dec;12(6):509-21.

The study measured the uptake of pentachlorobenzene, trichlorobenzene, and hexachlorobiphenyl in juvenile rainbow trout (Oncorhynchus mykiss) after 2 and 4-day exposures in water. Addition of humic acid equal to or greater than 4.81 mg/L significantly reduced whole body concentrations of all three substances. In contrast, the lowest concentration of humic acid that was tested (1.54 mg/L) significantly increased

uptake (up to 112%) for both pentachlorobenzene and trichlorobenzene, both of which have a lower K_{ow} than hexachlorobiphenyl.
Qiao P, Farrell AP. Department of Biological Sciences, Simon Fraser University, Burnaby, BC, Canada V5A 1S6. Influence of dissolved humic acid on hydrophobic chemical uptake in juvenile rainbow trout. Comp Biochem Physiol C Toxicol Pharmacol. 2002 Dec;133(4):575-85.

"This study assessed the relative contributions of aqueous versus dietary uptake of three hydrophobic chemicals, 1,2, 4-trichlorobenzene (1,2,4-TCB), 1,2,3,4,5-pentachlorobenzene (PeCB), and 2,2',4,4',6,6'-hexachlorobiphenyl (HCBP). Juvenile rainbow trout (Oncorhynchus mykiss) were exposed separately to chemically spiked water and food for 4 days and 12 days, respectively. Chemical concentrations were measured in the food, water, and tissues, and this allowed calculation of uptake rate constants (k(1) from water exposure, k(d) from food exposure)." "The model predicted for all three test chemicals that the two uptake routes would contribute equally to the chemical body burden in fish whenever the food:water chemical concentration ratio was near 10(5). However, using food:water chemical concentration ratios that might be expected in nature, the model predicted that gill uptake could account for over 98% of fish body burden for both 1,2,4-TCB and PeCB uptake (log K(ow) values of 3.98 and 5.03, respectively). For HCBP (log K(ow) of 7.55), the model predicted that the dietary uptake could contribute over 85% of the body burden. Thus, depending on the actual food:water chemical concentration ratio, aqueous uptake via the gills can predominate even when the chemicals have a log K(ow) value greater than 5.0. In addition, we confirmed that dietary uptake of hydrophobic xenobiotics increases with increasing log K(ow)."
Qiao P, Gobas FA, Farrell AP. Department of Biological Sciences, Simon Fraser University, Burnaby, BC V5A 1S6, Canada. Relative contributions of aqueous and dietary uptake of hydrophobic chemicals to the body burden in juvenile rainbow trout. Arch Environ Contam Toxicol. 2000 Oct;39(3):369-77.

"BAFs of 810 and 20 000 were reported for QCB [pentachlorobenzene] in mussel (*Mytilis edulis*) and rainbow trout, respectively, but a much higher BAF for earthworms (*E. andrei*) (401 000) has also been reported (Government of Canada, 1993e). 1993e). More recently, Burkhard *et al*. (1997) reported BAFs based on freely dissolved, lipid normalized concentrations for TCBs, TeCBs and QCB in a number of species. When considered on a whole-body wet weight basis, the BAFs reported by Burkhard *et al.* (1997) were between 427 and 630, between 871 and 1905, and between 6310 and 12 883 for TCBs, TeCBs and QCB, respectively. Bioaccumulation of CBzs generally increases with degree of chlorination. The estimated log octanol-water partition coefficient (log K_{ow}) for both 1,2-DCB and 1,4- DCB is 3.4. The log K_{ow} estimates for TCB, TeCBs and QCB are 3.85–4.30, 4.5 and 5.0, respectively (Mackay *et al*., 1992)."
Environment Canada, Follow-up Report on Five PSL1 Substances for Which There Was Insufficient Information to Conclude Whether the Substances Constitute a Danger to the Environment, December 2003
http://www.ec.gc.ca/substances/ese/eng/psap/assessment/PSL1_chlorobenzenes_followup.pdf

