3rd Edition

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PREFACE

This handbook is aimed at the broad spectrum of artists, art-workers and students in teaching, industrial, cottage or home situations. It is intended that the handbook be used in conjunction with the Safety and Hazard Audit, (Appendix 1).

The tables of hazardous chemicals are not intended to provide exhaustive health and safety information, but to alert the reader to the fact that a chemical or process being used may be injurious to health. More detailed information can be obtained through the resources listed in the bibliography and sources of further information

This book is designed to be regularly updated and the author would welcome comments, criticisms and additional information. Please forward these to:

Bob Hall,
5 Hewitt Street,
Reservoir,
Vic. 3073.
Australia.

"... the workers of certain arts and crafts sometimes derive from them grave injuries, so that where they hoped for a subsistence that would prolong their lives and feed their families, they are too often repaid with the most dangerous diseases and finally, uttering curses on the profession to which they had devoted themselves, they desert their post among the living."

from De Morbis Artificum (Diseases of Workers) by Bernardino Ramazzini, 1713; translated by Wilmer Cave White, Hafner Publishing Company, New York, 1964.

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GLOSSARY OF GENERAL HEALTH AND SAFETY TERMS

The following is a glossary of health and safety terms which may be useful for a more in-depth explanation.

Acclimatisation Building up over time a resistance to or a tolerance for exposure to heat or cold This results from repeated exposure but does have its limits.

ADG Code Australian Code for the Transport of Dangerous Goods by Road and Rail. See also Dangerous Goods Class. A Code prepared by the standing national Advisory Committee on the Transport of Dangerous Goods and endorsed by the Australian Transport Advisory Council. The Code is based on recommendations prepared by the United Nations Committee of Experts on the Transport of Dangerous Goods. It covers the classification, packaging, marking and transport of dangerous goods.

Acuity (visual) Ability of the eye to discriminate fine detail. Use for SBE standard setting and an integral element of eye-testing.

Acute toxicity Effects that occur immediately or shortly after a single exposure.

Aerosol An aerosol is an airborne solid or liquid substance that may remain suspended in the air for long periods of time. Aerosols are primarily dusts, fumes and mists.

Air Sampling Testing procedure to measure airborne contaminants in a precise quantity of air.

Allergic reaction An over-reaction by the immune system to an antigen. It can take the form of a rash, asthma, weeping eyes and sneezing.

Allergic Sensitiser - see dermatitis.

Alveoli Small air spaces within the lungs where oxygen diffuses into the blood and carbon dioxide escapes. Damage to the alveoli can lead to lung disease.

Ames test A screening test using strains of bacteria in an attempt to determine whether a chemical has mutagenic effects.

Anaemia A condition in which the number or quality of red blood cells in the body is greatly reduced or altered. People with anaemia tend to suffer from weakness and fatigue.

Anemometer An instrument used for measuring the speed of air flow. It can be used to check ventilation systems.

Antidote A treatment for chemical overexposure which is specific (more or less) to the chemical or class of chemicals; in contrast to supportive treatment which maintains body functions.

Appearance A description of the physical state of the material.

Asbestosis A chronic lung disease which makes breathing more and more difficult; can cause death. The breathing difficulties are caused by the build up of fibrous scar tissue in the lungs usually after intensive exposure to asbestos dust.

Asphyxiant A chemical which acts as an asphyxiant is a gas, or can form a gas, which has little or no effect of its own, but which is present in high enough concentrations to cause a decreased oxygen supply and produce unconsciousness and death.

Asthma A lung disease in which the small air passages in the lung are in spasm, making breathing difficult.

Audiogram/Audiometer An audiometer is a machine used to measure an individual' s hearing ability. The result of the hearing test is an audiogram, a graph that records a person's ability to hear sounds of different volume and pitch.

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Australian Standard (AS) Standard published by Standards Australia, formerly the Standards Association of Australia.

Autoignition temperature The minimum temperature required to start or cause self-sustained combustion in any substance in the absence of a high temperature ignition source, such as a spark or flames. This is not applicable to many substances.

Benign Tumour Benign means harmless or not progressive. Therefore, a benign tumour is one that is generally not fatal and does not spread rapidly to other parts of the body. Certain types of benign tumours, however, may become malignant.

Biological exposure index This represents a warning level of biological response to a substance or agent, or warning levels of the substance, agent or its metabolites in the tissues, fluids or exhaled air of exposed workers. Biological exposure levels will be developed by the National Occupational Health and Safety Commission and are intended to be used in conjunction with other means of controlling exposure.

Biological Monitoring Another term to refer to medical tests (blood, urine, etc.) used to indicate the dose of a substance received by the body. The primary purpose of these tests is to determine human exposure to a hazard and they should not be seen as prevention. They may be part of a treatment program.

Boiling point The temperature at which the product changes to gas. Normally measured in degrees C at atmospheric pressure.

Bulk density Bulk density is the weight of a unit volume of powder, usually expressed in grams per cubic centimetre (g/cm).It is determined by a specific method. Apparent density is an alternate (but less commonly used) term for bulk density. See also density.

Cancer A malignant tumour which can spread to other organs of the body, as distinct from a benign tumour which cannot. (Although leukaemia and some other malignant diseases are not solid tumours, they meet other criteria for cancer and can be (and often are) included under this definition).

Capture velocity The velocity of air which is sufficient to capture a contaminant at its source causing it to flow into the hood.

Carcinogen An agent which is responsible for the formation of a cancer.

Carcinogenesis The causing of cancer.

Carcinogenic Capable of causing cancer.

