

## Code of Practice H: Carcinogens

### 1. Chemical Carcinogens and Mutagens: Rules and Usage Guidance Notes

Information regarding the potential for materials to act as carcinogens can be found in the Hazard Statements: such materials are classified as H340, H341, H350, H351, H360, H361 *etc.*

Identification of chemical carcinogens causing cancer in man has been slow because there is a time-lag; exposure of young persons must be taken particularly seriously. Extra care is needed to avoid exposure of women who are pregnant, or liable to become pregnant, because in a number of cases the foetus has been shown to be especially sensitive to harmful substances ingested or inhaled by the mother. There is now a wide measure of overlap between carcinogens and mutagens (agents that cause inherited changes in the genetic message) and, to a lesser extent, with teratogens (agents that act early in pregnancy to cause malformations of the developing foetus).

Chemicals differ very greatly in carcinogenic potency, and there is no clear dividing line between very weak carcinogens, in which it is very difficult to establish activity with certainty, and non-carcinogens. Thus, expressed as daily dose per kilogramme of body weight to induce tumours in 50% of test cases, the carcinogenic dose of aflatoxin B<sub>1</sub> (a fungal metabolite) is about 1 mg, the dose of 2-naphthylamine (a human occupational carcinogen) is about 10 mg and the dose of the weakest (doubtful) agents, such as saccharin, approaches 10 g. Some chemicals have a weak potency and can be handled without significant risk so long as the usual rules of laboratory hygiene are observed. Others are very potent and should only be used, if at all, with strict precautions in special accommodation.

Besides actual potency, factors affecting the degree of hazard are the volatility of the substance, whether it forms a fine dust, its ease of being absorbed through the lungs, mouth or skin, and the duration and severity of exposure.

Please note the following guidance:

- (a) The use of high-risk chemical carcinogens that are not formally prohibited should be avoided wherever possible. If they must be used, the most stringent conditions must be applied to their acquisition, storage, use and disposal. They must be handled and used in such a way as to prevent entry of the carcinogens into the body of the researcher or of anyone else by any route.
- (b) When using materials that are known or suspected carcinogens or mutagens a specific risk assessment **must** be made in the worker's laboratory notebook and counter signed by the supervisor. This assessment should include detailed information regarding the handling, uses and disposal procedures for the material. The following list covers many known or suspected carcinogens, but there is no definitive list. Manufacturers and suppliers have a legal duty to provide and maintain material safety data sheets (MSDS) for chemicals which they supply. *Up-to-date MSDS should be consulted to check for whether chemicals to be used have been identified as suspected carcinogens.* New materials prepared during the course of research should also be considered.

- (c) The need to avoid the use of benzene and carbon tetrachloride should be noted particularly. Formaldehyde shows mutagenic activity but there is no published work showing it to be carcinogenic. However, it would be prudent to minimise inhalation of formaldehyde fumes and to avoid its interaction, even in small concentrations, with hydrogen chloride. The product bis(chloromethyl)ether is a human carcinogen with high risk potential.
  
- (d) **Any work involving carcinogenic, mutagenic or teratogenic materials should be subject to a separate risk assessment.**

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6 September 2019

(Review date: 6 September 2020)

**A**

A-alpha-C (2-Amino-9H-pyrido[2,3-b]indole)  
 Acetaldehyde  
 Acetamide  
 Acetochlor  
 2-Acetylaminofluorene  
 Acifluorfen  
 Acrolein  
 Acrylamide  
 Acrylonitrile  
 Actinomycin D  
 Adriamycin (Doxorubicin hydrochloride)  
 AF-2;[2-(2-furyl)-3-(5-nitro-2-furyl)]acrylamide  
 Aflatoxins  
 Agaritine  
 Alachlor  
 Alcidine  
 Aldrin  
 Allyl chloride  
 Allyl glycidyl ether  
 Allyl isothiocyanate  
 Allyl isovalerate  
 Aluminium products  
 2-Aminoanthraquinone  
 p-Aminoazobenzene  
 o-Aminoazotoluene [solvent yellow 3]  
 4-Aminobiphenyl (4-aminodiphenyl)  
 3-Amino-9-ethylcarbazole hydrochloride  
 1-Amino-2-methylantraquinone  
 Amitrole  
 Ammonium dichromate  
 Analgesic mixtures containing phenacetin  
 Androgenic (anabolic) steroids  
 Aniline (and homologs)  
 ortho-Anisidine  
 ortho-Anisidine hydrochloride  
 para-anisidine  
 anthanthrene  
 Antimony oxide (antimony trioxide)  
 Aramite  
 Arsenic (inorganic arsenic compounds)  
 Arsine  
 Asbestos  
 Auramine  
 Azaserine  
 Azathioprine  
 Azacitidine  
 Azobenzene  
 Azathioprine

