Thieme

Hazard Information for Science of Synthesis

Introduction

Chemicals are associated with two types of hazard: hazards that are a direct result of the physical or reactive properties of a chemical; and hazards posed by the effect of a chemical on biological systems.

Flammability and the stability of a chemical in air or towards water may be included in the first group, while the carcinogenic potential of a chemical or its effect on the reproductive system are health hazards due to the biological properties of a chemical.

The different hazardous properties that Copy Editors should take into consideration when annotating experimental procedures are as follows:

Physical and Reactive Chemical Hazards

• Flammability

• Explosive properties

• Stability in air or in contact with water (pyrophoric and water-reactive compounds)

• Incompatibility with commonly-available chemicals and reagents

• Potential for peroxidation

• Oxidizing/reducing properties

• Storage properties

Health Effects of Chemicals

• Known human carcinogens and probable human carcinogens according to the International Agency for Research on Cancer (IARC) classifications

• Known human teratogens

• Chemicals known to have an effect on human reproduction

• Chemicals that are irritants to the skin, eyes and respiratory system (data from human exposure or animal tests)

• Chemicals that are corrosive to the skin, eyes and respiratory system (data from human exposure or animal tests)

• Skin sensitizers

• Chemicals that are highly toxic as a result of some specific pharmacological mechanism (e.g. the potent neurotoxin tetrodotoxin)

Apart from the necessity to be aware of hazardous properties before embarking on any manipulations with chemicals, hazard information is also required for risk assessments. It should be emphasised that hazard and risk are not interchangeable terms. **Hazard** is the set of inherent properties of a chemical substance that makes it capable of causing adverse effects in man or in the environment when a particular degree of exposure occurs. **Risk** is the prediction or actual frequency of occurrence of an adverse effect of a chemical substance from a given exposure to humans or the environment. In other words risk is a function of the **physical**, **reactive** or **toxic properties** of a chemical and the **exposure** to that substance. Risk assessment therefore requires knowledge of both the hazard of a chemical and the purpose for which it is being used. Risk assessments of hazardous substances used in the workplace are part of the regulatory framework for enacting national health and safety legislation. Some of the key regulations, which apply to laboratory safety in the UK, USA, and European Union, are described below.

Literature Sources for Hazard Information

A short review of hazard information may be found in Rhodes, P.H., The Organic Chemist's Desk Reference, Chapman & Hall, London, (1995), pp 112-126. An up-dated list of references from that review is available from the electronic file for 'Hazard Information for Science of Synthesis' together with the following Appendices:

Appendix 1: Incompatible Chemicals

Appendix 2: Pyrophoric Chemicals

Appendix 3: Reactive and Explosive Chemicals

Appendix 4: Common Peroxide-forming Chemicals

Appendix 5: Chemical Carcinogens

Appendix 6: Human Teratogens

Two useful sources of reactive hazard data, which Copy Editors should consult regularly, if at all possible are:

Urben, P.G. (ed.), Bretherick's Handbook of Reactive Chemical Hazards, 6th Edition, Butterworth-Heinemann, Oxford, 1999 (two volumes)

Luxon, S.G. (ed.), Hazards in the Chemical Laboratory, 5th Edition, Royal Society of Chemistry, Cambridge, 1992, (the 'yellow pages' section).

Many entries in the current Aldrich Catalogue contain European Union R(isk) and S(afety) phrases, which are used to classify the health risks of chemicals for EU and national legislation.

National Legislation Associated with Laboratory Safety

Although the exact regulatory details may differ from country to country, the essential aims of national health and safety legislation relating to the handling of chemicals in laboratories (and in the workplace in general) are the same:

• Identify the risks of handling hazardous substances and inform employees.

• Prevent, minimise, or control exposure.

• Ensure that control measures are correctly used and maintained, and that personal protection equipment is available.

• Monitor exposure in the workplace and comply with national occupational exposure limits.

• Provide information, training and instruction of the risks involved.

• Keep records of risk assessments, records of the maintenance and testing of engineering controls, and occupational health records.

Work with certain chemicals may also require a mandatory health check.

In the **United Kingdom**, these aims are incorporated in The Control of Substances Hazardous to Health Regulations 1999 (The COSHH Regulations). Suppliers of hazardous substances must comply with The Chemicals (Hazard Information and Packaging for Supply) Regulations 1999 (CHIP) as amended. Inter alia, these regulations require suppliers to provide material safety data sheets (MSDSs).

In the **United States of America**, management of laboratory health and safety requires the preparation and implementation of a chemical hygiene plan (CHP) that complies with the

Occupational Health and Safety Administration (OSHA) laboratory standard, 29 CFR 1910.1450.

The following **European Union Directives** protect workers from exposure to chemical (and biological) agents:

Council Directive 80/1107/EEC of 27 November 1980 on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work, Official Journal No. L 327 of 03.12.1980, p. 8.

Council Directive 88/642/EEC of 16 December 1988 amending Directive 80/1107 on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work, Official Journal No. L 356 of 24.12.1988, p. 74.

Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (fourteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC). This Directive – the **Chemical Agents Directive** (CAD)– will replace Council Directive 80/1107/EEC and amendment from 5th May 2001.

In **Europe**, the Chemical Agents Directive will be subsumed into the existing national health and safety legislation of European Union member states. National legislation, including legislation relevant to laboratories, will be amended if necessary.

A summary of these European Union Directives is included in the electronic file for 'Hazard Information for Science of Synthesis' – see Appendix 7. The impact of the Chemical Agents Directive on UK health and safety legislation is explained in Appendix 8.

Under **Japan's** Industrial Safety and Health Law, 1972, there are 'Guidelines for the Necessary Means to Prevent Health Impairments to Workers due to Chemical Substances'. These guidelines include a Chemical Substances Management Plan, and mirror the European and USA approach to handling chemicals in the workplace.

Literature Sources for Legislation Associated with Laboratory Safety

United Kingdom

General COSHH ACOP (Approved Code of Practice) and Carcinogens ACOP and Biological Agents ACOP (1999 edition): Control of Substances Hazardous to Health Regulations 1999, HSE Publications, 1999, ISBN 0 7176 1670 3.

COSHH Essentials: Easy Steps to Control Chemicals, HSE Publications, 1999, ISBN 0 7176 2421 8. Introduces a scheme based on the Risk phrases quoted in MSDSs for the risk assessment of chemicals.

Croner's Laboratory Manager, Croner Publications, 1997, ISBN 1 85524 442 X (revised quarterly). Provides updated information on changes to health and safety legislation affecting the management of laboratories.

COSHH in Laboratories, Royal Society of Chemistry, 1989, ISBN 0 85186 3191 (contains a generic approach to the risk assessment of laboratory chemicals, which the HSE have adopted in their 1999 publication COSHH Essentials).

United States

Stricoff, R.S.; Walters, D.B., Handbook of Laboratory Health and Safety, 2nd Edition, J. Wiley, 1995. Contains detailed guidance for implementing a chemical hygiene plan.

Montgomery, L., Health and Safety Guidelines for the Laboratory, The American Society of Clinical Pathologists Press, 1995.

Japan

The Japan International Center for Occupational Safety and Health Website: http://www.jicosh.gr.jp/english/index.html has details of Japanese health and safety legislation.

Laboratory Safety Data on the Web

There is a wealth of information on laboratory safety available on the Web, particularly from North American universities. The following sites have extensive links and illustrate the range of safety data and advice, which can be accessed. A more comprehensive list can be obtained by searching with the key words "laboratory" AND "safety" on the google.com search engine http://www.google.com/. The sites also lead to information on the more hazardous groups of chemicals encountered in the laboratory, and which are specifically listed in Appendices 1-6 in the electronic file for 'Hazard Information for Science of Synthesis'.