Cardiovascular System The system of the heart, blood vessels, and circulation of blood.

Cataract A clouding over of the lens of the eye, causing a partial or total loss of vision. Leads to blindness if cataract is not surgically removed.

Caustic A corrosive chemical with a high pH (basic or alkaline).

Ceiling Limit The maximum concentration or level of a chemical, dust or physical agent that is allowed at any time.

Central Nervous System Depressant Chemical that can cause a slowing of the central nervous system activity in the brain and spinal cord. Results in dizziness, headache, loss of co-ordination, stupor, coma and possibly death. Many solvents are CNS depressants.

Central Nervous System Depression A lowering or decrease of function or activity of the central nervous system. Inhalation, ingestion, or skin absorption *of* substances like organic solvents can produce this condition. Symptoms, which can be progressive, may range from headaches and dizziness to mental confusion, eventual loss of consciousness, and even death.

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Chest X-Ray A test to detect damage to lung tissue. Shows the appearance and location of fibrotic changes in the lungs.

CAS number or Chemical Abstracts Services number A number assigned to a single chemical by the Chemical Abstracts Services (a US-based reference service) which serves to identify that chemical. Some mixtures (but not many) are assigned a CAS number. This is the only "one-chemical-one number" system covering all publicly known chemicals.

Chromosome Part of the cell's genetic material. Damage to chromosomes can cause harmful changes to an individual's body and may also result in birth defects.

Chronic toxicity Harmful effects of a chemical which occur after repeated or prolonged exposure. Chronic effects may also occur some time after exposure has ceased

Circadian Rhythms The daily patterns of the body' s self -regulatory mechanisms, eg. heart rate, production of hormones, temperature, sleep/wake cycles.

Circulatory System The parts of the body involved with the movement of blood. This includes the blood, blood vessels, and heart.

Code of Practice A practical guide for employers and workers on how to achieve a particular objective for health and safety at work. Codes of Practice do not have the legal force of Acts or Regulations. They should however be applied in the absence of a better solution or approach and may be used as evidence to support a prosecution.

Commercially confidential information Information (such as chemical identity or exact composition) which if made public would significantly damage genuine commercial interests.

Congenital Present at birth.

Conjunctivitis Inflammation of the delicate membrane that lines the eyelids and covers the eyeball (conjunctiva). May be caused by chemicals or other irritants or infection.

Contact Dermatitis Dermatitis of the skin due to direct contact with an irritating substance

Contaminant Poison, toxic substance - anything that makes air or water unfit for human consumption or contact.

Correct Shipping Name Name for identifying substances classified as dangerous goods under the ADG Code. (Refer to the Code for further information).

Correct Technical Name This means in order of preference:

* the name of the substance as listed in section 9 and 10 of the ADG Code:

* the name of the substance in the Schedules of the National Health and Medical Research Council's "Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP)"; or

* a name commonly used in scientific and technical handbooks, textbooks and texts, which accurately identifies the substance.

Corrosive A substance which causes destruction of or damage to materials or living tissue on contact. For precise criteria for determining whether a substance is classified as corrosive under the ADG Code, refer to Section 2 of the Code.

Cumulative Additive effects of a substance with long-term exposure, particularly as it affects the same organ (lungs, liver, etc.).

Dangerous Goods Substances which are either specifically listed in the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code) or meet the classification criteria of Section 2 of that Code.

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Dangerous Goods Class The class allocated to a substance under the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code). Classification is according to the predominant type of risk involved:

Class 1 Explosives

Class 2 Gases: compressed, liquefied or dissolved under pressure

- Class 2.1 Flammable gases
- Class 2. 2 Non-flammable, non-toxic gases
- Class 2. 3 Toxic gases

Class 3 Flammable liquids

- Class 3 PG I Highly Flammable Liquids with a boiling point (BP) below 35°C, eg. diethyl ether
- Class 3 PG II Highly Flammable Liquids with a flashpoint less than 23°C and BP greater than 35°C, eg. petrol, acetone
- Class 3 PG III Flammable Liquids with a flashpoint of 23°C or more, but less than or equal to 61°C, eg. kerosene, mineral turpentine

Class 4 Flammable solids

- Class 4.1 Flammable solids
- Class 4. 2 Substances liable to spontaneous combustion
- Class 4.3 Substances which emit flammable gases on contact with water

Class 5 Oxidising agents and organic peroxides

- Class 5.1 Oxidising agents
- Class 5. 2 Organic peroxides

Class 6 Toxic and infectious substances

- Class 6.1 Substances which are liable to cause death or serious injury or to harm human health if swallowed or inhaled or by skin contact, eg. cyanides, arsenic compounds
- Class 6.2 Infectious substances, eg. pathology samples

Class 7 Radioactive substances

Class 8 Corrosives

Class 9 Miscellaneous dangerous goods

Dead Finger Damage to the hand due to vibration, causing whiteness and pain in the fingers. Also called white finger.

Decibel (dB) A unit used to measure sound pressure level or sound intensity. To account for the ear's response to different frequencies, a special "A" weighting is applied ie. dB(A). The dB(A) unit is generally used for noise exposure surveys in the workplace.

Density Ratio of mass of a substance to its volume. It is usually measured at 20 C and expressed in grams per cubic centimetre (g/cm). See also bulk density.

Dermal Relating to the skin.

