IPCS INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY

Health and Safety Guide No. 107

HEXACHLOROBENZENE

HEALTH AND SAFETY GUIDE

UNEP

UNITED NATIONS
ENVIRONMENT PROGRAMME

ILO

INTERNATIONAL
LABOUR ORGANISATION

WORLD HEALTH
ORGANIZATION

WORLD HEALTH ORGANIZATION, GENEVA 1998

Other HEALTH AND SAFETY GUIDES available:
(continued on the inside back cover)

Acetaldehyde (No. 90, 1995)
Acrolein (No. 67, 1992)
Acrylamide (No. 45, 1991)
Acrylic acid (No. 104, 1997)
Acrylonitrile (No. 1, 1986)
Aldicarb (No. 64, 1991)
Aldrin and dieldrin (No. 21, 1988)
Allethrins (No. 24, 1989)
Amitrole (No. 85, 1994)
Ammonia (No. 37, 1990)
Arsenic compounds, inorganic, other than arsine (No. 70, 1992)
Atrazine (No. 47, 1990)
Barium (No. 46, 1991)
Benomyl (No. 81, 1993)
Bentazone (No. 48, 1990)
Beryllium (No. 44, 1990)
Brodifacoum (No. 93, 1995)
Bromadiolone (No. 94, 1995)
1-Butanol (No. 3, 1987)
2-Butanol (No. 4, 1987)
tert-Butanol (No. 7, 1987)
Camphechlor (No. 40, 1990)
Captafol (No. 49, 1990)
Captan (No. 50, 1990)
Carbaryl (No. 78, 1993)
Carbendazim (No. 82, 1993)
Chlordane (No. 13, 1988)
Chlordecone (No. 41, 1990)
Chloroform (No. 87, 1995)
Chlorothalonil (No. 98, 1995)
Cresols (No. 100, 1996)
Cyhalothrin and lambda-cyhalothrin (No. 38, 1990)
Cypermethrin (No. 22, 1988)
Deltamethrin (No. 30, 1989)
1,2-Dichloroethane (No. 55, 1991)
2,4-Dichlorophenoxyacetic acid(2,4-D) (No. 5, 1987)
1,3-Dichloropropene, 1,2-dichloropropane, and mixtures of 1,3-dichloropropene and 1,2-dichloropropane (No. 76, 1992)
Dichlorvos (No. 18, 1988)
Difenacoum (No. 95, 1995)
Diflubenzuron (No. 99, 1995)
Dimethoate (No. 20, 1988)
Dimethyl sulfate (No. 29, 1989)
Dimethylarsinic acid, methanearsonic acid, and salts (No. 69, 1992)
Dimethylformamide (No. 43, 1990)
Diquat (No. 52, 1991)
Endosulfan (No. 17, 1988)
Endrin (No. 60, 1991)
Epichlorohydrin (No. 8, 1987)
Ethylene oxide (No. 16, 1988)
Fenitrothion (No. 65, 1991)
Fenvalerate (No. 34, 1989)
Folpet (No. 72, 1992)
Formaldehyde (No. 57, 1991)
Heptachlor (No. 14, 1989)
Hexachlorobenzene (No. ...., 1997)
Hexachlorobutadiene (No. 84, 1993)
Hexachlorocyclohexanes, alpha- and beta- (No. 53, 1991)
Hexachlorocyclopentadiene (No. 63, 1991)
n-Hexane (No. 59, 1991)
Hydrazine (No. 56, 1991)
Hydroquinone (No. 101, 1996)
Isobenzan (No. 61, 1991)
Isobutanol (No. 9, 1987)
Isophorone (No. 91, 1995)
Kelevan (No. 2, 1987)
Lindane (No. 54, 1991)
Magnetic fields (No. 27, 1990)
Methamidophos (No. 79, 1993)
Methanol (No. 105, 1997)
Methomyl (No. 97, 1995)
Methyl bromide (Bromomethane) (No. 86, 1995)
Methyl isobutyl ketone (No. 58, 1991)
Methyl parathion (No. 75, 1992)
Methylene chloride (No. 6, 1987)
Mirex (No. 39, 1990)
Monocrotophos (No. 80, 1993)
Morpholine (No. 92, 1995)
Nickel, nickel carbonyl, and some nickel compounds (No. 62, 1991)
Paraquat (No. 51, 1991)
Parathion (No. 74, 1992)
Pentachlorophenol (No. 19, 1988)
Permethrin (No. 33, 1989)

IPCS

Health and Safety Guide No. 107

HEXACHLOROBENZENE HEALTH AND SAFETY GUIDE

This is a companion volume to
Environmental Health Criteria 195: Hexachlorobenzene

Published by the World Health Organization for the International Programme on Chemical Safety (a collaborative programme of the United Nations Environment Programme, the International Labour Organisation, and the World Health Organization) and produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals

WORLD HEALTH ORGANIZATION, GENEVA 1998

This report contains the collective views of an international group of experts and does not necessarily represent the decisions or the stated policy of the United Nations Environment Programme, the International Labour Organisation, or the World Health Organization.