Oklahoma State University, Department of Environmental Health & Safety

http://www.pp.okstate.edu/ehs/LINKS/Labchem.htm

The Physical and Theoretical Chemistry Laboratory, Oxford University

http://physchem.ox.ac.uk/MSDS/

University of British Columbia, Department of Health, Safety and the Environment

http://web.uvic.ca/ohs/labsafety.html

University of Medicine and Dentistry of New Jersey

http://www2.umdnj.edu/eohssweb/lablinks.htm

University of Wisconsin, Milwaukee, Environmental Health, Safety & Risk Management

http://www.uwm.edu/Dept/EHSRM/EHSLINKS/

Princeton University Environmental, Health and Safety: Laboratory Safety Training Guide

http://www.princeton.edu/~ehs/labguide/sec-1a.htm

Other Websites for health and safety information are listed in the 'Sources of Hazard Information' section of the electronic file for Hazard Information for Science of Synthesis.

Hazard Information for Science of Synthesis

Sources of Hazard Information

1. Printed Reference and Other Books

Risk and Hazard Assessment (general)

Richardson, M.L. (ed.), Toxic Hazard Assessment of Chemicals, Royal Society of Chemistry, London, 1986 (definitions of risk and hazard).

King, R., Safety in the Process Industries, Butterworth-Heinemann, London, 1990.

Risk Assessment of Chemicals, Van Leeuwen, C.J. et al., (ed.), Kluwer Academic, 1995.

Handbook of Occupational Safety and Health, 2nd Edition, DiBerardinis, L.J. (ed.), J. Wiley, New York, 1999.

Physical Properties related to Hazard

Riddick, J.A. et al, Organic Solvents: Physical Properties and Methods of Purification, 4th Edition, Wiley-Interscience, New York, 1986.

Stephenson, R.M., Flash Points of Organic and Organometallic Compounds, Elsevier, 1987.

Kirk-Othmer's Encyclopedia of Chemical Technology, 4th Edition, Wiley, New York, 1991.

Bond, J., Sources of Ignition, Butterworth, Oxford, 1991 (flash points, explosive limits and auto-ignition temperatures).

Lide, D.R., Handbook of Organic Solvents, CRC Press, Boca Raton, 1995.

Verschueren, K., Handbook of Environmental Data on Organic Chemicals, 3rd Edition, John Wiley, Chichester, 1999.

Occupational Exposure Limits

Occupational Exposure Limits for Airborne Toxic Substances, 3rd Edition, ILO, Geneva, 1991 (data from 16 countries)

EH40/99 Occupational Exposure Limits 1999, The Stationery Office, London, 1999 (UK)

Threshold Limit Values and Biological Exposure Indices for 2000, American Conference of Governmental Industrial Hygienists, Ohio, 2000 (USA).

List of MAK and BAT Values 2000, Deutsche Forschungsgemeinschaft, Wiley-VCH, Weinheim, 2000 (German Maximum Arbeitplatz Konzentrations).

Reactive Hazards

Jackson, H.L., et al, J. Chem. Ed., 1970, **47**, A175 (peroxidizable compounds).

Luxon, S.G. (ed.), Hazards in the Chemical Laboratory, 5th Edition, Royal Society of Chemistry, Cambridge, 1992.

IUPAC-IPCS, Chemical Safety Matters, Cambridge University Press, Cambridge, 1992, 118, 242 (peroxidizable compounds)

Kelly, R.J., Chemical Health & Safety, 1996, **3**(5), 28-36 (peroxidizable organic compounds)

Urben, P.G. (ed.), Bretherick's Handbook of Reactive Chemical Hazards, 6th Edition, Butterworth-Heinemann, Oxford, 1999 (two volumes).

Toxicology

General

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans, International Agency for Research on Cancer, Lyon, 1971-.

Braker, W. et al, Effects of Exposure to Toxic Gases - First Aid and Medical Treatment, 2nd Edition, Matheson, Lyndhurst, NJ, 1977.

Dangerous Prop. Ind. Mater. Rep., 1980, **1**,- (toxicological and ecotoxicological data on chemicals produced on a large scale).

Grandjean, P., Skin Penetration: Hazardous Chemicals at Work, Taylor & Francis, London, 1990 (300 chemicals which are toxic by skin absorption).

Clayton, G.D. et al (ed.), Patty's Industrial Hygiene and Toxicology, 4th Edition, Volume I Parts A & B, Volume II Parts A-F, Volume III Parts A & B, J. Wiley 1991-1995.

Hathaway, G.J. et al. (ed.), Proctor and Hughes' Chemical Hazards of the Workplace, 4th Edition, Van Nostrand-Reinhold, New York, 1996.

Comprehensive Toxicology, Sipes, I.G. et al., (ed.), Elsevier, 1996 (13 volume set also on CD-ROM).

Lewis, R.J., Sax's Dangerous Properties of Industrial Materials, 10th Edition, John Wiley, New York, 2000.

Drug Toxicity

Textbook of Adverse Drug Reactions, 4th Edition, Davies, D.M. (ed.), Oxford Medical Publications, 1991.

Martindale, The Complete Drug Reference, 32nd Edition, Pharmaceutical Press, London, 1999 (adverse effects of therapeutic agents).

Reproductive Toxicology

Lewis, R.J., Reproductively Active Chemicals: A Reference Guide, Van Nostrand-Reinhold, New York, 1991.

Kolb, V.M. Ed., Teratogens, 2nd Edition, Elsevier, Amsterdam, 1993.

Shepard, T.H., Catalog of Teratogenic Agents, 9th Edition, The John Hopkins University Press, Baltimore, 1998.

Solvent Toxicity

Solvents in Common Use: Health Risks to Workers, Royal Society of Chemistry, London, 1988.

Ethel Browning's Toxicity and Metabolism of Industrial Solvents, 2nd Edition, Snyder, R., (ed.) Elsevier, Volumes 1/2/3, 1987/1990/1992.

Metal Toxicity

Barnes, J.M. et al., Organometallic Chemistry Reviews, 1968, **3**, 137 (toxicology of organometallic compounds).

Venugopal, B. et al., Metal Toxicity in Mammals, Volumes 1 and 2, Plenum Press, 1977 and 1978.

Handbook on the Toxicology of Metals, Friberg, L. et al. (ed.), Second Edition, Volumes I and II, Elsevier, 1986.

Biological Monitoring of Toxic Metals, Clarkson, T.W. et al. (ed.), Plenum Press, 1988.

Handbook on Toxicity of Inorganic Compounds, Seiler, H.G. et al. (ed.), M. Dekker, 1988.

Metal Neurotoxicity, Bondy, S.C. et al. (ed.), CRC Press, 1988.

Hostýnek, J.J. et al., CRC Crit. Rev. Toxicol., 1993, **23**, 171 (skin effects of metals).

Metal Toxicology, Goyer, R.A. et al., (ed.), Academic Press, San Diego, 1995.

Toxicology of Metals, Chang, L.W. et al. (ed.), CRC Press, Boca Raton, 1996.

Pesticide Toxicology

Ballantyne, B. et al., Clinical and Experimental Toxicology of Organophosphates and Carbamates, Butterworth-Heinemann, Oxford, 1992.

Handbook of Pesticide Toxicology, Hayes W.J. et al., (ed.), Academic Press, San Diego, 1995.