Dermatitis Inflammation of the skin. **Irritant contact dermatitis** is direct damage to the skin which is due to contact with the irritant substance (for example, acids, alkalis, organic solvents) in sufficient concentration and for sufficient time. It occurs soon after exposure and persists long after exposure has ceased. **Allergic contact dermatitis** is an inflammatory reaction caused by substances which penetrate the skin and cause a specific allergic response (sensitisation) after a variable lag period ranging from a matter of days to several months. Once sensitisation has occurred, exposure to only a relatively small quantity of the substance will trigger a reaction within 48-96 hours due to developed hypersensitivity of the body.

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Diffusers Shields fitted to light sources to reduce direct glare and spread light evenly.

Dilution Ventilation A type of general ventilation to be used for providing fresh air in the plant. This usually means installing fans in the roof or sides of the plant. Those in the roof usually pull stale air out of the plant and thus pull fresh air in through windows or make-up air units. Fans in the side of the plant usually pull fresh air into the plant directly. Dilution ventilation is not effective as a way to control direct exposures to chemicals.

Direct-Reading Instrument An instrument that gives an immediate indication of concentration of an airborne contaminant by some means such as a meter or the changing colour of a chemical. Some types are simple to operate and can be used by workers to check for hazardous levels of substances in the workplace.

Dosimeters A range of instruments used for measuring levels of exposure of radiation, noise, carbon monoxide. etc

Dose The quantity of a substance or a physical agent at the site of effect. The site may be the whole body, the skin or particular organs. Rarely measured accurately.

Dose-Effect The relationship between a given dose and the size of observable biological effects in a specified proportion of the population .

Dose-Response The "cause and effect" relationship. The expected range of health effects in the total population following exposure to specific agents.

Dusts Fine, solid, powdery particles, varying in size, that do not diffuse in air, but eventually settle because of gravitational force. They are' distributed by air currents. Suspension of solid particles in the air.

Earth The connection of containers to ground to prevent shocks and sparks.

Eczema An allergic skin rash.

Electro-cardiogram A measure of the electrical activity of the heart muscle.

Embryotoxic Causing toxic effects during early pregnancy.

Emphysema A destructive lung disease in which breathing gets more and more difficult because the alveoli in the lungs are damaged and break down. This reduces the ability of the lungs to pass oxygen into the bloodstream.

Engineering Controls Changes to the design of plant and work processes to eliminate or control worker exposure to hazards.

Entity A single chemical.

Epidemiology The study of the occurrence of illness/disease.

Ergonomics Analysis and design of work processes and equipment to suite the humans who work in a given situation.

Evaporation The change of a substance from a solid or a liquid into the gaseous phase.

Evaporation Rate The ratio of the time required to evaporate a measured volume of a liquid to the time required to evaporate the same volume of a reference liquid (usually ethyl ether or butyl acetate). The higher the ratio, the slower the evaporation rate. The term relative evaporation rate is also used to describe the above ratio.

Explosive Limits See flammability limits.

Exposure Quantity of contaminant present in the immediate area of the worker. Must be measured over time and with record of variations and other factors which may influence actual dose receive by a work.

Exposure Standard An exposure standard represents an airborne concentration of a particular substance in the worker's breathing zone, exposure to which, according to current knowledge, should not cause adverse health effects

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nor cause undue discomfort to nearly all workers. The exposure standard can be: Time-Weighted Average (TWA), Peak, Short Term Exposure Limit (STEL) or General Excursion. The applicable exposure standard, when calculated as defined, shall not be exceeded.

Exposure Standard - General Excursion Where a "peak" or "STEL" is not specified, the airborne concentration of a particular substance, measured over a period not exceeding 15 minutes, should not exceed three times the TWA exposure standard for more than a total of 30 minutes per eight-hour shift and under no circumstances should the values exceed five times the TWA exposure standard, provided that the TWA exposure standard is not exceeded.

Exposure Standard - Peak A maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time.

Exposure Standard - STEL The airborne concentration of a particular substance, averaged over a period of 15 minutes, should not be exceeded at any time during a normal eight hour working day. Workers should not be exposed at the STEL concentration continuously for longer than 15 minutes, or for more than four such periods per working day. A minimum of 60 minutes should be allowed between successive exposures at the STEL concentration

Exposure Standard - Time-Weighted Average (TWA) The average airborne concentration of a particular substance when calculated over a normal eight hour workday, for a five-day working week.

Fetotoxic (foetotoxic) Causing toxic effects during pregnancy.

Fibrosis A thickening associated with growth of scar tissue usually in the lungs.

Flammability The property describes a danger of the product catching fire and under what conditions

Flammability limits The range of concentrations of a flammable vapour in air at which a flame can be propagated or an explosion will occur, if a source of ignition is present. Normally expressed as upper and lower limits of this range (as percentage of the volume of vapour in air). The term Explosive Limits means the same as flammability limits.

Flammable Capable of being ignited and of burning in air, or in the case of flammable liquids those which have a flashpoint not greater than 61°C.

Flashpoint In general terms, the lowest temperature in C at which a liquid will produce enough vapour to ignite, if the vapour is flammable. For a specific definition for the purposes of classifying substances under the ADG Code, refer to the Code. Flashpoint is established by closed or open cup methods. The lower the flashpoint, the higher the risk of fire.

Fumes Extremely small, solid particles produced through a process involving the vaporisation and subsequent condensation of solids, usually metals. They are generally produced when metals are heated above their melting points, for example, in welding or soldering.

Gas A state of matter that has no definite volume or shape, and which can expand and contract in response to changes in temperature and pressure and will diffuse to fill a space.

Gastrointestinal (GI) Tract Body system including mouth, oesophagus, stomach, small intestine, and large intestine (colon).

Gene The material contained within cells responsible for determining inherited characteristics.

