diphenyl (54%) are 1 mg/m³ and 0.5 mg/m³ respectively.

ROUTES OF ENTRY

Inhalation of fume or vapor and percutaneous absorption of liquid.

HARMFUL EFFECTS

Local—

Prolonged skin contact with its fumes or cold wax may cause the formation of comedones, sebaceous cysts, and pustules, known as chloracne. Irritation to eyes, nose, and throat may also occur. The above standards are considered low enough to prevent systemic effects, but it is not known whether or not these levels will prevent local effects.

Systemic—

Generally, toxic effects are dependent upon the degree of chlorination; the higher the degree of substitution, the stronger the effects. Acute and chronic exposure can cause liver damage. Signs and symptoms include edema, jaundice, vomiting, anorexia, nausea, abdominal pains, and fatigue.

Studies of accidental oral intake indicate that chlorinated diphenyls are embryotoxic, causing stillbirth, a characteristic grey-brown skin, and increased eye discharge in infants born to women exposed during pregnancy.

MEDICAL SURVEILLANCE

Placement and periodic examinations should include an evaluation of the skin, lung, and liver function. Possible effects on the fetus should be considered.

SPECIAL TESTS

None in common use.

PERSONAL PROTECTIVE METHODS

Protection of exposed skin should be encouraged, since the above standards may not be low enough to prevent chloracne. Barrier creams, protective clothing, and good personal hygiene are good protective measures. Respirators should be used in areas of vapor concentration.

BIBLIOGRAPHY

Meigs, J. W., J. J. Albom, and B. L. Kartin. 1954. Chloracne from an unusual exposure to arochlor. J. Am. Med. Assoc. 154:1417.

Peakall, D. B. 1972. Polychlorinated diphenyls: occurrence and biological effects. Residue Rev. 44:1.

CHLORINATED BENZENES

DESCRIPTION

Chlorinated benzenes are aromatic rings with one or more chlorines substituted for a hydrogen. Included in this group are:

Chlorobenzene: phenyl chloride, monochlorobenzene, chlorobenzol.
o-dichlorobenzene: 1,2-dichlorobenzene
m-dichlorobenzene: 1,3-dichlorobenzene.
p-dichlorobenzene: 1,4-dichlorobenzene.
1,2,3-trichlorobenzene: None.
1,2,4-trichlorobenzene: None.
1,3,5-trichlorobenzene: None.
1,2,4,5-tetrachlorobenzene: None.
Hexachlorobenzene: perchlorobenzene.

Compounds with only a few chlorines are usually colorless liquids at room temperature and have an aromatic odor. The more highly substituted compounds are crystals (typically monoclinic).

SYNONYMS

None.

POTENTIAL OCCUPATIONAL EXPOSURES

Chlorobenzene is used as a solvent and as an intermediate in dyestuffs. o-Dichlorobenzene is used as a solvent, fumigant, insecticide, and chemical intermediate. p-Dichlorobenzene finds use as an insecticide, chemical intermediate, disinfectant and moth preventative. Other chlorinated benzenes are not as widely used in industry but find use as chemical intermediates, and to an even lesser extent, as insecticides and solvents.

A partial list of occupations in which exposure may occur includes:

Cellulose acetate workers	Insecticide makers and workers
Deodorant makers	Lacquer workers
Disinfectant workers	Organic chemical synthesizers
Dyers	Paint workers
Dye makers	Resin makers
Fumigant workers	Seed disinfectors

PERMISSIBLE EXPOSURE LIMITS

The Federal standards are:

chlorobenzene	75 ppm	350 mg m³
o-dichlorobenzene	50 ppm	300 mg m³
p-dichlorobenzene	75 ppm	450 mg m³

Threshold limit values for the other compounds have not as yet been established.

ROUTES OF ENTRY

Inhalation of vapor, percutaneous absorption of the liquid.

HARMFUL EFFECTS

Local—

Chlorinated benzenes are irritating to the skin, conjunctiva, and

PCB-ARCH-EXT0375827

mucous membranes of the upper respiratory tract. Prolonged or repeated contact with liquid chlorinated benzenes may cause skin burns.

Systemic—

In contrast to aliphatic halogenated hydrocarbons, the toxicity of chlorinated benzenes generally decreases as the number of substituted chlorine atoms increases. Basically, acute exposure to these compounds may cause drowsiness, incoordination, and unconsciousness. Animal exposures have produced liver damage.

Chronic exposure may result in liver, kidney, and lung damage as indicated by animal experiments.

MEDICAL SURVEILLANCE

Preplacement and periodic examinations should consider skin, liver, lung, and kidney.

SPECIAL TESTS

None commonly used. Urinary excretion of 2,5-dichlorophenol may be useful as an index of exposure.