"[14C]Benzene, [14C]1,2,4-trichlorobenzene, [14C]pentachlorobenzene, and [14C]hexachlorobenzene were applied to soils in outdoor lysimeters to a 10-cm depth (2 mg/kg dry soil); barley and cress plants were grown for one vegetation period and analyzed after varying time intervals. The bioaccumulation factors (concentration of radioactive substances in plants divided by that in soils) of barley were higher than those of cress, except for hexachlorobenzene. In barley, bioaccumulation factors increased with decreasing chlorine content of the molecules, except for benzene, whereas in cress hexachlorobenzene exhibited the highest bioaccumulation factor. The conversion ratios of chlorinated benzenes (percentage of conversion products based on total radioactivity in plants) were negatively correlated to the chlorine content of the molecules and, in barley, positively correlated with time; in general, they were higher in barley than in cress. The concentration of radioactive substances in the plants, as well as bioaccumulation factors, decreased with time, except for a slight increase in benzene-derived residues in barley after 125 days. This effect is due to growth dilution. The percentage of radioactivity in barley seeds, based on that in the whole plant, was negatively correlated to the chlorine content of the molecule."
Topp E, Scheunert I, Korte F. Umweltforschung mbH Munchen, Institut fur Okologische Chemie, Neuherberg, Federal Republic of Germany. Kinetics of the uptake of 14C-labeled chlorinated benzenes from soil by plants. Ecotoxicol Environ Saf. 1989 Apr;17(2):157-66.

(d) Monitoring data **(provide summary information and relevant references)**

Human

Pentachlorobenzene found to accumulate more in human placenta than in breast milk. The authors suggest that this may be due to a tissue specific metabolic activity.
Shen H, Main KM, Virtanen HE, Damggard IN, Haavisto AM, Kaleva M, Boisen KA, Schmidt IM, Chellakooty M, Skakkebaek NE, Toppari J, Schramm KW., Institute of Ecological Chemistry, GSF-National Research Center for Environment and Health, Ingolstadter Landstrasse 1, D-85764 Neuherberg, Germany. From mother to child: Investigation of prenatal and postnatal exposure to persistent bioaccumulating toxicants using breast milk and placenta biomonitoring, Chemosphere 2007 January 3

This case-control study used 62 milk samples from mothers of cryptorchid boys and 68 from mothers of healthy boys. Milk was collected as individual pools between 1 and 3 months postpartum and analyzed for 27 organochlorine pesticides. Pentachlorobenzene was among a group of five substances (octachlorostyrene (OCS); pentachlorobenzene, 1,1-dichloro-2,2-bis(4-chlorophenyl) ethane(p,p -DDD) ; o,p -DDT ; mirex) that were measurable in most samples (91% - 99%) and formed part of a middle group in terms of concentrations.
Damgaard IN, Skakkebaek NE, Toppari J, Virtanen HE, Shen H, Schramm KW, Petersen JH, Jensen TK, Main KM; Nordic Cryptorchidism Study Group. University Department of Growth and Reproduction, Copenhagen, Denmark. ind@rh.dk Persistent pesticides in human breast milk and cryptorchidism. Environ Health Perspect. 2006 Jul;114(7):1133-8.

A cohort study examined factors affecting in utero transfer of organochlorine compounds by sampling cord blood and sera collected from children at 4 years of age from Minorca. The island did not have industrial production of POPs but used DDT in the past. “The cohort recruited all women presenting for antenatal care over 12 months starting in mid 1997 (*18*). 482 children were enrolled, and 470 (97.5%) provided complete outcome data up to the fourth year visit. Among these, 410 (85%) had OCs measured in cord blood and 285 (59%) in sera collected at four years.” “PeCB was the OC found in lowest concentration, 0.081 and 0.023 ng/mL in cord blood and sera collected at four years, respectively.” “Only PeCB and the PCB congeners having three (e.g., #28), four (e.g., #52), and some having five (e.g., #101) chlorine atoms were not correlated to lactation time.” “In breastfed children, the average concentration differences between sera collected at four years and cord blood showed an increase in the concentrations of all OC, with the only exceptions being PeCB, HCB, and 4,4¢-DDT.” “The small increases of PeCB and HCB, 0.06 and 0.04 *í*g, respectively, are consistent with their low *K*oa…” Carrizo D, Grimalt JO, Ribas-Fito N, Sunyer J, Torrent M. Department of Environmental Chemistry, Institute of Chemical and Environmental Research (IIQAB-CSIC), Jordi Girona, 18, 08034-Barcelona, Catalonia, Spain. Physical-chemical and maternal determinants of the accumulation of organochlorine compounds in four-year-old children. Environ Sci Technol. 2006 Mar 1;40(5):1420-6.

This study measured a variety of organochlorines in extracts of abdominal, mammary, and perirenal fat tissue from 27 adult Finnish males and females. Pentachlorobenzene was among seven (out of 23) substances found in the extracts.
Smeds A, Saukko P. Department of Organic Chemistry, Abo Akademi University, Turku, Finland. ansmeds@abo.fi Identification and quantification of polychlorinated biphenyls and some endocrine disrupting pesticides in human adipose tissue from Finland. Chemosphere. 2001 Sep;44(6):1463-71.