The Pesticide Manual, 11th Edition, Tomlin, C.D.S. (ed.), British Crop Protection Council, 1997.

Health and Safety Data Sheets

International Chemical Safety Cards, Commission of the European Communities, Luxembourg (produced for the International Programme on Chemical Safety).

Keith, L.H. et al (ed.), Compendium of Safety Data Sheets for Research and Industrial Chemicals, VCH, Deerfield Park, Parts I-VI, 1985-1987.

Chemical Safety Sheets, Kluwer Academic, Dordrecht, 1991 (includes a section on the prediction of chemical handling properties from physical data).

Hazard Data Sheets, BDH, Poole, Dorset.

Laboratory Safety

Laboratory Safety: Theory and Practice, Fuscaldo, A.A. et al, (ed.), Academic Press, New York, 1980.

Lunn, G. et al., Destruction of Hazardous Chemicals in the Laboratory, J. Wiley, New York, 1990.

Young, J.A., Ed., Improving Safety in the Chemical laboratory: A Practical Guide, 2nd Edition, J. Wiley, New York, 1991

Safe Storage of Laboratory Chemicals, 2nd Edition, Pipitone, D.A. (ed.), J. Wiley, New York, 1991.

IUPAC-IPCS, Chemical Safety Matters, Cambridge University Press, Cambridge, 1992 (useful laboratory safety advice including storage and disposal of waste chemicals).

Luxon, S.G. (ed.), Hazards in the Chemical Laboratory, 5th Edition, Royal Society of Chemistry, Cambridge, 1992.

Palluzi, R.P., Pilot Plant and Laboratory Safety, McGraw Hill, New York, 1994.

Furr, A.K., CRC Handbook of Laboratory Safety, 4th Edition, CRC Press, Boca Raton, 1995.

Stricoff, R.S.; Walters, D.B., Handbook of Laboratory Health and Safety, 2nd Edition, J. Wiley, 1995.

Prudent Practices in the Laboratory, National Academic Press, 1995.

2. Electronic Media

CD/ROMs

Registry of Toxic Effects of Chemical Substances (RTECS), The National Institute for Occupational Safety and Health (NIOSH), Ohio, USA. RTECS is available on a quarterly-updated CD-ROM (Chem-Bank), which also includes other health and safety databanks, from SilverPlatter International N.V.

Websites

The following Websites, based mainly around centres of excellence in the USA, provide health and safety information on chemicals:

Organisation Internet Address and Description of Content

Occupational Health and Safety www.osha-slc.gov Sources of compliance and rates of

Administration injury/illness information

Environmental Protection Agency www.epa.gov Environmental regulations, research activities, toxic substances control, chemical specific information

Agency for Toxic Substances and www.atsdr1.atsdr.cdc.gov:8080/

Disease Registry Health effects information concerning chemicals, chemicals released from hazardous waste disposal sites, physician case studies

National Toxicology Program http://157.98.13.224/ Extensive information on chemicals, reactivity, long-term and short-term effects

National Institutes of Health www.nih.gov Includes ongoing research on cancer and its causes

National Institute for Occupational www.cdc.gov/niosh Research studies, health

Health and Safety hazard evaluations, extensive links to occupational safety and health resources on the Internet

World Health Organisation www.who.ch

International Agency for Research www.iacr.fr

On Cancer

American Conference of Governmental www.acgih.org Sources of information on TLVs,

Industrial Hygienists biological exposure indices, chemicals under study and revisions to TLVs

National Library of Medicine www.nlm.nih.gov Over 40 databases including MEDLINE and TOXLINE. Databases also on genetic toxicology, reproductive toxicology, toxic release inventory

Material Safety Datasheets (MSDSs) www.d.umn.edu/ehso/MSDS.html A site with links to other MSDS sites

Appendix 1

Incompatible chemicals

A wide variety of chemicals react dangerously when mixed with certain other materials. Some of the more widely-used incompatible chemicals are given below, but the absence of a chemical from this list should not be taken to indicate that it is safe to mix it with any other chemical.

• acetic acid: chromic acid, ethylene glycol, nitric acid, hydroxyl compounds, perchloric acid, peroxides, permanganates

• acetone: concentrated sulphuric and nitric acid mixtures

• acetylene: chlorine, bromine, copper, fluorine, silver, mercury

• alkali and alkaline earth metals: water, chlorinated hydrocarbons, carbon dioxide, halogens, alcohols, aldehydes, ketones, acids

• aluminium (powdered): chlorinated hydrocarbons, halogens, carbon dioxide, organic acids.

• anhydrous ammonia: mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid

• ammonium nitrate: acids, metal powders, flammable liquids, chlorates, nitrites, sulphur, finely divided organic combustible materials

• aniline: nitric acid, hydrogen peroxide

• arsenic compounds: reducing agents

• azides: acids

• bromine: ammonia, acetylene, butadiene, hydrocarbons, hydrogen, sodium, finely-divided metals, turpentine, other hydrocarbons

• calcium carbide: water, alcohol

• calcium oxide: water

• carbon, activated: calcium hypochlorite, oxidizing agents

• chlorates: ammonium salts, acids, metal powders, sulphur, finely divided organic or combustible materials

• chromic acid: acetic acid, naphthalene, camphor, glycerol, turpentine, alcohols, flammable liquids in general

• chlorine: see bromine

• chlorine dioxide: ammonia, methane, phosphine, hydrogen sulphide

• copper: acetylene, hydrogen peroxide

• cumene hydroperoxide: acids, organic or inorganic

• cyanides: acids, nitrates

• flammable liquids: ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens

• hydrocarbons: fluorine, chlorine, bromine, chromic acid, sodium peroxide

• hydrocyanic acid: nitric acid, alkali

• hydrofluoric acid: aqueous or anhydrous ammonia

• hydrogen peroxide: copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, oxidizing gases

• hydrogen sulphide: fuming nitric acid, oxidizing gases

• hypochlorites: acids, activated carbon

• iodine: acetylene, ammonia (aqueous or anhydrous), hydrogen

• mercury: acetylene, fulminic acid, ammonia

• mercuric oxide: sulphur

• nitrates: sulphuric acid

• nitric acid (conc.): acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases

• oxalic acid: silver, mercury

• perchloric acid: acetic anhydride, bismuth and its alloys, ethanol, paper, wood

• peroxides (organic): acids, avoid friction or shock

• phosphorus (white): air, alkalies, reducing agents, oxygen

• potassium: carbon tetrachloride, carbon dioxide, water

• potassium chlorate: acids

• potassium perchlorate: acids

• potassium permanganate: glycerol, ethylene glycol, benzaldehyde, sulphuric acid

• selenides: reducing agents

• silver: acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid

• sodium: carbon tetrachloride, carbon dioxide, water

• sodium nitrate: ammonium salts

• sodium nitrite: ammonium salts

• sodium peroxide: ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulphide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural

• sulphides: acids

• sulphuric acid: potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)

• tellurides: reducing agents

• zinc powder: sulphur

Appendix 2

Partial List of Pyrophoric Chemicals

Grignard reagents, RMgX

Metal alkyls and aryls, e.g. RLi, RNa, R_3Al, R_2Zn

Metal carbonyls, e.g. $Ni(CO)_4$, $Fe(CO)_5$, $Co_2(CO)_8$

Alkali metals e.g. Na, K

Metal powders, e.g. Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr

Metal hydrides, e.g. NaH, $LiAlH_4$

Nonmetal hydrides, e.g. B_2H_6 and other boranes, PH_3, AsH_3

Nonmetal alkyls, e.g. R_3B, R_3P, R_3As

Phosphorus (white)