WHO Library Cataloguing in Publication Data

Hexachlorobenzene: health and safety guide.

(Health and safety guide ; no. 107)

1.Hexachlorobenzene - toxicity 2.Environmental exposure
3.Guidelines I.International Programme on Chemical Safety
II.Series

ISBN 92 4 151107 9 (NLM Classification: QV 633)
ISSN 0259-7268

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Germany) provided financial support for, and undertook the printing of, this publication

Printed by Wissenschaftliche Verlagsgesellschaft mbH · D-70009 Stuttgart 10

CONTENTS

		Page
INTRODUCTION		5
1.	PRODUCT IDENTITY AND USES	
	1.1 Identity	7
	1.2 Physical and chemical properties	7
	1.3 Analytical methods	8
	1.4 Uses	8
2.	SUMMARY AND EVALUATION	10
	2.1 Exposure	10
	2.2 Environmental fate	10
	2.3 Kinetics and metabolism	10
	2.4 Effects on animals and *in vitro* test systems	11
	2.5 Effects on humans	13
	2.6 Effects on organisms in the environment	14
3.	CONCLUSIONS	16
	3.1 Human health	16
	3.2 Environment	17
4.	HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION	18
	4.1 Human health hazards, prevention and protection, first aid	18
	4.2 Advice to physicians	19
	4.2.1 Decontamination	19
	4.2.2 Prevention of absorption after oral exposure	19
	4.2.3 Treatment	19
	4.3 Health surveillance advice	19
	4.4 Explosion and fire hazards, prevention	20
	4.4.1 Explosion and fire hazards	20
	4.4.2 Prevention	20
	4.4.3 Fire-extinguishing agents	20
	4.5 Storage	20
	4.6 Transport	20
	4.7 Spillage	20

CONTENTS

5. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION 21

6. SUMMARY OF CHEMICAL SAFETY INFORMATION 22

7. CURRENT REGULATIONS, GUIDELINES AND STANDARDS 25
   - 7.1 Occupational exposure limit 25
   - 7.2 Specific restrictions 26
   - 7.3 Labelling, packaging and transport 26
   - 7.4 Waste disposal 26

BIBLIOGRAPHY 27

INTRODUCTION

The Environmental Health Criteria (EHC) monographs produced by the International Programme on Chemical Safety include an assessment of the effects on the environment and on human health of exposure to a chemical or combination of chemicals, or physical or biological agents. They also provide guidelines for setting exposure limits.

The purpose of a Health and Safety Guide is to facilitate the application of these guidelines in national chemical safety programmes. The first three sections of a Health and Safety Guide highlight the relevant technical information in the corresponding EHC. Section 4 includes advice on preventive and protective measures and emergency action; health workers should be thoroughly familiar with the medical information to ensure that they can act efficiently in an emergency. Within the Guide is a Summary of Chemical Safety Information which should be readily available, and should be clearly explained, to all who could come into contact with the chemical. The section on regulatory information has been extracted from the legal file of the International Register of Potentially Toxic Chemicals (IRPTC) and from other United Nations sources.

The target readership includes occupational health services, those in ministries, governmental agencies, industry, and trade unions who are involved in the safe use of chemicals and the avoidance of environmental health hazards, and those wanting more information on this topic. An attempt has been made to use only terms that will be familiar to the intended user. However, sections 1 and 2 inevitably contain some technical terms. A bibliography has been included for readers who require further background information.

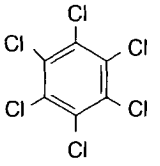
Revision of the information in this Guide will take place in due course, and the eventual aim is to use standardized terminology. Comments on any difficulties encountered in using the Guide would be very helpful and should be addressed to:

The Director
International Programme on Chemical Safety
World Health Organization
1211 Geneva 27
Switzerland

THE INFORMATION IN THIS GUIDE SHOULD BE CONSIDERED AS A STARTING POINT TO A COMPREHENSIVE HEALTH AND SAFETY PROGRAMME

1. PRODUCT IDENTITY AND USES

1.1 Identity

CAS/IUPAC name	Hexachlorobenzene (HCB)
Chemical formula	C_6Cl_6
Chemical Structure	
Common synonyms	perchlorobenzene, pentachlorophenyl chloride, phenyl perchloryl
CAS registry number	118-74-1
RTECS number	DA 2975 000
UN transport number	2729
Conversion factors	1 ppm = 11.8 mg/m^3 1 mg/m^3 = 0.08 ppm