**B**

Benz[a]anthracene  
 Benzene

Benzidine [and its salts]  
 Benzidine-based dyes  
 Benzo[b]fluoranthene  
 Benzo[j]fluoranthene  
 Benzo[k]fluoranthene  
 Benzofuran  
 Benzo[a]pyrene  
 Benzotrichloride  
 Benzyl chloride  
 Benzyl violet 4B  
 Beryllium and beryllium compounds  
 Bis(2-chloroethyl)ether  
 N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornapazine)  
 Bischloroethyl nitrosourea (BCNU) (Carmustine)  
 Bis(chloromethyl)ether and technical-grade chloromethyl methyl ether  
 Bitumens, extracts of steam-refined and air refined  
 Bleomycins  
 Bracken fern  
 Bromodichloromethane  
 2-bromoethyl ether  
 Bromoform  
 1,3-Butadiene  
 1,4-Butanediol dimethanesulfonate (Busulfan, myleran)  
 Butylated hydroxyanisole (BHA)  
 t-butyl methyl ether  
 beta-Butyrolactone

**C**

Cadmium and cadmium compounds  
 Caffeic acid  
 Captafol  
 Captan  
 Carbazole  
 Carbon tetrachloride  
 Carbon-black extracts  
 Carrageenan, degraded  
 Ceramic fibers (airborne particles of respirable size)  
 Chlorambucil  
 Chloramphenicol  
 chlorbenzilat  
 Chlordane  
 Chlordecone (Kepone)  
 Chlordimeform  
 Chlorendic acid  
 Chlorinated camphene  
 Chlorinated Paraffins  
 alpha-Chlorinated toluenes  
 Chlormadinone aceate  
 Chlornaphazine[n,n-bis(2-chloroethyl)-2-naphthylamine]  
 Chlorodibromomethane  
 Chloroethane (ethyl chloride)

p-Chloroaniline  
 Chlorodiphenyl (chlorinated biphenyls)  
 1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU) (Lomustine)  
 1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)  
 Chloroform  
 bis(Chloromethyl) ether  
 Chloromethyl methyl ether  
 3-Chloro-2-methylpropene  
 4-Chloro-ortho-phenylenediamine  
 p-Chloro-o-toluidine  
 Chlorophenols  
 Chlorophenoxy herbicides  
 Chloroprene  
 Chlorothalonil  
 Chlorozotocin  
 Chromium  
 Chromium (hexavalent compounds)  
 Chrysene  
 C.I. Acid Red 114  
 C.I. Basic Red 9 monohydrochloride  
 Ciclosporin (Cyclosporin A; Cyclosporine)  
 Cinnamyl anthranilate  
 Cisplatin  
 Citrus Red No. 2  
 Clofibrate  
 Coal gasification products  
 Coal-tars and pitches  
 Cobalt metal powder  
 Cobalt [II] oxide  
 Conjugated estrogens  
 Copper acetoarsenite  
 Creosotes  
 Crystal violet  
 para-Cresidine  
 Cupferron  
 Cycasin  
 Cyclamates  
 1,4-cyclohexadiene  
 Cyclophosphamide (anhydrous)  
 Cyclophosphamide (hydrated)

**D**

D&C Orange No. 17  
 D&C Red No. 8  
 D&C Red No. 9  
 D&C Red No. 19  
 Dacarbazine  
 Daminozide  
 Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)  
 dapsone  
 Daunomycin  
 DCM  
 DDD (Dichlorodiphenyldichloroethane)