Appendix 3

Reactive and Explosive Chemicals

Shock-sensitive compounds

Acetylenic compounds, especially polyacetylenes, haloacetylenes, and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive)

Acyl nitrates

Alkyl nitrates, particularly polyol nitrates such as nitrocellulose and nitroglycerine

Alkyl and acyl nitrites

Alkyl chlorates

Amine metal oxosalts: metal compounds with coordinated ammonia, hydrazine, or similar nitrogenous donors and ionic chlorate(VII), nitrate(V), manganate(VII) or other oxidizing group

Azides, including metal, non-metal, and organic azides

Chlorate(III) salts of metals, such as $AgClO_2$ and $Hg(ClO_2)_2$

Chlorate(VII) salts. Most metal, non-metal, amine, and organic cation chlorates(VII) can be detonated or undergo violent reaction in contact with combustible materials

Diazo compounds such as CH_2N_2

Diazonium salts, when dry

Fulminates (silver fulminate, AgCNO, can form in the reaction mixture from the Tollens' test for aldehydes if it is allowed to stand for some time. This can be prevented by adding dilute nitric(V) acid to the test mixture as soon as the test has been completed.)

Hydrogen peroxide becomes increasingly treacherous as the concentration rises above 30%, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals

N-Halogen compounds such as difluoroamino compounds and halogen azides

N-Nitro compounds such as N-nitromethylamine, nitrourea, nitroguanidine, and nitric amide

Oxo salts of nitrogenous bases: chlorates(VII), dichromates(VI), nitrates(V), iodates(V), chlorates(III), chlorates(V), and manganates(VII) of ammonia, amines, hydroxylamine, guanidine, etc.

Peroxides and hydroperoxides, organic

Peroxides (solid) that crystallize from or are left from evaporation of peroxidizable solvents

Peroxides, transition-metal salts

Picrates, especially salts of transition and heavy metals, such as Ni, Pb, Hg, Cu, and Zn; picric acid is explosive but is less sensitive to shock or friction than its metal salts and is relatively safe as a water-wet paste

Polynitroalkyl compounds such as tetranitromethane and dinitroacetonitrile

Polynitroaromatic compounds, especially polynitro hydrocarbons, phenols, and amines

Potentially explosive combinations of some common reagents

Acetone with chloroform in the presence of base

Acetylene with copper, silver, mercury, or their salts

Ammonia (including aqueous solutions) with $C1_2$, Br_2, or I_2

Carbon disulfide with sodium azide

Chlorine with an alcohol

Chloroform or carbon tetrachloride with powdered Al or Mg

Decolorizing carbon with an oxidizing agent

Diethyl ether with chlorine (including a chlorine atmosphere)

Dimethyl sulfoxide with an acyl halide, $SOCl_2$, or $POCl_3$ or with CrO_3

Ethanol with calcium chlorate(I) or silver nitrate(V)

Nitric(V) acid with acetic anhydride or acetic acid

Picric acid with a heavy-metal salt, such as of Pb, Hg, or Ag

Silver oxide with ammonia with ethanol

Sodium with a chlorinated hydrocarbon

Sodium chlorate(I) with an amine

Appendix 4

Common Peroxide-forming Chemicals

Severe peroxide hazard on storage with exposure to air: discard within 3 months

Diisopropyl ether

Divinylacetylene

Potassium metal

Sodium amide (sodamide)

Vinylidene chloride (1,1-dichloroethylene)

Potassium amide

Peroxide hazard on concentration: do not distil or evaporate without first testing for the presence of peroxides: discard or test for peroxides after six months

Ethylene glycol dimethyl ether (glyme)

Ethylene glycol ether acetates

Ethylene glycol monoethers (cellosolves)

Acetaldehyde diethyl acetal (acetal)

Cumene (isopropylbenzene)

Cyclohexene

Cyclopentene

Furan

Decalin (decahydronaphthalene)

Methylacetylene

Diacetylene

Methylcyclopentane

Dicyclopentadiene

Methyl isobutyl ketone

Diethyl ether (ether)

Tetrahydrofuran

Diethylene glycol dimethyl ether (diglyme)

Tetralin (tetrahydronaphthalene)

Dioxan

Vinyl ethers

Hazard of rapid polymerization initiated by internally formed peroxides

Liquids: Discard or test for peroxides after 6 months

Chloroprene (2-chloro-1,3-butadiene)

Vinyl acetate

Styrene

Vinylpyridine

Gases: Discard after 12 months

Butadiene

Tetrafluoroethylene

Vinylacetylene

Vinyl chloride

Appendix 5

Chemical Carcinogens

Lists of IARC Evaluations of Carcinogenicity

In the first 57 volumes of the IARC Monographs, over 700 agents (chemicals, groups of chemicals, complex mixtures, occupational exposures and cultured habits) have been evaluated.

In the IARC Monographs, the agents are classified as to their carcinogenic risk to humans in accordance with the procedures adopted as standard IARC practice:

° **Group l** - The agent (mixture) is carcinogenic to humans.

The exposure circumstance entails exposures that are carcinogenic to humans.

° **Group 2**

° **Group 2A** - The agent (mixture) is probably carcinogenic to humans.

The exposure circumstance entails exposures that are probably carcinogenic to humans.

° **Group 2B** - The agent (mixture) is possibly carcinogenic to humans.

The exposure circumstance entails exposures that are possibly carcinogenic to humans.

° **Group 3** - The agent (mixture or exposure circumstance) is not classifiable as to its carcinogenicity to humans.

° **Group 4** - The agent (mixture) is probably not carcinogenic to humans.

Overall Evaluations of Carcinogenicity to Humans

Summary of overall evaluations from IARC Monographs Volumes 1-57, published by IARC as Supplement 7, 1987.

[CAS Registry Numbers: in square brackets] (Year in brackets: year in which an evaluation was published subsequent to Supplement 7)

Group 1 - Carcinogenic to humans

Agents and groups of agents

Aflatoxins [1402-68-2] (1993)

4-Aminobiphenyl [92-67-1]

Arsenic [7440-38-2] and arsenic compounds

Asbestos (1332-21-4]

Azathioprine (446-86-6]

Benzene [71-43-2]

Benzidine [92-87-5]

N,N-Bis (2-chloroethyl)-2-naphthylamine (Chlornaphazine) [494-03-1]

Bis (chloromethyl) ether (542-88-1] and chloromethyl methyl ether [107-30-2] (technical-grade)

1,4-Butanediol dimethanesulfonate (Myleran) [55-98-1]

Chlorambucil [305-03-3]

1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-l-nitrosourea (Methyl-CCNU) [13909-09-6]

Chromium[VI] compounds (1990)

Ciclosporin [79217-60-0] (1990)

Cyclophosphamide [50-18-0] [6055-19-2]

Diethylstilboestrol [56-53-1]

Erionite [66733-21-9]

Melphalan [148-82-3]

8-Methoxypsoralen (Methoxsalen) [298-81-7] plus ultraviolet radiation

MOPP and other combined chemotherapy including alkylating agents

Mustard gas (Sulfur mustard) [505-60-2]

2-Naphthylamine [91-59-8]

Nickel compounds (1990)

Oestrogen replacement therapy

Oestrogens, nonsteroidal

Oestrogens, steroidal

Oral contraceptives, combined

Oral contraceptives, sequential

Radon [10043-92-2] and its decay products (1988)

Solar radiation (1992)

Talc containing asbestiform fibres

Thiotepa [52-24-4] (1990)