1.2 Physical and chemical properties

At ambient temperature, HCB is a white crystalline solid. Technical grade HCB is available as a wettable powder, liquid or dust. It is virtually insoluble in water, but is soluble in ether, benzene, chloroform and hot ethanol. HCB has a high octanol/water partition coefficient, low vapour pressure and low flammability. Some physical and chemical properties of hexachlorobenzene (HCB) are listed in Table 1. Technical grade HCB contains up to 2% impurities, about half of which is pentachlorobenzene, the remainder including hepta- and octa-chlorodibenzofurans, octachlorodibenzo-*p*-dioxin, and decachlorobiphenyl.

Table 1. Some physical and chemical properties of hexachlorobenzene

Property	Value
Relative molecular mass	284.79
Melting point (°C)	230
Boiling point (°C)	322 (sublimes)
Vapour pressure (Pa at 25 °C)	0.0023
Water solubility (mg/litre at 25 °C)	0.005
Log octanol/water partition coefficient	5.5

1.3 Analytical methods

Analysis of HCB in environmental media and biological materials generally involves extraction of the sample into organic solvents, often followed by a clean-up step to remove potential interference by other organochlorine compounds. Organic extracts are analysed by gas chromatography/mass spectrometry (GC/MS) or gas chromatography with electron capture detection (GC/ECD). Using an electron capture detector, limits of detection of 0.1 $\mu g/m^3$ in air, 0.05 $\mu g/g$ in water, and 33 pg/g in breast milk have been reported.

1.4 Uses

Historically, HCB had many uses in industry and agriculture. The major agricultural application for HCB was as a seed dressing for crops such as wheat, barley, oats and rye to prevent fungal disease. The use of HCB in such applications was discontinued in many countries in the 1970s owing to concerns about adverse effects on the environment and human health. However, HCB continued to be used for this purpose in some countries as late as 1985. The present situation is not clear.

Other previous commercial applications of HCB include the production of munitions, as a fluxing agent in the manufacture of aluminium, a wood-preserving agent, in the manufacture of graphite anodes, and in the rubber industry. It is likely that many of these applications have been discontinued, although no information to verify this fact could be found.

PRODUCT IDENTITY AND USES

Worldwide production of HCB was estimated to be 10 000 tonnes/year for the period 1978-1981. An estimated 300 tonnes was produced in the USA in 1973. HCB was produced in the European Community at 8000 tonnes/year in 1978, and a company in Spain produced an estimated 150 tonnes of HCB annually. Approximately 1500 tonnes of HCB are manufactured annually in Germany for the production of the rubber auxiliary PCTP, but that production was to have been discontinued in 1993. No other recent data on levels of production have been reported. However, production of HCB has probably declined as a result of restrictions on its uses starting in the 1970s. Considerable amounts of HCB are also produced as a by-product in the manufacture of chlorinated solvents and chlorinated pesticides.

2. SUMMARY AND EVALUATION

2.1 Exposure

The major source of human exposure to HCB is as a contaminant in food. Very low levels of HCB are found in drinking-water and ambient air. It is estimated that the total average daily intake of HCB in the general population varies between 0.0004 and 0.003 μg/kg body weight. Owing to elimination of HCB in breast milk, intakes in nursing infants are estimated to range from < 0.018 to 5.1 μg/kg body weight per day.

Inappropriate manufacturing and waste management practices may expose nearby populations to higher HCB concentrations than the general population. Exposure to HCB may be elevated in some indigenous subsistence populations consuming food species near the top of the food chain.

Workers in some industries may be exposed to higher levels of HCB than the general population, particularly those involved in the manufacture of chlorinated solvents and in the manufacture and application of chlorinated pesticides contaminated with HCB.

2.2 Environmental fate

HCB is widely distributed in the environment by virtue of its chemical stability and mobility (subject to long-range aerial transport). Slow photodegradation of airborne HCB occurs with a half-life of 80 days, and slow microbial degradation of HCB does take place (half-life of several years). It is a bioaccumulative substance, and biomagnification of HCB through the food chain has been reported.

2.3 Kinetics and metabolism

There is a lack of toxicokinetic information for humans. HCB is readily absorbed by the oral route but only poorly through the skin in experimental animals, and it undergoes limited metabolism to pentachlorophenol, tetrachlorohydroquinone and pentachlorothiophenol, which are excreted in the urine. Elimination half-lives for HCB range from about one month in rats and rabbits to two or three years in monkeys. In animals and humans HCB accumulates in lipid-rich tissues such as adipose, adrenal cortex, bone marrow, skin and some endocrine tissues. It can be transferred to offspring both by placental transfer and via breast milk.