“Blood samples from a total of 35 persons divided into three different groups, with and without exposure to chlorinated hydrocarbons in the work atmosphere, have been investigated by gas chromatography using electron capture detection. It is shown that the group of workers with an occupational exposure to pentachlorobenzene, hexachlorobenzene, heptachlorostyrene and octachlorostyrene had a higher level of these chlorinated hydrocarbons in their blood samples than did the other groups. On the average, the concentration of hexachlorobenzene is about 20 times higher in blood samples from the occupationally exposed workers than from the control group.”
Lunde G, Bjorseth A. Human blood samples as indicators of occupational exposure to persistent chlorinated hydrocarbons. Sci Total Environ. 1977 Nov;8(3):241-6.

Animals

This study examined the transfer and distribution of Lindane and pentachlorobenzene (its metabolite) in fetuses and newborns after administration of 30 mg/kg Lindane to 16 pregnant rabbits. “The pentachlorobenzene metabolite produced after Lindane administration to the mothers crossed the placental barrier with difficulty during pregnancy, but was readily transferred to off-spring via milk. Pentachlorobenzene levels

in neonates increased during lactation by transfer and also as a consequence of endogenous production. At the 20th day of lactation the pentachlorobenzene concentration in maternal and foetal tissues was higher than that of Lindane."
Pompa G, Fadini L, Di Lauro F, Caloni F. Institute of Veterinary Pharmacology and Toxicology, Milano, Italy. Transfer of Lindane and pentachlorobenzene from mother to newborn rabbits. Pharmacol Toxicol. 1994 Jan;74(1):28-34.

This study examined placental transfer of Pentachloro-, pentachloronitro-, and hexabromobenzene when administered to rats daily from days 6 – 15 of gestation at 40, 100, and 200 mg/kg body weight. "Maternal brain, heart, kidney, liver, spleen and adipose tissue as well as whole fetus, fetal liver and fetal brain were analyzed for organohalogen residue by GLC. Pentachlorobenzene accumulated in the fetus to a greater extent than hexabromobenzene. In maternal tissues pentachlorobenzene accumulated to the greatest extent in adipose tissue, followed by liver, spleen, brain, heart and kidney."
Villeneuve DC, Khera KS. Placental transfer of halogenated benzenes (pentachloro-, pentachloronitro-, and hexabromo-) in rats. Environ Physiol Biochem. 1975;5(5):328-31.

(e) Exposure in local areas **(provide summary information and relevant references)**

- general

"The content of chlorinated fat-soluble aromatic hydrocarbons was determined in fish from an area polluted by industrial effluents. The fish species investigated were selected among those used for human consumption. For some samples, both the fillet and liver were investigated. For others the whole fish was used. The following compounds were analysed and quantified: Trichlorobenzene, tetrachlorobenzene, pentachlorobenzene, hexachlorobenzene, heptachlorostyrene, octachlorostyrene and polychlorinated biphenyls. The results indicate an appreciable accumulation in fish of the higher chlorinated compounds as pentachlorobenzene, hexachlorobenzene, heptachlorostyrene and octachlorostyrene. Other chlorinated hydrocarbons as decachlorobiphenyl, pentachloronaphthalene, hexachloronaphthalene and hexachlorostyrene were identified, but not quantified. The total content of fat-soluble chlorine was determined in some samples before and after sulphuric acid treatment. The content of chlorine in the identified and quantified compounds accounted for between 40 and 100 per cent of the total amount of chlorine present in the samples as persistent (sulphuric acid resistant) compounds."
Ofstad EB, Lunde G, Martinsen K, Rygg B. Chlorinated aromatic hydrocarbons in fish from an area polluted by industrial effluents. Sci Total Environ. 1978 Nov;10(3):219-30

- as a result of long-range environmental transport

Organochlorines were measured in the fat tissues of 107 polar bears sampled between 1996 and 2002 in the Arctic and sub-Arctic regions of Alaska, Canada, Greenland, and Svalbard. The Alaskan polar bears had higher proportions of relatively volatile compounds such as pentachlorobenzene.
Verreault J, Muir DC, Norstrom RJ, Stirling I, Fisk AT, Gabrielsen GW, Derocher AE, Evans TJ, Dietz R, Sonne C, Sandala GM, Gebbink W, Riget FF, Born EW, Taylor MK, Nagy J, Letcher RJ. University of Windsor, Great Lakes Institute for Environmental

Research, Windsor, Canada, ON N9B 3P4. Chlorinated hydrocarbon contaminants and metabolites in polar bears (Ursus maritimus) from Alaska, Canada, East Greenland, and Svalbard: 1996-2002. Sci Total Environ. 2005 Dec 1;351-352:369-90. 2005 Aug 22.