General Duty Requirement in legislation for employers to provide and maintain healthy and safe work practices.

Generic Name A means of classifying a group of things (usually chemicals) according to some basic characteristics in common. Can be misleading if used as a guide to health effects.

Genotoxicity The effect of causing damage to genetic material.

Hazard The possibility that exposure to an agent (physical, chemical or biological) will cause injury or harm.

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Hazard Data Sheet See Material Safety Data Sheet.

Hazchem Code The Hazchem emergency action code of numbers and letters gives information to emergency services. Its use is required by the Australian Code for the Transport of Dangerous Goods by Road and Rail.

Heat Cramps The muscles used to perform a job develop painful spasms (usually in the legs, arms, or abdomen) as a result of exposure to excess heat.

Heat Exhaustion A condition usually caused by loss of body water because of exposure to excess heat. Symptoms are - headache, tiredness, nausea, giddiness and sometimes fainting.

Heat Stroke The most serious disorder resulting from exposure to excess heat. Heat stroke results from sweat suppression and increased storage of body heat. Symptoms are: hot dry skin, high core temperature (usually above 40 C and rising), mental confusion, loss of consciousness, convulsions and coma. Heat stroke is usually fatal unless treated QUICKLY and CORRECTLY.

Heritable Capable of being inherited

I.A.R.C. The acronym for the International Agency for Research on Cancer.

Identification A section of an MSDS providing information on the name of a product, some of its other names, its use, properties and chemical composition.

Ignition Setting fire to or being set fire to.

Incidence The number of cases of a particular injury or disease reported in a particular period of time (eg. one year).

Incompatibility A situation where any substance or residue which by combining chemically with the incompatible substances or promoting self-reaction or decomposition of the incompatible substances, may create a hazard.

Industrial Deafness A name given to permanent hearing loss due to exposure to noise at work.

Ingestion Taking a material into the body by mouth (swallowing).

Inhalation Taking into the body by breathing in.

Interaction Modification of toxic effects of one substance by another. The effects can be amplified (synergism) or reduced (antagonism).

"In Vitro" Tests Simple, inexpensive laboratory screening tests using bacteria rather than more complex living organisms to detect *mutagens* and *carcinogens.* The tests are based on the fact that *genetic* material is the same in all living organisms. The most popular test for detecting mutagens is the Ames test. It can also be used to detect carcinogens.

Ionising Radiation High-energy radiation (x-rays, beta-rays, gamma rays, alpha particles) that can destroy living matter. Capable of causing cancer and genetic effects.

Irritant A substance that will produce local irritation or inflammation on contact with tissues and membranes such as skin or eyes, or with nasal or lung tissue after inhalation.

LC_{Lo} The lowest concentration of a substance (usually in air) that is reported to have caused death in humans or animals.

LC_{50} (Lethal Concentration for 50%,) The concentration of a substance in the air which will kill half the test animals exposed within a certain time.

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LD_{50} (Lethal Dose for 50%) A dose of a substance that produces death in 50% of a population of experimental animals. LD_{50}'s may be estimated after swallowing, by injection or after application to the skin. It is usually expressed as mg per kg of body weight.

Latency Period The time that elapses between exposure and the first signs of disease

Leq The equivalent continuous sound pressure level. The Leq integrates the sound energy of a fluctuating sound and presents a level which is equivalent to a continuous sound with the same energy content.

Leukemia Cancer of the blood, involving abnormal growth of white blood cells.

Local effects Harmful effects of a chemical at the point of contact or entry to the body.

Local Exhaust Ventilation Engineering controls to capture contaminants at the point of release usually with a specially designed hood.

Lung Function Tests A range of tests to determine the respiratory effectiveness of lungs, in terms of air flow ratio and capacities.

Malignant Signifying an invasive cancer with an ability to grow at sites other than the tissue of origin as distinct from benign cancer which remains localised within the tissue.

Material Safety Data Sheet A document that describes the properties and uses of a chemical product or formulation - identity, chemical and physical properties; health hazard information; precautions for use; and safe handling information.

Mesothelioma A rare cancer of the lining of the lungs and of the pleural cavity. Almost always related to asbestos exposure.

Metal Fume Fever Flu-like symptoms: commonly experienced after inhalation of welding fumes.

Metabolite A substance produced by the action of the body on an absorbed chemical.

Melting Point A temperature in degrees Celsius at which a substance can exist in solid and liquid form. Normally measured at 760 mm Hg.

mm Hg Millimetre of mercury (Hg). A unit of pressure. See also pascal.

Mist Airborne liquid droplets that are created either by a gas going into the liquid state or by a liquid being splashed, foaming or atomised. Examples: oil mist from cutting, grinding, or from pressure; paint mists from spraying. Using aerosol cans.

Molar (M) Moles per litre. T his is a unit of concentration.

Mole Gram molecular weight. This is a unit of mass.

Morbidity The number and type of illnesses suffered by a certain group of people over a particular time. It is usually expressed as morbidity rate.

Mortality The number and causes of deaths for a particular group of people over a specific time. Often expressed as a mortality rate.

Mucous membrane A membrane lining body cavities connected to the outside. From occupational health aspects the most important mucous membranes are the nose, throat and lung linings.

Mutagens A mutagen is a substance which can cause changes in the DNA of cells (mutations). **Mutagenic** means able to cause mutations. **Mutagenicity** is the ability of a substance to cause mutations. DNA determines the characteristics that children inherit from their parents. DNA also determines how cells in the body divide or reproduce.

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Mutagenesis The process of producing a mutation. See mutation.

Mutation A change in the genetic material of cells.