2.4 Effects on animals and *in vitro* test systems

The toxicity of HCB after a single oral dose to experimental animals is low; LD_{50} values between 1000 and 10 000 mg/kg body weight have been reported. Reported LC_{50} values for inhalation exposures range from 1600 mg/kg body weight in the cat to 4000 mg/kg body weight in the mouse. Lethal doses elicit convulsions, tremors, weakness, ataxia, paralysis, and pathological changes in several organs.

In experimental animals, HCB is not a skin or eye irritant and did not sensitize the guinea-pig.

The effects of short-term repeated exposure to HCB are primarily hepatotoxic and neurological. The pathway for the synthesis of haem appears to be a major target of HCB toxicity. Porphyria has been reported in rats after short-term and long-term exposures between 2.5 and 15 mg HCB/kg body weight per day. Excretion of coproporphyrins was increased in pigs that ingested 0.5 mg HCB/kg body weight per day. Repeated exposure to HCB can also affect a wide range of organ systems, but such effects occur less frequently and usually at higher doses than porphyria. HCB is a mixed cytochrome P-450-inducing compound and is known to bind to the Ah receptor.

Other non-neoplastic effects of HCB exposure include reproductive, developmental and immunological. Oral exposure of monkeys for 90 days to 0.1 mg HCB/kg body weight per day affected the ultrastructure of the surface germinal epithelium and the primordial germ cells. Male reproductive effects were observed in monkeys at much higher doses (between 30 and 221 mg HCB/kg body weight per day). The offspring of mink with chronic exposure to about 0.16 mg HCB/kg body weight per day had reduced birth weights and increased mortality before weaning. Neurobehavioural development of rat pups was affected by *in utero* exposure to HCB at oral maternal doses of 0.64 to 2.5 mg/kg body weight per day. HCB adversely affects the immune system in rats, mice and monkeys. In mice immunosuppression was noted with an oral dose of 0.6 mg HCB/kg body weight per day for 3 to 18 weeks. When exposed *in utero* and through nursing to maternal doses of 0.5 and 5 mg HCB/kg body weight per day, mice showed severe depression of the delayed-type hypersensitivity response to a contact allergen. In rats immunostimulating effects were seen at oral doses of about 0.2 mg HCB/kg body weight per day.

SUMMARY AND EVALUATION

In long-term studies, mild histopathological changes and enzyme induction occurred in the liver in several studies in rats at dose levels between 0.25 and 0.6 mg HCB/kg body weight per day; the no-observed-effect levels (NOELs) in these studies were 0.05 to 0.07 mg HCB/kg body weight per day. Calcium homoeostasis and bone morphometry were affected in subchronic studies in rats at 0.7 mg HCB/kg body weight per day, but not at 0.07 mg/kg body weight per day.

In summary, with respect to non-neoplastic effects of HCB after repeated exposures, a wide range of effects in several species of animals, with similar lowest-observed-effect levels (LOELs) and NOELs for a number of end-points, have been reported. These effects include hepatotoxicity in pigs and rats, calcium metabolism in rats, ovarian histopathology in monkeys, immune function in rats and mice and neurotoxicity in mink and rats. The range over which the various effects have been observed is quite narrow; the lowest LOELs range from 0.1 to 0.7 mg/kg body weight per day, while the lowest NOELs range from 0.05 to 0.07 mg/kg body weight per day.

HCB has little capability to directly induce gene mutation, chromosomal damage and DNA repair. It exhibited weak mutagenic activity in a small number of the available studies on bacteria and yeast, although it should be noted that each of these studies had limitations. There is also some evidence of low-level binding to DNA *in vitro* and *in vivo*, but at levels that were all below those expected for genotoxic carcinogens.

Based on the induction of a variety of tumours in hamsters, rats and mice exposed by ingestion, there is sufficient evidence that HCB is carcinogenic in experimental animals. In a two-generation study in rats where animals were exposed to a combination of *in utero*, lactational and direct oral ingestion from food for 130 weeks *post-utero*, there were increased incidences of neoplastic nodules and adrenal phaeochromocytomas in females and of parathyroid adenomas in males at the highest average daily doses (1.5 mg HCB/kg body weight per day in males and 1.9 mg/kg body weight per day in females).

The available evidence indicates that HCB has little or no genotoxic activity, and is therefore unlikely to be a direct-acting (genotoxic) carcinogen.

However, tumours, some of which were malignant, have been induced in multiple species, at multiple sites, and in some instances at doses that were not overtly toxic in other respects and are within an order of magnitude of doses causing more subtle toxicological effects from chronic or subchronic exposure. Although there is some evidence to suggest that HCB may cause cancer by indirect mechanisms, the evidence is not definitive at this time and does not address all tumour sites.