Treosulfan [299-75-2]

Vinyl chloride [75-01-4]

Mixtures

Alcoholic beverages (1988)

Analgesic mixtures containing phenacetin

Betel quid with tobacco

Coal-tar pitches [65996-93-2]

Coal-tars [8007-45-2]

Mineral oils, untreated and mildly-treated

Salted fish (Chinese-style) (1993)

Shale-oils [68308-34-9]

Soots

Tobacco products, smokeless

Tobacco smoke

Exposure circumstances

Aluminium production

Auramine, manufacture of

Boot and shoe manufacture and repair

Coal gasification

Coke production

Furniture and cabinet making

Haematite mining (underground)

Iron and steel founding

with exposure to radon

Isopropanol manufacture (strong-acid process)

Magenta, manufacture of (1993)

Painter (occupational exposure as a painter) (1989)

Rubber industry

Strong-inorganic-acid mists containing sulfuric acid (occupational exposure to) (1992)

Group 2A - Probably carcinogenic to humans

Agents and groups of agents

Acrylonitrile [107-13-1]

Adriamycin [23214-92-8]

Androgenic (anabolic) steroids

Azacitidine [320-67-2] (1990)

Benz[a]anthracene [56-55-3]

Benzidine-based dyes

Benzo[a]pyrene [50-32-8]

Beryllium [7440-41-7] and beryllium compounds

Bischloroethyl nitrosourea (BCNU) [154-93-8]

1,3-Butadiene [106-99-0] (1992)

Cadmium [7440-43-9] and cadmium compounds

Captafol [2425-06-1] (1991)

Chloramphenicol [56-75-7](1990)

1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU) [13010-47-4]

para-Chloro-ortho-toluidine [95-69-2] and its strong acid salts (1990)

Chlorozotocin [54749-90-5] (1990)

Cisplatin [15663-27-1]

Dibenz[a,h]anthracene [53-70-3]

Diethyl sulfate [64-67-5] (1992)

Dimethylcarbamoyl chloride [79-44-7]

Dimethyl sulfate [77-78-1]

Epichlorohydrin [106-89-8]

Ethylene dibromide [106-93-4]

Ethylene oxide [75-21-8]

N-Ethyl-N-nitrosourea [759-73-9]

Formaldehyde [50-00-0]

IQ (2-Amino-3-methylimidazo[4,5-f]quinoline) [76180-96-6] (1993)

5-Methoxypsoralen [484-20-8]

4,4'-Methylene bis(2-chloroaniline) (MOCA) [101-14-4] (1993)

N-Methyl-N'-nitro-N-nitrosoguanidine (MNNG) [70-25-7]

N-Methyl-N-nitrosourea [684-93-5]

Nitrogen mustard [51-75-2]

N-Nitrosodiethylamine [55-18-5]

N-Nitrosodimethylamine [62-75-9]

Phenacetin [62-44-2]

Procarbazine hydrochloride [366-70-1]

Propylene oxide [75-56-9]

Silica [14808-60-7], crystalline

Styrene oxide [96-09-3]

Tris(2,3-dibromopropyl)phosphate [126-72-7]

Ultraviolet radiation A (1992)

Ultraviolet radiation B (1992)

Ultraviolet radiation C (1992)

Vinyl bromide [593-60-2]

Mixtures

Creosotes [8001-58-9]

Diesel engine exhaust (1989)

Hot mate (1991)

Non-arsenical insecticides (occupational exposures in spraying and application of) (1991)

Polychlorinated biphenyls [1336-36-3]

Exposure circumstances

Hairdresser or barber (occupational exposure) (1993)

Petroleum refining (occupational exposures in) (1989)

Sunlamps and sunbeds (use of) (1992)

Group 2B - Possibly carcinogenic to humans

Agents and groups of agents

A-α-C (2-Amino-9H-pyrido[2,3-b]indole) [26148-68-5]

Acetaldehyde [75-07-0]

Acetamide [60-35-5]

Acrylamide [79-06-1]

AF-2 [2-(2-Furyl)-3-(5-nitro-2-furyl)acrylamide [3688-53-7]

Aflatoxin M_1 [6795-23-9] (1993)

para-Aminoazobenzene [60-09-3]

ortho-Aminoazotoluene [97-56-3]

2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole [712-68-5]

Amitrole [61-82-5]

ortho-Anisidine [90-04-0]

Antimony trioxide [1309-64-4] (1989)

Aramite [140-57-8]

Atrazine [1912-24-9] (1991)

Auramine [492-80-8] (technical-grade)

Azaserine [115-02-6]

Benzo[b]fluoranthene [205-99-2]

Benzo[j]fluoranthene [205-82-3]

Benzo[k]fluoranthene [207-08-9]

Benzyl violet 4B [1694-09-3]

Bleomycins [11056-06-7]

Bracken fern

Bromodichloromethane [75-27-4] (1991)

Butylated hydroxyanisole (BHA) [25013-16-5]

β-Butyrolactone [3068-88-0]

Caffeic acid [331-39-5] (1993)

Carbon-black extracts

Carbon tetrachloride [56-23-5]

Ceramic fibres

Chlordane [57-74-9] (1991)

Chlordecone (Kepone) [143-50-0]

Chlorendic acid [115-28-6] (1990)

α-Chlorinated toluenes

para-Chloroaniline [106-47-8] (1993)

Chloroform [67-66-3]

Chlorophenols

Chlorophenoxy herbicides

4-Chloro-ortho-phenylenediamine [95-83-0]

CI Acid Red 114 [6459-94-5] (1993)

CI Basic Red 9 [569-61-9] (1993)

CI Direct Blue 15 [2429-74-5] (1993)

Citrus Red No.2 [6358-53-8]

Cobalt [7440-48-4] and cobalt compounds (1991)

para-Cresidine [120-71-8]

Cycasin [14901-08-7]

Dacarbazine [4342-03-4]

Dantron (Chrysazin; 1, 8-Dihydroxyanthraquinone) (1990) [117-10-2]

Daunomycin [20830-81-3]

DDT [p,p'-DDT, 50-29-3] (1991)

N,N' -Diacetylbenzidine [613-35-4]

2,4-Diaminoanisole [615-05-4]

4,4' -Diaminodiphenyl ether [101-80-4]

2,4-Diaminotoluene [95-80-7]

Dibenz[a,h]acridine [226-36-8]

Dibenz [a ,j] acridine [224-42-0]

7H-Dibenzo [c,g] carbazole [194-59-2]

Dibenzo[a,e]pyrene [192-65-4]

Dibenzo[a,h]pyrene [189-64-0]

Dibenzo[a,i]pyrene [189-55-9]

Dibenzo[a,i]pyrene [191-30-0]

1,2-Dibromo-3-chloropropane [96-12-8]

para-Dichlorobenzene [106-46-7]

3,3'-Dichlorobenzidine [91-94-1]

3,3'-Dichloro-4, 4'-diaminodiphenyl ether [28434-86-8]

1,2-Dichloroethane [107-06-2]

Dichloromethane [75-09-2]

1,3-Dichloropropene [542-75-6] (technical grade)

Dichlorvos [62-73-7] (1991)

Diepoxybutane [1464-53-5]

Di(2-ethylhexyl)phthalate [117-81-7]

1, 2-Diethylhydrazine [1615-80-1]

Diglycidyl resorcinol ether [101-90-6]

Dihydrosafrole [94-58-6]

Diisopropyl sulfate [2973-10-6] (1992)