Organochlorine contaminants were measured in soils and mosses from Victoria Land, Antarctica. Pentachlorobenzene was one of the dominant contaminants in mosses and soils at 0.38 – 1.3 ng/g dry weight. Examination of temperature variations and HCB and 4/4'-DDE concentrations in mosses and alpha-HCH in soils led the authors to conclude that "temperature is a major factor determining the planetary scale distribution and accumulation of OCs giving additional ground to the general validity of the global distillation effect for description of planetary OC distribution."
Borghini F, Grimalt JO, Sanchez-Hernandez JC, Bargagli R. Department of Environmental Sciences, University of Siena, Via Mattioli 4, 53100 Siena, Italy. Organochlorine pollutants in soils and mosses from Victoria Land (Antarctica). Chemosphere. 2005 Jan;58(3):271-8.

Organochlorines including pentachlorobenzene were measured in mosses at three altitude gradients in the Andean mountains in Chile: 3200 – 4500 m, 234-1330 m, and 10 – 700 m. Pentachlorobenzene, hexachlorobenzene, hexachlorocyclohexanes, polychlorobiphenyls (PCBs), and DDTs were measured in a variety of concentrations at levels that were among the lowest for remote areas but higher than previously studied Antarctic areas. The study found that the most relevant factor affecting contaminant concentration was the lowest temperature value which correlated directly with higher altitudes.
Grimalt JO, Borghini F, Sanchez-Hernandez JC, Barra R, Garcia CJ, Focardi S. Department of Environmental Chemistry (ICER-CSIC), Jordi Girona, 18, 08034-Barcelona, Catalonia, Spain. jgoqam@cid.csic.es Temperature dependence of the distribution of organochlorine compounds in the mosses of the Andean mountains. Environ Sci Technol. 2004 Oct 15;38(20):5386-92.

- information regarding bio-availability

(f) National and international risk evaluations, assessments or profiles and labelling information and hazard classifications, as available **(provide summary information and relevant references)**

Environment Canada, Follow-up Report on Five PSL1 Substances for Which There Was Insufficient Information to Conclude Whether the Substances Constitute a Danger to the Environment, December 2003
http://www.ec.gc.ca/substances/ese/eng/psap/assessment/PSL1_chlorobenzenes_followup.pdf

Van de Plassche, E.J., Schwegler, A.M.G.R., Rasenberg, M. and Schouten, A. 2002. Pentachlorobenzene. Dossier prepared for the third meeting of the UN-ECE Ad hoc Expert Group on POPs. Royal Haskoning report L0002.A0/R0010/EVDP/TL
http://www.unece.org/env/popsxg/docs/2005/EU%20pentachloorbenzeen.pdf

Belfroid, A., van der Aa, E. and Balk, F. 2005. Addendum to the risk profile of Pentachlorobenzene. Royal Haskoning report 9R5744.01/R0005/ABE/CKV/Nijm. (http://www.unece.org/env/popsxg/docs/2005/PeCB%20_def__NL.pdf)
UNECE 2005
http://www.unece.org/env/popsxg/docs/2005/EU%20pentachloorbenzeen.pdf

(g) Status of the chemical under international conventions

"International regulation

European Union: PeCB is one of the priority substances of the recently adopted EU Water Framework Directive (Dir. 2000/60/EC). The EU will propose community- wide water quality standards and emission controls for these priority substances**.** Within the list of these priority substances a group of so-called priority hazardous substances is identified which are of particular concern for the freshwater, coastal and marine environment. These substances will be subject to cessation or phasing out of discharges, emissions and losses within an appropriate timetable that shall not exceed 20 years. PeCB is regarded as a priority hazardous substance.

OSPAR: PeCB appears on the OSPAR DYNAMEC list in Group V: Substances with PTB properties, but which are heavily regulated or withdrawn from the market (OSPAR 2000)."

Belfroid, A., van der Aa, E. and Balk, F. 2005. Addendum to the risk profile of Pentachlorobenzene. Royal Haskoning report 9R5744.01/R0005/ABE/CKV/Nijm. (http://www.unece.org/env/popsxg/docs/2005/PeCB%20_def__NL.pdf)
UNECE 2005
http://www.unece.org/env/popsxg/docs/2005/EU%20pentachloorbenzeen.pdf