2.5 Effects on humans

Available data on the effects of HCB in humans are limited principally to those concerning people exposed in an accidental poisoning incident that occurred in Turkey between 1955 and 1959. More than 600 cases of porphyria cutanea tarda (PCT) were observed, and infants of exposed mothers experienced cutaneous lesions, clinical symptoms and high mortality. It has been estimated that victims were exposed to 50-200 mg HCB/day for an undetermined, but extended, period of time. However, the basis for this estimate was not provided, making exposure calculations unreliable for this population. In this incident, disturbances in porphyrin metabolism, dermatological lesions, hyperpigmentation, hypertrichosis, enlarged liver, enlargement of the thyroid gland and lymph nodes, and (in roughly half the cases) osteoporosis or arthritis were observed, primarily in children. Breast-fed infants of mothers exposed to HCB in this incident developed a disorder called "pembe yara" ("pink sore"), and most died within a year. There is also some limited evidence that PCT occurs in humans exposed to relatively high levels of HCB in the workplace or in the general environment.

Studies of the carcinogenicity of HCB in humans are limited to two small epidemiological studies of cancer incidence in populations with poorly characterized exposures to HCB as well as to numerous other chemicals. No excesses of neoplasms have been reported in long-term follow-up studies of the people with porphyria in the incident in Turkey, but only a small fraction of the population was followed up, and these studies were not designed specifically to assess neoplastic end-points.

The available data on humans are inadequate to serve as a basis for assessment of effects from exposure to HCB. The development of health-based guidance values for the daily intake of HCB is based upon the evaluation of studies in animals.

2.6 Effects on organisms in the environment

HCB is widely distributed in the environment, by virtue of its mobility and resistance to degradation, although slow photodegradation in air (half-life of around 80 days) and microbial degradation (half-life of several years) do occur. It has been detected in air, water, sediment, soil and biota from around the world. HCB is a bioaccumulative substance (bioconcentration factors range from 375 to > 35 000), and biomagnification of HCB through the food chain has been reported.

In studies of the acute toxicity of HCB to aquatic organisms, exposure to concentrations in the range of 1 to 17 μg/litre reduced production of chlorophyll in algae and reproduction in ciliate protozoa. In longer-term studies, the growth of sensitive freshwater algae and protozoa was affected by a concentration of 1 μg/litre, while concentrations of approximately 3 μg/litre caused mortality in amphipods and liver necrosis in largemouth bass. The concentration of HCB in surface water around the world is much lower than these effect levels (3 to 5 orders of magnitude lower), except in a few extremely contaminated locales.

Injection studies in eggs have shown that tissue levels of 1500 ng/g wet weight (lowest dose tested) reduced embryo weights in herring gulls. No studies were available to establish a no-observed-adverse-effect level (NOAEL). For many bird species, reduced embryo weights are associated with lower survival of chicks. This effect level is within an order of magnitude of the levels measured in the eggs of sea birds and raptors from a number of locations from around the world, suggesting that present levels of HCB in certain locations may harm embryos of bird species.

SUMMARY AND EVALUATION

Experimental studies on mink indicate that they are sensitive to the toxic effects of HCB. Long-term ingestion of diets containing 1000 ng HCB/g (the lowest dose tested) increased mortality and decreased birth weights of offspring exposed *in utero* and via lactation, as well as altered levels of neurotransmitters in the hypothalamus of dams and their offspring. No studies were available to establish a NOAEL. This dietary effect level is only a few times higher than the concentrations of HCB measured in various species of fish from a number of industrialized locations from around the world, suggesting that present levels of HCB in fish species from certain locations may adversely affect mink and perhaps other fish-eating mammals.

3. CONCLUSIONS

3.1 Human health

Exposure of the general population to HCB occurs by consumption of food. Levels in drinking-water and ambient air are very low.

The total average daily intake of HCB in the general population varies between 0.0004 and 0.003 μg HCB/kg body weight per day. Intakes of nursing infants are estimated to range from <0.018 to 5.1 μg/kg body weight per day.

Animal studies have shown that HCB causes cancer and affects a wide range of organ systems, including the liver, lungs, kidneys, thyroid, reproductive tissues, nervous and immune systems.

Clinical toxicity, including porphyria cutanea tarda in children and adults, and mortality in nursing infants, has been observed in humans with high accidental exposures.

Available data on the effects of HCB exposure in experimental animals are sufficient to develop guidance values for daily exposure to HCB based on non-neoplastic and neoplastic effects.