DDE (Dichlorodiphenyldichloroethylene)	3,3'-Dimethylbenzidine (ortho-Tolidine)	Gallium arsenide
DDT (Dichlorodiphenyltrichloroethane)	3,3'-Dimethylbenzidine dihydrochloride	Gasoline (petrol)
DDVP (Dichlorvos)	Dimethylcarbamoyl chloride	Glasswool fibers (airborne particles of respirable size)
Decabromodiphenyl ether	1,1-Dimethylhydrazine (UDMH)	Glu-P-1 (2-Amino-6-methylpiperido[1,2-a:3',2'-d]imidazole)
N,N'-Diacetylbenzidine	1,2-Dimethylhydrazine	Glu-P-2 (2-Aminodipyrido[1,2-a:3',2'-d]imidazole)
2,4-Diaminoanisole	Dimethyl sulfate	Glycidaldehyde
2,4-Diaminoanisole sulfate	Dimethylvinyl Chloride	Glycidol
4,4'-Diaminodiphenyl ether (4,4'-Oxydianiline)	2,4-dinitrofluorobenzene	Griseofulvin
2,4-Diaminotoluene	1,6-Dinitropyrene	Gyromitrin (Acetaldehyde methylformylhydrazone)
Diaminotoluene (mixed)	1,8-Dinitropyrene	
o-Dianisidine-based dyes	2,4-Dinitrotoluene	<b>H</b>
Dibenz[a,h]acridine	2,6-Dinitrotoluene	HC Blue 1
Dibenz[a,j]acridine	1,4-Dioxane	Heptachlor
Dibenz[a,h]anthracene	1,2-diphenylhydrazine (hydrazobenzene)	Heptachlor epoxide
7H-Dibenzo[c,g]carbazole	Diphenylhydantoin (Phenytoin)	Hexachlorobenzene
Dibenzo[a,e]pyrene	Diphenylhydantoin (Phenytoin), sodium salt	Hexachlorobutadiene
Dibenzo[a,h]pyrene	Direct Black 38	Hexachlorocyclohexanes
Dibenzo[a,i]pyrene	Direct Blue 6	Hexachlorodibenzodioxin
Dibenzo[a,l]pyrene	Direct Brown 95	Hexachloroethane
1,2-Dibromo-3-chloropropane (DBCP)	Disperse Blue 1	Hexamethylphosphoramide (HMPA)
1,2-Dibromoethane		Hydrazine
2,3-Dibromo-1-propanol	<b>E</b>	Hydrazine dihydrobromide
Dichloroacetylene	Epichlorohydrin	Hydrazine sulfate
p-Dichlorobenzene	Erionite	Hydroquinone
3,3'-Dichlorobenzidine	Estradiol 17B	Hydroxybutyric acid lactone
3,3'-Dichlorobenzidine dihydrochloride	Estrogens (not conjugated)	
1,4-Dichloro-2-butene	Estradiol-17	<b>I</b>
3,3'-Dichloro-4,4'-diaminodiphenyl ether	Estrone	Indeno [1,2,3-cd]pyrene
1,1-Dichloroethane	Ethinylestradiol	Indium trichloride
1,2-Dichloroethane	Mestranol	IQ (2-Amino-3-methylimidazo[4,5-f]quinoline)
Dichloroethyl ether	Estrone	Iron dextran complex
Dichloromethane (Methylene chloride)	Ethinylestradiol	Isosafrole
1,2-Dichloropropane	Ethyl acrylate	
1,3-Dichloropropene	Ethyl methanesulfonate	<b>K</b>
Dieldrin	Ethyl-4,4'-dichlorobenzilate	Kepone (Chlordecone)
Dienestrol	Ethylene dibromide	
Diepoxybutane	Ethylene dichloride (1,2-Dichloroethane)	<b>L</b>
Di(2-ethylhexyl)phthalate	N-Ethyl-N-nitrosourea	Lactofen
1,2-Diethylhydrazine	Ethylene imine	Lasiocarpine
Diethyl sulfate	Ethylene oxide	Lead
DES, Diethylstilbestrol	Ethylene thiourea	Lead acetate
Diglycidyl resorcinol ether (DGRE)	Ethyleneimine	Lead phosphate
Dihydrosafrole		Lindane and other hexachlorocyclohexane isomers
Diisopropyl sulfate	<b>F</b>	
3,3'-Dimethoxybenzidine (ortho-Dianisidine)	Folpet	<b>M</b>
3,3'-Dimethoxybenzidine dihydrochloride (ortho-dianisidine dihydrochloride)	Formaldehyde (gas or aqueous solution)	Malonaldehyde
para-Dimethylaminoazobenzene	2-(2-Formylhydrazino)-4-(5-nitro-2-furyl) thiazole	Mancozeb
4-Dimethylaminoazobenzene	Furan	Maneb
trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole	Furazolidone	Me-A-alpha-C (2-Amino-3-methyl-9H-pyrido[2,3-b]indole)
7,12-Dimethylbenz(a)anthracene	Furmecyclox	Medroxyprogesterone acetate
	Fusarin C	
	<b>G</b>	