PERSONAL PROTECTIVE METHODS

Barrier creams, protective clothing, and good personal hygiene are good preventive measures. Respirators in areas of vapor concentrations are advised.

BIBLIOGRAPHY

Brown, V. K. H., C. Muir, and E. Thorpe. 1969. The acute toxicity and skin irritant properties of 1,2,4-trichlorobenzene. Ann. Occup. Hyg. 12:209.

Girard, R., F. Tolot, P. Martin, and J. Bourret. 1969. Hemopathies graves et exposition a des derives chlores du benzene (a propos de 7 cas). J. Med. Lyon 50:771.

Hollingsworth, R. L., V. K. Rowe, F. Oyen, T. R. Tokelson, and E. M. Adams. 1956. Toxicity of o-dichlorobenzene. Studies on animals and industrial experience. AMA Arch. Ind. Health 17:180.

Pagnotto, L. D., and J. E. Walkley. 1965. Urinary dichlorophenol as an index of paradichlorobenzene exposure. Am. Ind. Hyg. Assoc. J. 26:137.

Tolot, F., B. Soubrier, J. R. Bresson, and P. Martin. 1969. Myelose proliferative devoultion rapide. Role etiologique possible des derives chlores du benzene. J. Med. Lyon 50:761.

Varshavskaya, S. P. 1968. Comparative toxicological characteristics of chlorobenzene and dichlorobenzene (ortho- and para-isomers) in relation to the sanitary protection of water bodies. Hyg. Sanit. 33:17.

CHLORINATED NAPHTHALENES

DESCRIPTION

$C_{10}H_{8-x}Cl_x$, the chlorinated naphthalenes, are naphthalenes in which one or more hydrogen atoms have been replaced by chlorine to form wax-like substances, beginning with monochloronaphthalene and going on to the octochlor derivatives. Their physical states vary from mobile liquids to waxy-solids depending on the degree of chlorination.

SYNONYMS

Chloronaphthalenes

POTENTIAL OCCUPATIONAL EXPOSURES

Industrial exposure from individual chlorinated naphthalenes is rarely encountered; rather it usually occurs from mixtures of two or more chlorinated naphthalenes. Due to their stability, thermoplasticity, and nonflammability, these compounds enjoy wide industrial application. These compounds are used in the production of electric condensers, in the insulation of electric cables and wires, as additives to extreme pressure lubricants, as supports for storage batteries, and as a coating in foundry use.

A partial list of occupations in which exposure may occur includes:

Cable coaters	Rubber workers
Condenser impregnators	Solvent workers
Electric equipment makers	Transformer workers
Insecticide workers	Wire coaters
Petroleum refinery workers	Wood preservers
Plasticizer makers	

PERMISSIBLE EXPOSURE LIMITS

The Federal standards are:

Trichloronaphthalene	5.0 mg/m³	Set I
Tetrachloronaphthalene	2 mg/m³	Set I
Pentachloronaphthalene	0.5 mg/m³	Set G
Hexachloronaphthalene	0.2 mg/m³	Set H

ROUTES OF ENTRY

Inhalation of fumes and percutaneous absorption of liquid.

HARMFUL EFFECTS

Local—

Chronic exposure to chlorinated naphthalenes can cause chloracne, which consists of simple erythematous eruptions with pustules, papules, and comedones. Cysts may develop due to plugging of the sebaceous gland orifices.

Systemic—

Cases of systemic poisoning are few in number and they may occur without the development of chloracne.

It is believed that chloracne develops from skin contact and inhalation of fumes, while systemic effects result primarily from inhalation of fumes. Symptoms of poisoning may include headaches, fatigue, vertigo, and anorexia. Jaundice may occur from liver damage. Highly chlorinated naphthalenes seem to be more toxic than those chlorinated naphthalenes with a lower degree of substitution.

PCB-ARCH-EXT0375828

MEDICAL SURVEILLANCE

Preplacement and periodic examinations should be concerned particularly with skin lesions such as chloracne and with liver function.

SPECIAL TESTS

None are in common use.

PERSONAL PROTECTIVE METHODS

Skin contact should be avoided whenever possible. Barrier creams, protective clothing, and good personal hygiene are all good preventive measures. Use of respirators in areas of vapor concentration is advised.

BIBLIOGRAPHY

Kleinfeld, M., J. Messite, R. Swencicki. 1972. Clinical effects of chlorinated naphthalene exposure. J. Occup. Med. 14:377.

Mayers, M. R., and M. G. Silverberg. 1938. Effects upon the skin due to exposure to some chlorinated hydrocarbons. Ind. Bull. N.Y. State Dep. Labor. 17:358 and 425.