For non-neoplastic effects, based on the lowest reported no-observed-effect level (0.05 mg HCB/kg body weight per day) for primarily hepatic effects observed at higher doses in studies on pigs and rats exposed by the oral route, and incorporating an uncertainty factor of 300 (x 10 for interspecies variation, x 10 for intraspecies variation, and x 3 for severity of effect), a tolerable daily intake of 0.17 μg/kg body weight per day has been derived.

CONCLUSIONS

The approach for neoplastic effects is based on the Tumorigenic Dose$_5$ (TD_5), i.e., the intake associated with a 5% excess incidence of tumours in experimental studies on animals. Based on the results of the two-generation carcinogenicity bioassay in rats, and using the multi-stage model, the TD_5 value is 0.81 mg/kg body weight per day for neoplastic nodules of the liver in females. Based on consideration of the insufficient mechanistic data, an uncertainty factor of 5000 was used to develop a health-based guidance value of 0.16 μg/kg body weight per day.

3.2 Environment

HCB is a persistent chemical, which bioaccumulates due to its lipid solubility and resistance to breakdown.

The number of experimental studies on which an environmental risk assessment can be made is small. Levels of HCB in surface waters are generally several orders of magnitude lower than those expected to present a hazard to aquatic organisms, except in a few extremely contaminated localities. However, HCB concentrations in the eggs of sea birds and raptors from a number of locations from around the world approach those associated with reduced embryo weights in herring gulls (1500 ng/g), suggesting that it has the potential to harm embryos of sensitive bird species. Similarly, levels of HCB in fish at a number of sites worldwide are within an order of magnitude of the dietary level of 1000 ng/g associated with reduced birth weights and increased mortality of weaning in mink. This suggests that HCB has the potential to adversely affect mink and perhaps other fish-eating mammals.

4. HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY RESPONSE

4.1 Human health hazards, prevention and protection, first aid

The human health hazards associated with exposure to HCB, preventive and protective measures, and first aid measures are indicated in the Summary of Chemical Safety Information in Section 6.

HCB is harmful by dust inhalation or if swallowed. Occupational exposure to HCB and dietary intake of contaminated food or water are the chief circumstances where intoxication occur.

HCB may cause a slight irritation to eyes, skin and mucous membranes. Inhalation results in irritation of the respiratory tract.

The central nervous system toxicity is low. Ingestion of large amounts of HCB may cause headache, dizziness, nausea, vomiting, numbness of hands and arms, apprehension, partial paralysis of extremities, coma and seizures.

Prolonged periods of ingestion may cause porphyria cutanea tarda, where blistering and epidermolysis of the unusually light-sensitive skin occurs (Hayes & Laws, 1991). Pigmented scars, contractures, alopecia, hirsutism, arthritis, osteomyelitis, anorexia, weight loss and muscle atrophy can be features of the syndrome. Hepatomegaly and thyroid enlargement have been observed. The mortality can be as high as 10%. Long-term sequelae are hyperpigmentation, hirsutism, scarring of hands and face, fragile skin, enlarged liver and persistent active porphyria.

Infants may develop the syndrome of "pink sore" when exposed to HCB-contaminated breast milk and transplacental transfer. It carries a high mortality (95%). Diarrhoea, fever, papules on the back of hands, infiltration of the lungs, subcutaneous abscesses, severe hypochromic anaemia and leukocytosis occur.

HCB is carcinogenic in animals and causes hepatomas, hepatocellular carcinomas, bile duct adenomas, parathyroid adenomas, phaeochromocytomas and renal cell adenomas. No excess cancer was reported in two follow-up studies of affected humans.

4.2 Advice to physicians

4.2.1 *Decontamination*

In cases of exposure after inhalation, the victim should be moved to fresh air. Contaminated clothing and shoes should be removed and isolated at the site. Eyes or skin should be flushed with running water for at least 15 min after exposure. Skin, including hair and nails, should be washed vigorously. Leather absorbs pesticides and hence should not be worn.

4.2.2 *Prevention of absorption after oral exposure*

Emesis is not recommended. Gastric lavage may be indicated if it can be performed soon after ingestion. The airways must be protected at all times. Activated charcoal should be administered. A saline cathartic given orally may reduce absorption. Oils should not be given by mouth as this tends to increase intestinal absorption of the lipophilic chemical.

4.2.3 *Treatment*

This is mainly symptomatic and supportive. Chelating agents such as sodium-calcium-EDTA may enhance excretion of porphyrins in the urine. The faecal excretion might be increased by oral administration of cholestyramine. Avoidance of sunlight reduces the development of photo-sensitive skin eruptions. Haemodialysis, haemoperfusion or exchange transfusion have not been shown to be effective.

Inhalation exposure might make assisted ventilation and administration of humidified oxygen necessary. When HCB is heated to decomposition, the toxic fumes produced may result in pulmonary oedema.