Narcotic Affecting the central nervous system, especially the brain. Symptoms include giddiness, dizziness, headache, confusion, and in some cases, possibly coma or death. Common effect of organic solvent exposure.

New Technology A general term for the rapid changes in equipment, methods and process in the workplace. New technology often brings unknown new hazards which must be anticipated and dealt with as part of the implementation of change.

NH&MRC National Health and Medical Research Council (Aust.). Used to set voluntary national standards for various occupational hazards. Functions now exercised by NOHSC.

NOHSC National Occupational Health and Safety Commission (Aust) also called Worksafe Australia. Responsible for national co-ordination of health and safety activities and standards. Is a tripartite body with representatives of major employee organisations (ACTU), employer organisations (ACCI), and the State/Territory and Commonwealth Governments.

Noise Unwanted sound.

Noise Induced Hearing Loss (NIHL) The slowly progressive inner ear hearing loss that results from exposure to continuous noise over a long period of time as contrasted to trauma or physical injury to the ear.

Occupational Diseases result from repeated or long term exposure to an agent(s) or event(s) or which are the result of a single traumatic event where there was a long latency period (eg. the development of hepatitis following a single exposure to the infection).

Occupational Hygiene The identification, assessment and control of workplace hazards

Occupational Injury An employment related injury (damage to the body) as a result of a single traumatic event or the result of a single exposure to an agent(s) causing acute toxic effect. Employment injuries with a long latency period are included in occupational diseases.

Odour Threshold The minimum concentration of the substance in air capable of being detected by the human sense of smell. Normally expressed in parts per million (ppm) or milligrams per cubic metre (mg/m3).

Oncogenic Capable of producing tumours.

Oral By mouth

Organic Compounds Chemicals containing hydrogen and carbon, along with other atoms. All living things are made of organic compounds.

Overuse Injuries Also called RSI or Occupational Overuse Syndrome. A wide range of distinct conditions affecting muscles and tendons. Associated with rapid repetitive movements of fingers, hands, arms and legs and also with forced static postures.

Oxidising property A property of substances which, although not necessarily combustible, may readily liberate oxygen or be the cause of an oxidation process and which, as a result, may start a fire in other materials or promote the combustion of other materials.

Packing Group (formerly called packaging group) As defined by the ADG code, this means the division of dangerous goods of Classes 3, 4, 5, 6.1, 8 and 9 into three groups according to the degree of danger they present for packaging purposes: "I" (great danger), "II" (medium danger) and "III" (minor danger).

Particulates Solid or liquid particles suspended or dispersed in air. Examples are dusts, mists, fumes, and smoke.

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p.p.m. Parts per million. The standard unit of measurement of concentration of contaminants in the environment.

ppm (w/v) in water = mg/L
ppm (w/w) in solids = mg/kg

Pascal SI unit of pressure. See also mm Hg. 101.25 kPa = l atmosphere = 760 mm Hg.

Per cent volatiles Percentage of a chemical substance or substances lost by evaporation.

Percutaneous Through or across the skin. Usually refers to absorption of a chemical.

Permit-to-work A document which identifies the plant to be worked on and details of precautions to be taken before work can commence. It predetermines the safe procedure and is a clear record of the hazards that have been anticipated defining the appropriate precautions to avoid them.

Personal Protection Refers to clothing and equipment worn by individual workers when no other means is available to control hazards of work

pH A unitless value representing how acid or alkaline a solution is. Acids have a pH of less than 7. The lower the pH, the stronger the acid (normal minimum 0). Alkalis have a pH greater than 7. The higher the pH, the stronger the alkali (normal maximum 14).

0. 01 M hydrochloric acid has a pH of 2.

0. 01 M sodium hydroxide has a pH of 12.

0. 01 M acetic acid (a weak acid) has a pH of 3 and 0.1 M ammonium hydroxide (a weak alkali) has a pH of 11. As the pH scale (shown below) is logarithmic, the intervals are exponential, and thus represent far greater differences in concentration than the values seem to indicate.

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0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

strong acids neutral strong alkalis

Pure water has a pH of 7. The pH of sea water is 7. 8-8. 2, pH of gastric juices is 1.7, pH of urine is 5-7, pH of blood is 7.3-7.5 and the pH of milk is 6.5-7.

Photo-Sensitisation Where the skin reacts to exposure to light as result of earlier exposure to particular chemicals or other agents.

Physical Hazards Non chemical agents in the workplace which may post a threat. Heat, Noise, Vibration and Radiation.

Physical State/form Whether a product is in the solid, liquid or gaseous state at room temperature (20°C).

Poisons Schedule A classification of compounds requiring special labelling and precautions in use. The Poisons Scheduling ultimately applies restrictions at the point of sale. The Standard for Uniform Scheduling of Drugs and Poisons (SUSDP) is recommended by the National Health and Medical Research Council (NH&MRC) and is the basis for State and Territory legislation.

Prohibition Notice A legal written order issued by an Inspector requiring cessation of work until further notice.

Provisional Improvement Notice (P.I.N.) A legal notice which may only be issued by elected Health and Safety Representatives. For use when attempts at negotiation to resolve an issue have f ailed and there is a breach of the Act or Regulations.

Pulmonary 0f the lung.

Radiation: electromagnetic - the transmission of energy via alternating electric and magnetic fields through space or matter eg. air. Radiowaves, microwaves, infra-red, visible light, ultra-violet radiation and X-rays are examples of electromagnetic radiation.