3,3' -Dimethoxybenzidine (ortho-Dianisidine) [119-90-4]

para-Dimethylaminoazobenzene [60-11-7]

trans-2-[(Dimethylamino)methylimino]-5- [2- (5-nitro-2-furyl)-vinyl]- l ,3,4-oxadiazole [25962-77-0]

2, 6-Dimethylaniline (2, 6-xylidine) [87-62-7] (1993)

3,3 '-Dimethylbenzidine (ortho-Tolidine) [119-90-4]

Dimethylformamide [68-12-2] (1989)

1, 1-Dimethylhydrazine [57-14-7]

l ,2-Dimethylhydrazine [540-73-8]

1,6-Dinitropyrene [42397-64-8] (1989)

1,8-Dinitropyrene [42397-65-9] (1989)

1,4-Dioxane [123-91-1]

Disperse Blue l [2475-45-8] (1990)

Ethyl acrylate [140-88-5]

Ethylene thiourea [96-45-7]

Ethyl methanesulfonate [62-50-0]

2-(2-Formylhydrazino) -4- (5-nitro-2-furyl)thiazole [3570-75-0]

Glasswool (1988)

Glu-P- l (2-Amino-6-methyldipyrido [1,2-a: 3', 2 '-d] imidazole) [67730-11-4]

Glu-P-2 (2-Aminodipyrido [1,2-a: 3', 2' -d] imidazole) [67730-10-3]

Glycidaldehyde [765-34-4]

Griseofulvin [126-07-8]

HC Blue No. l [2784-94-3] (1993)

Heptachlor [76-44-8] (1991)

Hexachlorobenzene [118-74-1]

Hexachlorocyclohexanes

Hexamethylphosphoramide [680-31-9]

Hydrazine [302-01-2]

Indeno[l ,2,3-cd]pyrene [193-39-5]

Iron-dextran complex [9004-66-4]

Lasiocarpine [303-34-4]

Lead [7439-92-1] and lead compounds, inorganic

Magenta [632-99-5] (containing CI Basic Red 9) (1993)

MeA-α-C (2-Amino-3-methyl-9H-pyrido [2,3-b] indole) [68006-83-7]

Medroxyprogesterone acetate [71-58-9]

MeIQ (2-Amino-3, 4-dimethylimidazo [4,5-f] quinoline)

[77094-11-2] (1993)

Me IQx (2-Amino-3, 8-dimethylimidazo [4,5-f] quinoxaline)

[77500-04-0] (1993)

Merphalan [531-76-0]

2-Methylaziridine [75-55-8]

Methylazoxymethanol acetate [592-62-1]

5-Methylchrysene [3697-24-3]

4,4' -Methylenebis(2-methylaniline) [838-88-0]

4,4' -Methylenedianiline [101-77-9]

Methyl methanesulfonate [66-27-3]

2-Methyl- 1-nitroanthraquinone [129-15-7] (uncertain purity)

N-Methyl-N-nitrosourethane [615-53-2]

Methylthiouracil [56-04-2]

Metronidazole [443-48-1]

Mirex [2385-85-5]

Mitomycin C [50-07-7]

Monocrotaline [315-22-0]

5- (Morpholinomethyl) -3-[(5-nitrofurfurylidene)amino] -2-oxazolidinone [3795-88-8]

Nafenopin [3771-19-5]

Nickel, metallic [7440-02-0] (1990)

Niridazole [61-57-4]

Nitrilotriacetic acid [139-13-9] and its salts (1990)

5-Nitroacenaphthene [602-87-9]

6-Nitrochrysene [7496-02-8] (1989)

Nitrofen [1836-75-5], technical-grade

2-Nitrofluorene [607-57-8] (1989)

1 -[(5-Nitrofurfurylidene) amino] -2-imidazolidinone [555-84-0]

N-[4- (5-Nitro-2-furyl) -2-thiazolyl] acetamide [531-82-8]

Nitrogen mustard N-oxide [126-85-2]

2-Nitropropane [79-46-9]

1-Nitropyrene [5522-43-0] (1989)

4-Nitropyrene [57835-92-4] (1989)

N-Nitrosodi-n-butylamine [924-16-3]

N-Nitrosodiethanolamine [1116-54-7]

N-Nitrosodi-n-propylamine [621-64-7]

3- (N-Nitrosomethylamino)propionitrile [60153-49-3]

4-(N-Nitrosomethylamino) - 1-(3-pyridyl) - 1-butanone (NNK) [64091-91-4]

N-Nitrosomethylethylamine [10595-95-6]

N-Nitrosomethylvinylamine [4549-40-0]

N-Nitrosomorpholine [59-89-2]

N' -Nitrosonornicotine [16543-55-8]

N-Nitrosopiperidine [100-75-4]

N-Nitrosopyrrolidine [930-55-2]

N-Nitrososarcosine [13256-22-9]

Ochratoxin A [303-47-9] (1993)

Oil Orange SS [2646-17-5]

Panfuran S (containing dihydroxymethylfuratrizine [794-93-4])

Pentachlorophenol [87-86-5] (1991)

Phenazopyridine hydrochloride [136-40-3]

Phenobarbital [50-06-6]

Phenoxybenzamine hydrochloride [63-92-3]

Phenyl glycidyl ether [122-60-1] (1989)

Phenytoin [57-41-0]

PhIP (2-Amino-1-methyl-6-phenylimidazo [4,5-b] pyridine) [105650-23-5] (1993)

Ponceau MX [3761-53-3]

Ponceau 3R [3564-09-8]

Potassium bromate [7758-01-2]

Progestins

1,3-Propane sultone [1120-71-4]

β-Propiolactone [57-57-8]

Propylthiouracil [51-52-5]

Rockwool (1988)

Saccharin [81-07-2]

Safrole [94-59-7]

Slagwool (1988)

Sodium ortho-phenylphenate [132-27-4]

Sterigmatocystin [10048-13-2]

Streptozotocin [18883-66-4]

Styrene [100-42-5]

Sulfallate [95-06-7]

2,3,7, 8-Tetrachlorodibenzo-para-dioxin (TCDD) [1746-01-6]

Tetrachloroethylene [127-18-4]

Thioacetamide [62-55-5]

4,4'-Thiodianiline [139-65-1]

Thiourea [62-56-6]

Toluene diisocyanates [26471-62-5]

ortho-Toluidine [95-53-4]

Trichlormethine (Trimustine hydrochloride) [817-09-4] (1990)

Trp-P- 1 (3-Amino-1,4-dimethyl-5H-pyrido [4,3-b] indole) [62450-06-0]

Trp-P-2 (3-Amino- 1-methyl-5H-pyrido [4,3-b] indole) [62450-07-1]

Trypan blue [72-57-1]

Uracil mustard [66-75-1]

Urethane [51-79-6]

Appendix 6

Known Human Teratogens

From: Shepard, T.H., Catalog of Teratogenic Agents, 9th Edition, The John Hopkins University Press, Baltimore, 1998.

Drugs and Environmental Chemicals

Aminopterin and methylaminopterin Androgenic hormones Busulfan Captopril (renal failure) Chlorobiphenyls Cocaine Coumarin anticoagulants Cyclophosphamide Diethylstilbestrol Diphenylhydantoin and trimethadione Enalapril (renal failure)

Etretinate Fluconazole, high dose

Iodides and goiter

Lithium Mercury (organic) Methimazole and scalp defects Methylene blue via intraamniotic injection

Misoprostol

Penicillamine 13-cis-Retinoic acid (isotretinoin and Accutane) Tetracyclines Thalidomide Toluene abuse

Trimethadione Valproic acid

Possible Human Teratogens

Carbamazepine

Colchicine

Disulfiram

Ergotamine

Vitamin A (large doses)

Lead

Primidone

Quinine (very large doses)

Streptomycin

Zinc deficiency

Appendix 7

European Union Directives

Chemical Agents

Council Directive 80/1107/EEC of 27 November 1980 on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work, Official Journal No. L 327 of 03.12.1980, p. 8.