4.3 Health surveillance advice

Where exposure to pure HCB is possible, preplacement and regular medical examinations should be performed.

4.4 Explosion and fire hazards, prevention

4.4.1 *Explosion and fire hazards*

There is a slight fire potential when HCB is exposed to heat or flame. Fire may produce irritating or poisonous gases.

4.4.2 *Prevention*

HCB should be kept away from open flames and there should be no smoking.

4.4.3 *Fire-extinguishing agents*

Fires involving HCB may be extinguished with dry chemical, CO_2, Halon, water spray or standard foam.

4.5 Storage

HCB must be stored separate from food and feedstuffs, in a cool, dry place.

4.6 Transport

HCB may be shipped via air, rail, road or water in containers bearing the label "Keep away from food".

4.7 Spillage

Small spills of HCB may be taken up with sand or other non-combustible material and placed into containers for later disposal as indicated by local and national regulations. Large spills should first be dyked far ahead of the spill, dampened to avoid dust, and then transferred to suitable containers. An appropriate respirator with adequate eye protection should be worn for these operations.

5. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION

HCB is released to the environment as a by-product from the manufacture of chlorinated solvents, chlorinated aromatics and pesticides, and in emissions from incinerators and other industrial processes. It is subject to long-range transport and thus may be deposited far from known sources. Therefore, HCB can be found worldwide in measurable concentrations in various media to which humans and other organisms may be exposed.

HCB is a persistent substance widely dispersed throughout the environment. It accumulates in aquatic sediments and is subject to biomagnification. This suggests that benthic biota and those of higher tropic levels (e.g., predatory birds and fish-eating mammals) are the most likely to be exposed to higher concentrations of HCB and to be at greater risk from adverse effects on reproduction and development and cancer.

6. SUMMARY OF CHEMICAL SAFETY INFORMATION

The material in this section is adopted from the IPCS International Chemical Safety Card number 895. This card should be easily available to all health workers concerned with, and users of, hexachlorobenzene. It should be displayed at, or near, entrances to areas where there is potential exposure to hexachlorobenzene and on processing equipment with containers. The card should be translated into the appropriate language(s). All persons potentially exposed to the chemical should also have the instructions on the chemical safety card clearly explained.

SUMMARY OF CHEMICAL SAFETY INFORMATION

HEXACHLOROBENZENE
C_6Cl_6

PHYSICAL PROPERTIES		OTHER CHARACTERISTICS
Boiling point (°C)	323-326	Hexachlorobenzene is a colourless to white solid in various forms. The substance decomposes on heating producing toxic fumes; it reacts violently with dimethyl formamide above 65 °C.
Melting point (°C)	231	
Relative density (water =1)	2.04	
Solubility in water	None	
Vapour pressure (kPa at 114 °C)	0.133	
Vapour pressure (Pa at 20 °C)	0.1	
Relative vapour density (air = 1)	9.8	
Flash point (°C)	242	
Octanol/water partition coefficient (low P_{ow})	6.2	

HAZARDS/SYMPTOMS	PREVENTION AND PROTECTION	FIRST AID
SKIN: may cause slight irritation and be absorbed	Protective gloves and clothing	Remove contaminated clothing. Rinse and then wash skin with water and soap. Refer for medical attention. Wear protective gloves when administering first aid.
EYES: slight irritation	Face shield or eye protection in combination with breathing protection	First rinse with plenty of water for at least 15 min (remove contact lenses if easily possible), then take to a doctor.

INHALATION	Local exhaust or breathing protection	Fresh air and rest. If patient is not breathing, give artificial respiration; if breathing is difficult, give oxygen. Refer for medical attention.
INGESTION	Do not eat, drink or smoke during work.	Rinse mouth. If victim is conscious, use gastric lavage to clean out stomach followed by saline catharsis. If unconscious or having convulsions, do nothing except keep victim warm. Refer for medical attention.
SPILLAGE	STORAGE	FIRE AND EXPLOSION
Sweep spilled substance into containers. Carefully collect remainder, then remove to safe place. Do NOT let this chemical enter the environment	Separated from food and feedstuffs Cool, dry environment	Hexachlorobenzene is slightly combustible; avoid heat or open flames. Fires involving hexachlorobenzene may be extinguished with dry chemical, CO_2, Halon, water spray or standard foam.
PACKAGING AND LABELLING		
May be shipped via air, rail, road and water in containers bearing the label "Keep away from food"		

7. CURRENT REGULATIONS, GUIDELINES AND STANDARDS

7.1 Occupational exposure limits

Examples of occupational exposure limit values are given in Table 2. Some guidance values and standards for HCB in other environmental media are given in Table 3.