Radiation: ionising - radiation that is capable of producing ions i. e. charged particles in the material that they pass through. Ionising radiation can be electromagnetic eg. X-rays, gamma rays, or particulate e. g. alpha, beta and neutrons. Capable of causing cancer and genetic defects .

Respirable dust Pieces of solid matter so small that they do not settle out of the air or become trapped by breathing passages. They enter the alveoli of the lungs thus making this type of dust the most hazardous.

Respirator A device which is designed to protect the wearer from inhaling harmful contaminants. May be air purifying non-powered or powered, requiring filters to remove particles or gases or both, or air supplied (eg. air-line supplied or self contained).

Risk The probability that a potential harm may become actual.

Sensitisation To become sensitive/allergic to the effects of even minute quantities of a substance.

Sensitiser A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

Shock sensitivity Tendency of a substance to explode if dropped or roughly handled.

SI Number Substance Identification Number. Synonymous with UN Number.

Solubility A measure of how soluble a substance is. Solubility in water is usually expressed as g/l. Other units include g/100cm, %,w/v or ppm of water.

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Specific gravity is the ratio of the density of a material to the density of water. The density of water is about 1 gram per cubic centimetre (g/cc). Materials which are lighter than water (specific gravity less than 1.0) *will* float. Most materials have specific gravities exceeding 1. 0, which means they are heavier than water and so will sink.

Subsidiary risk A risk in addition to the class to which Dangerous Goods are assigned; and which is determined by a requirement to have a subsidiary risk label under the ADG Code.

Substance A substance is defined as any natural or artificial substance other than an article, whether in solid or liquid form or in the form of a gas or vapour. Other terms used to describe substances include: 'chemicals', 'materials', 'mixtures', 'products', and 'preparations'. Most substances do not contain a single, pure component and many are of complex and variable composition.

SUSDP The Standard for the Uniform Scheduling of Drugs and Poisons. See Poisons schedule.

Synergistic Effects The situation in which the combined effect of two chemicals is much greater than the sum of the effect of each agent alone.

Systemic effects Pertaining to the effects of a chemical on the organs and fluids of the body remote to the point of contact or absorption (as opposed to local effects).

TC_{LO} The lowest concentration of a chemical substance (usually in air) reported to produce any toxic effect in humans or animals.

TD_{LO} The lowest dose of a chemical substance reported to produce any toxic effect in humans or animals.

Teratogen An agent capable of causing abnormalities in the developing foetus, ie. causing birth defects.

Teratogenesis The causing of abnormalities in a developing foetus, ie. causing birth defects.

TLV Threshold Limit Value These values are a type of exposure standard promulgated by the American Conference of Governmental and Industrial Hygienists (ACGIH). Three categories of Threshold Limit Value (TLV) exist:

(a) The Threshold Limit Value-Time Weighted Average (TLV-TWA) - the time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect

(b) Threshold Limit Value-Short Term Exposure Limit (TLV-STEL) - the concentration to which workers can be exposed continuously for a short period of time without suffering from:

(i) irritation;
(ii) chronic or irreversible tissue damage; or
(iii) narcosis of sufficient degree to increase the likelihood of accident injury, impair self-rescue or materially reduce work efficiency and provided that the daily TLW-TWA is not exceeded.

It is not a separate independent exposure limit; rather it supplements the time-weighted average (TWA) limit where there are recognised acute effects from a substance whose toxic effects are primarily of a chronic nature. STELs are recommended only where toxic effects have been reported from high short-term exposures in either humans or animals.

A STEL is defined as a 15-minute time-weighted average exposure which should not be exceeded at any time during a work day even if the eight-hour time-weighted average is within the TLV. Exposures at the STEL should not be longer than 15 minutes and should not be repeated more than four times per day. There should be at least 60 minutes between successive exposures at the STEL. An averaging period other than 15 minutes may be recommended when this is warranted by observed biological effects.

(c) Threshold Limit Value-Ceiling (TLV-C) - the concentration should not be exceeded during any part of the working exposure.

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Total Body Burden The amount of a chemical in the body as a result of the introduction by all routes. Many substances accumulate in the body. If the amount of a toxic substance received in the body exceeds the body's ability to excrete the substance, the total body burden may reach a level where bodily harm may occur

Toxic effect The property of an agent to produce harm or damage to an organism. Usually refers to functional (systemic) damage but may be developmental in respect of tissue and skeleton in the case of the embryo. The damage may be permanent or transient.

Tumour A swelling or enlargement; an abnormal mass of tissue in which the growth of cells is uncontrolled. A tumour can be either benign (not malignant) or malignant (cancerous). Also called neoplasm.

UN Number A system of four digit numbers assigned by the United National Committee of Experts on the Transport of Dangerous Goods. UN Numbers are assigned to one substance or to a group of substances with similar characteristics. They are not necessarily unique to one chemical, and may cover a group of chemicals with similar hazardous properties (for example epoxy resins)

Vapour The gaseous form of a material which, in its normal state, is a solid or liquid. Vapours occur through the evaporation of a liquid.

Vapour Density Ratio of the density of the vapour compared to the density of air (the density of air is assumed to be one). Vapours with a vapour density greater than 1 will tend to stay close to the floor,
whereas vapours with a vapour density less than 1 will tend to rise.

Vapour Pressure When a substance evaporates, its vapours create a pressure, the vapour pressure. This is the pressure at any given temperature in equilibrium with its liquid or solid form. The higher the vapour pressure, the more the substance tends to evaporate.

Ventilation:

General or dilution A system which allows for the continuous removal of contaminated air by replacement with fresh air;

Local Exhaust Ventilation Involves the removal of contaminated air at or near the point of source and is necessary for controlling highly toxic chemical pollutants. This system provides the most effective ventilation because it prevents the contaminants from entering the breathing zone.