MeIQ(2-Amino-3,4-dimethylimidazo[4,5-f]quinoline)  
 MeIQx(2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline)  
 Melphalan  
 Merphalan  
 Mestranol  
 Methoxychlor  
 2-Methylaziridine (Propyleneimine)  
 Methylazoxymethanol  
 Methylazoxymethanol acetate  
 Methyl bromide  
 3-Methylcholanthrene  
 5-Methylchrysene  
 4,4'-Methylene bis(2-chloroaniline) (MOCA, MBOCA)  
 4,4'-Methylene bis(N,N-dimethyl)benzenamine  
 Methylene chloride  
 4,4'-Methylene bis(2-methylaniline)  
 4,4'-Methylenedianiline (MDA)  
 4,4'-Methylenedianiline dihydrochloride  
 Methylhydrazine and its salts  
 Methyl chloromethyl ether  
 Methyl-CCNU  
 Methyl iodide  
 Methyl methanesulfonate  
 2-Methyl-1-nitroanthraquinone  
 N-Methyl-N'-nitro-N-nitrosoguanidine (MNNG)  
 N-Methyl-N-nitrosourea  
 N-Methylolacrylamide  
 Methylthiouracil  
 Metiram  
 Metronidazole  
 Michler's ketone  
 Mineral Oils, untreated and mildly treated  
 Mirex  
 Mitomycin C  
 MOPP  
 Monocrotaline  
 5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)-amino]-2-oxazolidinone  
 Mustard gas

## N

Nafenopin  
 1-Naphthylamine  
 2-Naphthylamine  
 3-Naphthylamine  
 Nickel and certain nickel compounds  
 Nickel carbonyl  
 Nickel subsulfide  
 Niridazole  
 Nitrilotriacetic acid  
 Nitrilotriacetic acid, trisodium salt monohydrate

5-Nitroacenaphthene  
 5-Nitro-o-anisidine  
 o-Nitroanisole  
 4-Nitrobiphenyl  
 p-Nitrochlorobenzene  
 6-Nitrochrysene  
 Nitrofen  
 2-Nitrofluorene  
 Nitrofurazone  
 1-[(5-Nitrofurfurylidene)amino]-2-imidazollidinone  
 1-[(5-Nitrofurfurylidene)-N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide  
 Nitrogen mustard (Mechlorethamine)  
 Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride)  
 Nitrogen mustard N-oxide  
 Nitrogen mustard N-oxide hydrochloride  
 2-Nitronaphthalene  
 2-Nitropropane  
 4-Nitropyrene  
 N-Nitrosodi-n-butylamine  
 N-Nitrosodiethanolamine  
 N-Nitrosodiethylamine  
 N-Nitrosodimethylamine  
 p-Nitrosodiphenylamine  
 N-Nitrosodiphenylamine  
 N-Nitrosodi-n-propylamine  
 N-Nitroso-N-ethylurea  
 3-(N-Nitrosomethylamino)propionitrile  
 4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone (NNK)  
 N-Nitrosomethylethylamine  
 N-Nitroso-N-methylurea  
 N-Nitroso-N-methylurethane  
 N-Nitrosomethylvinylamine  
 N-Nitrosomorpholine  
 N-Nitrososarcosine  
 N-Nitrosopiperidine  
 N-Nitrosopyrrolidine  
 N-Nitrososarcosine  
 Norethisterone (Norethindrone)

## O

Ochratoxin A  
 Oestrogen, nonstreoidal  
 Oestrogen, steroidal  
 Oil Orange SS  
 4,4'-Oxydianiline  
 Oxadiazon  
 Oxymetholone  
 Oxazepam