Abstract:

Objective

To harmonise national provisions relating to the protection of workers by measures to prevent exposure to certain chemical, physical and biological agents, or to keep it at as low a level as is possible.

Contents

The Directive does not apply to workers exposed to radiation covered by the Treaty establishing the European Atomic Energy Community (Euratom), sea transport and air transport.

Definition of the terms ‘agent’; ‘worker’: any employed person exposed or likely to be exposed to an agent at work; ‘limit value’: exposure limit or biological indicator limit in the appropriate medium. More detailed definitions of ‘limit value’ and ‘suspended matter’ are contained in Annex Ila.

Obligations of Member States:

When adopting provisions relating to an agent, the Member States must take a series of 14 measures, including: limitations of the use of the agent, technical preventive measures, determination of the nature and degree of the workers’ exposure, establishment of limit values and of sampling procedures, measuring procedures and procedures for evaluating results (a reference method is contained in Annex Ila), collective hygiene and protection measures, information and the use of signs, and a ban on an agent in cases where there is inadequate protection. The measures also include the adoption by the employer of appropriate measures to ensure that workers and/or their representatives receive the necessary information and full instruction concerning not only the potential risks, preventive measures and precautions but also the risk assessment methods used, the

existence of a limit value and the action to be taken in the event of a limit value being exceeded.

Additional measures must be taken in the case of the list of agents specified in Annex I: medical surveillance, access to the results of exposure measurements, biological tests and information of workers.

The list of agents may be amended by the Council. The Member States must determine the extent, if any, to which each of these measures is to apply to the agent in question.

In the case of the agents listed in Annex II, the Member States must provide medical surveillance during the period of exposure and access for workers at the place of work to information on the dangers which these agents present.

Adaptation to technical progress is restricted to the technical aspects listed in Annex III. A committee consisting of representatives of the Member States has been set up to assist the Commission with adaptation to technical progress.

The Council will establish, in the individual directives that it adopts with regard to the agents listed in Annex I, binding limit values and/or other specific requirements; in the case of other agents, indicative limit values will be drawn up by the Commission, assisted by the Committee for adaptation to technical progress. The indicative limit values reflect expert evaluations based on scientific data. The directives are without prejudice to the right of Member States to apply or adopt other provisions laying down more stringent standards.

Source: European Commission. Employment and Social Affairs: Current Status, 15 October 1999. Luxembourg: Office for Official Publications of the European Communities. 2000. 265 pp.

Modifications:

Council Directive 88/642/EEC of 16 December 1988 amending Directive 80/1107 on the protection of workers from the risks related to exposure to chemical, physical and biological agents at work, Official Journal No. L 356 of 24.12.1988, p. 74.

Note: The Directive shall be repealed with effect from 5 May 2001 by **Council Directive 98/24/EC** of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (fourteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC), Official Journal L 131, 05/05/1998 p. 0011 - 0023

Council Directive 98/24/EC of 7 April 1998 on the protection of the health and safety of workers from the risks related to chemical agents at work (fourteenth individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)

Abstract:

Objective

To lay down minimum requirements for the protection of workers from risks to their safety and health arising, or likely to arise, from the effects of chemical agents that are present at the workplace or as a result of any work activity involving chemical agents.

Contents

Definition of terms ‘chemical agent’, ‘hazardous chemical agent’, ‘activity involving chemical agents’, ‘occupational exposure limit value’, ‘biological limit value’, ‘health surveillance’, ‘hazard’ and ‘risk’.

On the basis of an independent scientific assessment of the relationship between the health effects of hazardous chemical agents and the level of occupational exposure, after consulting the Advisory Committee on Safety, Hygiene and Health Protection at Work, the Commission must propose European objectives in the form of indicative occupational exposure limit values for the protection of workers from chemical risks, to be set at Community level. These limit values must be established or revised, taking into account the availability of measurement techniques.

Member States must keep workers’ and employers’ organisations informed of these limit values. For any chemical agent for which an indicative occupational exposure limit value is established at Community level, Member States must establish a national occupational exposure limit value, taking into account the Community limit value. On the basis of reports provided by the Member States, the Commission must assess the way in which Member States have taken account of Community indicative limit values when establishing the corresponding national occupational exposure limit values.

On the same basis, binding occupational exposure limit values may be drawn up at Community level, account being taken of feasibility factors. For any chemical agent for which a binding occupational exposure limit value is established at Community level, Member States must establish a corresponding national binding occupational exposure limit value that does not exceed the Community limit value.

On the same basis, binding biological limit values may be drawn up at Community level with due regard to the availability of measurement techniques and taking account of feasibility factors. For any chemical agent for which a binding biological limit value is established at Community level, Member States must establish a corresponding national binding biological limit value that does not exceed the Community limit value.

Where a Member State introduces or revises a national (biological or occupational exposure) limit value for a chemical agent, it must inform the Commission and other Member States.

The employer must determine whether any hazardous chemical agents are present at the workplace and assess any risk to the safety and health arising from their presence, taking into consideration:

• Their hazardous properties;

• Information on safety and health provided by the supplier;

• The level, type and duration of exposure;

• The circumstances of work involving such agents, including their amount;

• Any national occupational exposure or biological limit values;

• The effect of preventive measures taken or to be taken;

• The conclusions to be drawn from any health surveillance already undertaken.

The employer must be in possession of an assessment of the risk in accordance with Article 9 of Directive 89/391/EEC. This assessment shall be kept up-to-date, particularly if there have been significant changes or if the results of health surveillance show it to be necessary.

In the case of activities involving exposure to several hazardous chemical agents, the risks must be assessed on the basis of the risk presented by all such chemical agents in combination.

In the case of a new activity involving hazardous chemical agents, work must commence only after the risk of that activity has been assessed and appropriate preventive measures had been taken.

The employer must take the necessary preventive measures set out in Article 6 of Directive 89/391/EEC and include the measures set out below. Risks must be eliminated or reduced to a minimum by:

• The design and organisation of systems of work;

• The provision of suitable equipment for any work with chemical agents;

• Reducing to a minimum the number of workers exposed or likely to be exposed;

• Reducing to a minimum the duration and intensity of exposure, appropriate hygiene measures;

• Reducing the quantity of chemical agents present at the workplace to the minimum required for the type of work concerned;

• Suitable working procedures.

The specific protection, prevention and monitoring measures listed below must be applied if the assessment carried out by the employer reveals a risk to the safety and health of workers.

The employer must ensure that the risk is eliminated or reduced to a minimum, preferably by substitution (replacing a hazardous chemical agent with a chemical agent or process which is not hazardous or less hazardous).

Where the nature of the activity does not permit risk to be eliminated by substitution, the following protection and prevention measures must be taken, listed in order of priority:

• Design of appropriate work processes and engineering controls and use of adequate equipment and materials so as to avoid or minimize the release of hazardous chemical agents;

• Application of collective protection measures at the source of the risk,

• Application of personal protection measures.

These measures must be accompanied by health surveillance in accordance with Article 10 if this is appropriate to the nature of the risk.

The employer must regularly measure chemical agents, which may present a risk to workers' health, in relation to the occupational exposure limit values.