Mayers, M. R. and A. R. Smith. 1942. Systemic effects from exposure to certain chlorinated hydrocarbons. Ind. Bull. N. Y. State Dep. Labor 21:30.

AROMATIC AMINES

The aromatic amines are aromatic hydrocarbons in which at least one hydrogen atom has been replaced by an amino ($-NH_2$) group. The hydrogen atoms in the amino group may be replaced by aryl or alkyl groups, giving rise to secondary and tertiary amino compounds. The aromatic amines are infrequently formed in nature although they do occur, e.g., anthranilic acid esters in grapes. They are generally synthesized by nitration of the aromatic hydrocarbon with subsequent reduction to the amine; an alternate method is by reaction of ammonia and a chloro- or hydroxy-hydrocarbon. Their most important uses are as intermediates in the manufacture of dyestuffs and pigments; however, they are also used in the chemical, textile, rubber, dyeing, paper, and other industries.

Most of the aromatic amines in the free base form are readily absorbed through the skin in addition to the respiratory route. The amino salts have a lower lipid solubility and, therefore, a lower amount of skin absorption. The two major toxic effects of these compounds are methemoglobinemia and cancer of the urinary tract. Other effects may be hematuria, cystitis, anemia, and skin sensitization.

Several of the aromatic amines have been shown to be carcinogenic in humans or animals or both. Occupational tumors of the bladder were recognized in the dyestuff industry as early as 1895. The most common site of cancer is the bladder, but cancer of the pelvis, ureter, kidney, and urethra do occur. It is thought that bladder cancer results from the presence of an active metabolite(s) of the amino compound in the urine, which acts on the bladder epithelium. Several of these metabolites have been identified and have been shown to have carcinogenic properties by implantation in mouse bladders. Man and the dog seem to be more susceptible to bladder tumors, suggesting a similarity in metabolism of the aromatic amino compounds.

The minimum exposure which produces cancer is not known. There are documented cases of tumors with exposures of less than one year; however, the latent period from first exposure to the development of tumors is usually long and ranges from 4 to over 40 years, with a mean of about 20 years. Bladder tumors are also relatively common in unexposed populations, and the incidence is considerably increased in heavy smokers. They are more common in older age males. It is unknown whether smoking plus exposure to a bladder carcinogen would be synergistic, but this seems possible, e.g., asbestos and smoking.

Clinically, occupationally induced bladder tumors are indistinguishable from those found in the general population; however, they generally occur at an earlier age than usual. These tumors may range from the extremes of benign papillomas to infiltrating carcinomas. Severe or fatal complications which may arise from papillomas are local spreading tumors, severe hemorrhage, and infection of the bladder and kidney.

Hematuria often does not appear until the tumor(s) is inoperable. Micro-examination of the urine is not specific, but routine cystoscopy is a reliable indicator of tumors at an early stage. Exfoliative cytology of urinary sediment using the stained smear method of Papanicolau permits early differentiation of malignant neoplasms and benign papillomas from normal tissue. Those individuals who give a positive test should be examined by cystoscopy and followed indefinitely. Renal pelvis, ureteric, and urethral tumors can also be detected by cytodiagnosis.

Because there may be significant skin absorption of the aromatic amines, protective clothing and polyvinyl chloride or rubber gloves should be worn, and there should be adequate wash and change facilities. Workers exposed to carcinogens should have a complete change of work clothes in addition to protective clothing. The recommended means of control of carcinogenic compounds is by engineering methods aimed at zero exposure levels and a program of periodic medical surveillance.

BIBLIOGRAPHY

Case, R. A. M., M. E. Hosker, D. B. McDonald, and J. T. Pearson. 1954. Tumors of the urinary bladder in workmen engaged in the manufacture and use of certain dyestuff intermediates in the British chemical industry. Part I. The role of aniline, benzidine, alpha-naphthylamine, and beta-naphthylamine. Brit. J. Ind. Med. 11:75.

Rye, W. A., P. F. Woolrich, and R. P. Zanes. 1970. Facts and myths concerning aromatic diamine curing agents. J. Occup. Med. 12:211.

Scott, T. S. 1962. Carcinogenic and Chronic Toxic Hazard of Aromatic Amines. Elsevier Publishing Company, New York.

Weisburger, J. H., P. H. Grantham, E. Vanhorn, N. H. Steigbigel, D. P. Rall, and E. K. Weisburger. 1964. Activation and detoxification of N-2-fluorenylacetamide in man. Cancer Res. 24:475.

2-ACETYLAMINOFLUORENE

DESCRIPTION

$CCH_3C_6H_3C_6H_3NHCOCH_3$. 2-Acetylaminofluorene, is a tan crystalline solid.

PCB-ARCH-EXT0375829