Table 2. Representative occupational exposure values for hexachlorobenzene

Country	Exposure limit value[a] (mg/m^3)	Effective date[b]
Czech Republic	1 (TWA)	1991[R]
Commonwealth of Independent States (former USSR)	0.9 (STEL)	1991[R]
USA (ACGIH)	0.25 (TWA)	1994

[a] TWA = time-weighted average (8 or 10 h shift); STEL = short-term exposure limit (15 min) not to be exceeded at any time during a shift.
[b] R = effective date of ILO publication.

Table 3. Guidelines and standards for non-occupational exposure

Country/organization	Environmental medium	Value
Canada	surface water	6.5 ng/litre
USA	drinking-water	1 μg/litre
WHO	drinking-water	1 μg/litre

7. CURRENT REGULATIONS, GUIDELINES AND STANDARDS

7.2 Specific restrictions

HCB is banned in Austria, Czech Republic, the European Union, Hungary, Liechtenstein, Panama, Switzerland, Turkey and the former USSR. It is severely restricted or has been voluntarily withdrawn in Argentina, New Zealand, Norway and Sweden.

7.3 Labelling, packaging and transport

HCB may be shipped via air, rail, road or water in containers bearing the label "Keep away from food". Internationally, HCB is classed as a poisonous (toxic) substance (UN number 2729 and packing group III, i.e., low risk of poisoning).

7.4 Waste disposal

Disposal methods are incineration, deep-well injection and landfill as required by local and national regulations. Incineration is most effective at 1300 °C for 0.25 seconds.

BIBLIOGRAPHY

BUA (German Chemical Society-Advisory Committee on Existing Chemicals of Environmental Relevance) (1994) Hexachlorobenzene. Stuttgart, S. Hirzel Wissenschaftliche Verlagsgesellschaft, 257 pp (BUA Report 119).

Canadian Environmental Protection Act (CEPA) (1993) Priority substances list assessment report on hexachlorobenzene, Ottawa, Canada, Government of Canada, 52 pp.

Hayes WJ & Laws ER (1991) Handbook of pesticides toxicology. New York, London, Academic Press, vol. III, pp 1422-1433.

IARC (1985) In: Morris CR & Cabral JRP ed. Hexachlorobenzene: Proceedings of an international symposium. Lyon, International Agency for Research on Cancer, 691 pp (IARC Scientific Publications No. 77).

IPCS (1997) Environmental Health Criteria 195: Hexachlorobenzene. Geneva, World Health Organization, International Programme on Chemical Safety.

IRPTC (1993) Legal File. Geneva, United Nations Environment Programme, International Register of Potentially Toxic Chemicals.

Mackay D, Shiu WY, & Ma KC (1992) Illustrated handbook of physical-chemical properties and environmental fate for organic chemicals - Vol. 1: Monoaromatic hydrocarbons, chlorobenzenes and PCBs. Chelsea, Michigan, Lewis Publishers.

Other HEALTH AND SAFETY GUIDES available:
(continued from inside front cover)

Phenol (No. 88, 1995)
d-Phenothrin (No. 32, 1989)
Phosgene (No. 106, 1998)
Phosphine (No. 28, 1989)
Phosphorus trichloride and phosphorus oxychloride (No. 35, 1989)
Polybrominated biphenyls (PBBs) (No. 83, 1993)
Polychlorinated biphenyls and polychlorinated terphenyls (PCBs and PCTs) (No. 68, 1992)
Propachlor (No. 77, 1992)
Propylene oxide (No. 15, 1988)
Pyrrolizidine alkaloids (No. 26, 1988)
Quintozene (No. 23, 1988)
Resmethrins (No. 25, 1989)
Rotenone (No. 73, 1992)
Tecnazene (No. 12, 1988)
Tetrachloroethylene (No. 10, 1987)
Tetradifon (No. 11, 1987)
Tetramethrin (No. 31, 1989)
Thallium and Thallium compounds (No. 102, 1997)
Tri-allate (No. 89, 1994)
Trichlorfon (No. 66, 1991)
Trimellitic anhydride (No. 71, 1992)
Vanadium (No. 42, 1990)
Vinylidene chloride (No. 36, 1989)
Warfarin (No. 96, 1995)
White Spirit (Stoddard solvent) (No. 103, 1997)

To obtain further copies of monographs in this series, or the Users' Manual for the IPCS Health and Safety Guides, please write to the Office of Distribution and Sales, World Health Organization, 1211 Geneva 27, Switzerland (Fax No: 4122 7914857; E-mail: publications@who.ch

Price: Sw. fr. 5.-
Price in developing countries: Sw. fr. 3.50

ISBN 92 4 151107 9