Where an occupational exposure limit value effectively established on the territory of a Member State has been exceeded, the employer must immediately take steps to remedy the situation.

The employer must take appropriate technical and/or organizational measures in the order of priority indicated to:

• Prevent the presence at the workplace of hazardous concentrations of inflammable substances or hazardous quantities of chemically unstable substances or, where the nature of the work does not allow that;

• Avoid the presence of ignition sources or the existence of conditions with an adverse effect on chemically unstable substances; and

• Mitigate the detrimental effects in the event of fire or explosion, or harmful physical effects arising from unstable substances.

Work equipment and protective systems must comply with the relevant Community provisions, in particular with Directive 94/9/EC.

The employer must establish procedures (action plans), which can be implemented in the event of an accident, incident or emergency related to the presence of hazardous chemical agents at the workplace.

These arrangements must include any relevant safety drills performed at regular intervals and the provision of appropriate first aid facilities. When one of these events occurs, the employer must take appropriate remedial action as soon as possible and inform the workers concerned. Only workers who are needed to restore the normal situation are permitted to remain in the affected area; they must be provided with protective clothing, personal protective equipment, and specialized safety equipment and plant.

The employer must ensure that information on emergency arrangements is available. This information must include:

• Advance notice of relevant work hazards and procedures so that the emergency services can prepare their own response;

• Any information on specific hazards arising, or likely to arise, at the time of an accident or emergency.

The employer must ensure that workers and/or their representatives are provided with:

• The results of the risk assessment;

• Full information on the hazardous chemical agents present at the workplace;

• Training and information on the appropriate precautions and on the personal and collective protection measures that are to be taken;

• Access to any safety data sheet provided by the supplier.

The information must be provided in an appropriate manner and updated to take account of changing circumstances.

The employer must ensure that the contents of containers and pipes and any hazard that they represent are clearly identifiable.

Member States may take measures necessary to ensure that employers may obtain on request all necessary information on hazardous chemical agents, preferably from producers or suppliers.

Annex III to the directive specifies limits above which certain chemical agents and activities involving chemical agents are prohibited. Member States may permit derogations from these prohibitions in the following circumstances:

• For the sole purpose of scientific research and testing;

• For activities intended to eliminate chemical agents that are present in the form of by-products or waste products;

• For the production and use of the chemical agents as intermediates.

In this case, the production and use of these chemical agents must take place as early as possible and in a single closed system.

Member States may provide for systems of individual authorizations.

When requesting derogation, the employer must provide the competent authority with the following information:

• The reason for requesting the derogation;

• The quantity of the chemical agent to be used annually; - the activities involved;

• The number of workers liable to be involved;

• The precautions envisaged to protect the safety and health of the workers concerned;

• The technical and organizational measures taken to prevent the exposure of workers.

Member States must introduce arrangements for carrying out appropriate health surveillance of workers for whom the results of the assessment made by the employer reveal a risk to health. The results of this surveillance must result in the taking of preventive measures when:

• The exposure of the worker to a hazardous chemical agent is such that an identifiable disease or adverse health effect may be related to the exposure;

• There is a likelihood that the disease or effect may occur under the particular conditions of the worker's work;

• The technique of investigation is of low risk to workers.

Health surveillance is compulsory for work with a chemical agent for which a binding biological limit value has been set. Individual health and exposure records must be made and kept up-to-date for each worker who undergoes health surveillance. The individual worker must have access to his personal records.

Where, as a result of health surveillance, a worker is found to have a disease or adverse health effect associated with exposure at work to a hazardous chemical agent or a binding biological limit value is found to have been exceeded, the worker must be informed by the doctor, who will provide him with information and advice regarding any health surveillance which he should undergo following the end of the exposure.

The employer must review the risk assessment that he made and the measures provided to eliminate or reduce these risks. To do this, he must take into account the advice of the occupational health-care professional in implementing any measures considered necessary, including the possibility of assigning the worker to alternative work where there is no risk of further exposure. Finally, he must arrange continued health surveillance and provide for a review of the health status of any other worker who has been similarly exposed.

Consultation and participation of workers and/or their representatives must take place in accordance with Article 11 of Directive 89/391/EEC.

Source: European Commission. Employment and Social Affairs: Current status 15 October 1999. Luxembourg: Office for Official Publications of the European Communities. 2000. 265 pp.

Appendix 8

Implementation of Chemical Agents Directive (98/24/EC) in the UK

This note is taken from the Website of the Safety Policy Directorate of the UK's Health & Safety Executive

http://www.hse.gov.uk/spd/noframes/spdatex.htm

- **Introduction**
- **Chemical Agents Directive (CAD)**
- **How the Health & Safety Commission proposes to implement CAD**
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Introduction

If you are an employer (or self-employed person) and your work involves substances that could put people's health or safety at risk you need to know about the Chemical Agents Directive (CAD).

This page gives information about:

- The requirements of the Chemical Agents Directive, and the Health and Safety Commission's implementation proposals
- Proposed key consultation and implementation dates
- Contacts for more information and other Web pages relevant to the various parts of CAD

This and associated pages will be revised as implementation progresses.

Chemical Agents Directive

CAD sets out what employers should do as a minimum to protect their workers from the effects of “hazardous chemical agents.” We intend to refer to these as substances hazardous to health or to safety as appropriate.

Any substance (solid, liquid, gas, vapor or dust) that could be hazardous to health or safety because of he way it is used or present at work is covered by the Directive. This includes substances that are harmful because they have an intrinsic property, which is:

• explosive

• flammable

• oxidizing

• toxic

• harmful

• corrosive

• irritant,

• or because of the way they are used at work

Key Features of CAD

CAD requires employers to:

- Determine and assess the risks from hazardous substances (Article 4)
- Prevent or reduce to a minimum such risks (Articles 5 and 6)
- Carry out air monitoring of exposure where appropriate (Article 6)

- Establish procedures to deal with accidents and emergencies (Article 7)
- Place employees under appropriate health surveillance (Article 10)
- Provide workers with information and training (Article 8)
- Consult them or their representatives on the issues covered by the Directive (Article 11).

The Directive also sets a new framework for establishing occupational exposure limits (Article 3).

CAD must be implemented in Member States by 5 May 2001.

How the Health and Safety Commission proposes to implement CAD

Existing British regulations already provide a sound and well-recognized basis for addressing risks from substances hazardous to health, and much of what CAD requires already features in these regulations. The Health and Safety Commission has decided that the best way to introduce the additional requirements of CAD is through new regulations that will revise and update these regulations, namely, the:

- Control of Substances Hazardous to Health Regulations 1999
- Control of Asbestos at Work Regulations 1987, and the
- Control of Lead at Work Regulations 1998.

In relation to the risks from substances hazardous to safety, the Health and Safety Commission proposes to introduce a new set of regulations to control risks from substances whose properties, under certain conditions of use, could lead to a fire or explosion. The proposed regulations would replace most of the existing law on flammable substances.

Further information about existing legislation on flammable substances can be found at HSE's flammable substances Web page. The new regulations would be the main vehicle for implementing the safety aspects of CAD and they would apply to most sectors of industry.

Proposed Key Consultation and Implementation Dates

Autumn 2000 Publication of a consultative document on proposals for new Control of Substances Hazardous to Health Regulations (COSHH) and for the Control of Lead at Work Regulations (which will implement remaining health requirements of CAD).

Autumn 2000 Publication of a consultative document on proposals for new regulations to control substances hazardous to safety (which will implement the safety requirements of CAD)

May 2001 New COSHH and Lead Regulations come into force

May 2001 New regulations come into force on the safety aspects of CAD