## P

Panfuran S  
 Pentachloroethane  
 Pentachlorophenol

Perylene  
 Phenacetin  
 Phenazopyridine hydrochloride  
 Phenesterin  
 Phenobarbital  
 Phenolphthalein  
 Phenoxybenzamine  
 Phenoxybenzamine hydrochloride  
 N-Phenyl-b-naphthylamine  
 Phenyl glycidyl ether  
 Phenylhydrazine and its salts  
 o-Phenylphenate, sodium  
 2-Phenylphenol  
 Phenytoin  
 PhiP(2-Amino-1-methyl-6-phenylimidazol[4,5-b]pyridine)  
 Polybrominated biphenyls  
 Polychlorinated biphenyls  
 Polychlorinated dibenzo-p-dioxins  
 Polychlorinated dibenzofurans  
 Polycyclic aromatic hydrocarbons  
 Polygeenan  
 Ponceau MX  
 Ponceau 3R  
 Potassium bromate  
 Potassium dichromate  
 Procarbazine  
 Procarbazine hydrochloride  
 Procymidone  
 Progesterone  
 Progestins  
 1,3-Propane sultone  
 Progargite  
 beta-Propiolactone  
 Propylene dichloride  
 Propylene imine  
 Propylene oxide  
 Propylthiouracil  
 Pyridinium chlorochromate

## R

Radionuclides  
 Radon  
 Reserpine  
 Residual (heavy) fuel oils  
 Rhodamine 101  
 Rosin core solder

## S

Saccharin  
 Saccharin, sodium  
 Safrole  
 Selenium sulfide  
 Shale-oils  
 Silica, crystalline (airborne particles of respirable size)  
 Sodium chromate tetrahydrate  
 Sodium dichromate

Sodium hexafluoroarsenate(V)  
 Sodium ortho-phenylphenate  
 Sterigmatocystin  
 Streptozotocin  
 Strontium chromate  
 Styrene  
 Styrene oxide  
 Sulfate  
 Sulfur trioxide  
 Sulphur trioxide N,N-dimethylformamide complex

**T**

Talc containing asbestiform fibers  
 Terrazole  
 Testosterone and its esters  
 2,3,7,8-Tetrachlorodibenzo-para-dioxin (TCDD, dioxin)  
 1,1,2,2-Tetrachloroethane  
 Tetrachloroethylene (Perchloroethylene)  
 p-a,a,a-Tetrachlorotoluene  
 3,3',5,5'-tetramethylbenzidine  
 Tetranitromethane  
 Thioacetamide  
 4,4'-Thiodianiline  
 Thiourea  
 Thorium dioxide  
 Titanium dioxide  
 Tobacco, oral use of smokeless products  
 Tobacco smoke  
 Toluene diisocyanate  
 p-toluenesulphonic acid  
 ortho-Toluidine  
 ortho-Toluidine-based dyes  
 ortho-Toluidine hydrochloride  
 para-Toluidine  
 Toxaphene  
 Tremolite silicates  
 Treosulfan (Tresoluphan)  
 Trichlormethine (Trimustine hydrochloride)  
 1,1,2-Trichloroethane  
 Trichloroethylene  
 2,4,6-Trichlorophenol  
 1,2,3-Trichloropropane  
 Triphenyltin hydroxide  
 Tris(aziridinyl)-para-benzoquinone (Triaziquone)  
 Tris(1-aziridinyl)phosphine sulfide (Thiotepa)  
 Tris(2-chloroethyl) phosphate  
 Tris(2,3-dibromopropyl)phosphate  
 TRIZMA base  
 Trp-P-1 (Tryptophan-P-1) (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole)

Trp-P-2 (Tryptophan-P-2) (3-Amino-1-methyl-5H-pyrido[4,3-b]indole)  
 Trypan blue

**U**

Uracil mustard  
 Uranium compounds  
 Urethane (Ethyl carbamate)

**V**

Vinyl bromide  
 Vinyl chloride  
 4-Vinyl-1-cyclohexene diepoxide (Vinyl cyclohexene dioxide)  
 Vinylidene chloride (1,1-dichloroethylene)  
 n-vinyl pyrrolidone  
 Vinyl pivalate  
 Vinyl trichloride (1,1,2-Trichloroethane)

**X**

2,6-Xylydine (2,6-Dimethylaniline)

**Z**

Zinc chromate  
 Zineb

**Source:** NIOSH (27/6/2017) and University of Oxford Department of Chemistry MSDS web resource (pre-2011).