Volatile Able to pass readily into the vapour state.

Volatility The tendency of a solid or liquid material to pass into the vapour state at a given temperature in degrees Celsius. Specifically, the vapour pressure of a component divided by its mole fraction (gram molecular weight) in the liquid or solid.

Weight per volume, W/V A measure of content of a solid in a solution.

Weight per weight, W/W A measure of content of a solid in a solid.

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INTRODUCTION

It is difficult to think of any field of human activity that encompasses a greater selection of processes and techniques than arts and crafts. A college of art and design may well have students mixing pigments, casting metals and plastics, operating machine tools, cutting and welding in studies as diverse as sculpture and photography, wood and leather craft, dance, drama and music, glasswork and ceramics, leadlighting and jewellery and painting and design. A far greater number of people are engaged in handicrafts for personal pleasure or business, or both, and can be found working at home, in studios or "cottage industries".

A vast array of chemicals are used in the arts and crafts (many of them the products of the burgeoning chemicals industry) and it is alarming that little or no attention is given to the subject of safe practice. What has largely gone unrecognised, and sometimes ignored is that art materials are composed of the same chemicals that cause major occupational health problems in industry. These same health problems can often be found in the art community. Artists and crafts people are often working without adequate ventilation exposing themselves to unacceptable levels of solvents, dusts and fumes. The lack of knowledge of the chemical environment that artists work in, combined with poor hygiene (eating and smoking while working with art materials) exacerbates the problem. Not only can these practices put artists themselves at risk but their families and co-workers.

This handbook provides basic information about some of the many hundreds of chemicals found in art techniques and processes; where to go for more detailed and up to date information; and the appropriate procedures and environmental controls to be used.

The first section of the handbook introduces some of the basic concepts in toxicology - the science of poison. It looks at the routes of entry for poisons, their general effects on the body and the control strategies that can be used to reduce or eliminate the problem.

A glossary is provided at the beginning of the handbook to enable the reader to familiarise themself with some of the technical terms used in the handbook or those found in a Material Safety Data Sheet.

Access to health and safety information on art materials is often difficult because many have little or no ingredient and health warning labels. The tables of hazardous materials in this book have been compiled to cover many of the materials used in the major areas of the visual arts; sculpture, painting, printing, ceramics and photography.

Many of the chemicals used in other areas of the arts and crafts, for example glass work, textile dyeing, etc. may also be found in these tables.

A Safety and Hazard Audit has been included as a practical aid in the recognition of chemical and physical hazards and as a guide to the blend of control strategies that may be required.

It is hoped that armed with this information the artist can develop safer work practices, the art teacher safer teaching programmes.

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CHEMICALS AND THE ARTIST

We are generally aware of our physical environment; we know if it is too hot or cold, too noisy, too dark. Similarly we are largely aware of physical hazards associated with many of the machines and tools used by artists. These are problems that can be easily identified. For example, we can see whether a tool can cut or trap, whether a grinding wheel can produce showers of sparks and particles, and with basic education and awareness take the right precautions, eg. ensuring that a machine is guarded or that eye protection is provided and used. (The hazards of some machinery is briefly covered in the sculpture section).

The chemical environment, on the other hand, is more insidious. Potters, sculptors, painters and printers may be aware of some of the occupational diseases suffered by earlier generations of artists and artisans; "potters rot" caused by inhaling silica dust from clays over many years or neurological problems caused by ingesting lead or cadmium from paints. These are the "traditional" occupational illnesses, most of which have been reduced or eliminated in work place situations.

(glass workers) "are liable to diseases of the chest ... their lungs become ulcerated".

"painters are attached by various ailments such as palsy of the limbs ... unhealthy complexions, melancholia, and loss of the sense of smell" "if one reads the lives of painters it will be seen that they are no means long-lived ...."

"In almost all cities there are other workers who habitually incur serious maladies from the deadly fumes or metals. Among these are the potters."

" Diemerbroeck ... when he discovered cadavers (of sculptors and stone-cutters) he found ... piles of sand in the lungs, so much of it that in cutting with his knife through the pulmonary vesicles he felt as though he were cutting a body of sand"

" Besides disease of the eyes printers (and compositors) incur other series maladies ... diseases of the chest".

from De Morbis Artificum (Diseases of Workers) by Bernardino Ramazzini, 1713.

In recent years a new generation of man-made chemicals have appeared for the artist to use in plastics, paints, inks and dyes; chemicals in a multitude of combinations under thousands of brand names. It is this new chemical environment that poses a serious danger for the artist, not necessarily in sudden, dramatic or acute ways but with a subtlety that may be hard to understand and difficult to diagnose. The incorrect use of these chemicals may result in reduced life expectancy, in a lessening of the quality of life and, for the artists, a loss of creative ability.

It is important to stress that the knowledge about the health effects of most of these new chemical is poor and while the acute and short term effects may be known, the long term chronic effects are often not, so it is wise to treat all chemicals as potentially dangerous. Table 1 lists the principle art and craft disciplines, the materials used and their possible health effects following exposure.

The following sections will look at ways in which chemicals can gain entry to the body and some of the mechanisms of damage.

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TABLE 1: ART HAZARDS

The table below lists art and craft disciplines, the associated materials used and their possible health effects following exposure.

Some people may never experience adverse health effects but others may, depending on the length of time and concentration of exposure, personal sensitivity, work habits, studio lay-out etc. Smoking, eating and drinking while working with chemicals increases the level of exposure and the damaging effects of the body.

Craft materials	Associated hazardous materials	Possible risk
Metal soldering casting welding forging	Solders containing lead, zinc, borax and fluorides produce toxic gases. Cadmium solder produces toxic fumes. Resin Fluxes. Metal moulds of silica or asbestos.	Damage to nervous system Fire Explosion Heat stress Electrical shock Burns and cuts Chronic lung disease
Painting	Pigments containing cadmium, lead nickel, cobalt, organic compounds. Solvents. Asbestos (pastels, gouache).	Irritation Danger to vital organs Chronic lung disease Some pigments are suspected carcinogens
Plastics, Rubber	Vapours from mixing and heating processes. Monomers, solvents and additives.	Irritation Intoxication Damage to vital organs Allergic skin reactions Chronic respiratory disease.
Printmaking	Pigments containing cadmium, lead compounds, nickel, cobalt, zinc, asbestos. Toxic and flammable solvents. Acids.	Irritation Intoxication Damage to vital organs Some pigments are suspected carcinogens
Sculptured Media clay plaster wax (see also metal, plastic, wood)	Some oil-based modelling clay. Stone containing asbestos or silica. Flammable waxes release toxic fumes when heated. Solvents.	Irritation Intoxication Damage to vital organs Lung disease
Textiles fibre dyes batik	Vegetable moulds. Solvents. Mordants. Corrosive vat and acid dyes. Direct dyes (azo, coal-tar, aniline). Toxic waxes.	Allergic reactions Chronic lung and other diseases Some dyes are suspected carcinogens

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Craft materials	Associated hazardous materials	Possible risk
Woodwork	Glues, paints, strippers, finishes and solvents. Timbers/dusts	Irritation Intoxication Damage to vital organs Allergic reactions Possible hearing impairment from machinery.
Biological materials plants feathers bone shells ivory	Poisonous plants. Plants containing toxic pesticides. Toxic glues, lacquers, paints, varnishes, dyes, solvents. Untreated animal material.	Respiratory irritation Damage to vital organs Allergic reactions Bacterial disease
Ceramics clay glazes firing	Many clays contain silica. Glazes containing lead cadmium, chrome, zinc, asbestos, silica, uranium oxides. Gases and metal fumes released during kiln firing, especially in salt glazing and Ruku firing.	Chronic lung disease Skin irritations Allergic reactions Damage to vital organs.
Enamelling	Corrosive acids. Some enamels contain silica, nitrobenzene, lead. Silver solders containing cadmium.	Acid burns Chronic lung disease Damage to vital organs
Glass glassblowing stained glass	Fluxes and stabilisers. Colourants (metal compounds). Corrosive acids. Lead Came Carbon monoxide. High temperatures. Infra-red radiation.	Heat stress Eye damage Acid, thermal and infra-red burns Carbon monoxide Damage to vital organs.
Leather and Tanning	Dyes and glues. Improperly-cured and stored hides esp. from middle and far east. Chromium.	Irritation Intoxication Damage to vital organs Bacterial disease Allergic reactions
Graphic Arts	Solvents from spray adhesives & aerosols - (toluene, xylene). Rubber solution - (petroleum ethers). Solvents. Pigments.	Nausea, headaches, irritation.

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Craft materials	Associated hazardous materials	Possible risk
Photography and Photoprocesses	Chemicals in: - Developers - Stop baths - Fixers - Intensifiers - Hardeners and stabilisers	Skin and eye irritations Burns Lung and respiratory tract irritation, Ulcerations, allergies, Nervous system disorders

Ensure "adequate ventilation" when working with any chemicals, ie. adequate to maintain exposure well below the Worksafe Occupational Exposure Standards or Threshold Limit Values (TLV's). Use personal protective devices (respirators, gloves, goggles) as advised on labels and in Material Safety Data Sheets. Ensure respirator cartridges are selected for the correct chemical (organic solvent, inorganic gases and vapours, dust etc.); ensure that respirator fit is effective and that it is maintained regularly.

> We all know what terrible maladies are contracted from mercury by goldsmiths, especially those employed in gilding silver and copper objects. This work cannot be done without the use of amalgam, and when they later drive of the mercury by fire they cannot avoid receiving the poisonous fumes into their mouths, even though they turn away their faces.
>
> Ramazzini

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ROUTES OF ENTRY

Chemicals can enter the body in three main ways:

1. inhalation ie. breathing the substance
2. ingestion ie. being swallowed
3. absorption through the skin

Once inside the body, chemicals are transported by the blood to the various organs of the body.

INHALATION

Once a substance is in the air it can be inhaled as a vapour, fume, mist or dust. Vapours (eg. from organic solvents) can dissolve directly into the cells of the lung wall causing damage and be absorbed into the blood stream and so reach the vital organs.

Small particles of dust and fumes and mists which are inhaled may also enter the blood stream or may remain in the lungs causing fibrosis (scarring), cancer or inflammation.

Larger particles are deposited in the nose, throat and upper respiratory tract. The body's defence mechanisms may then expel them.

Corrosive substances such as ammonia and acetic acid can cause damage quickly whereas chemicals such as silica dust and asbestos cause slow developing, long term damage. Some chemicals can cause severe allergic responses.

Inhalation of hazardous vapours, dusts and fumes constitute one of the most commonly encountered art-related dangers.

Inhalation of Aerosols

Aerosols may be in the form of dusts, fumes and mists.

Dusts are solid particles of material, of varying size, dispersed in the air. Dust will eventually settle under gravity but fine dust may remain dispersed in the air for days. Dusts are distributed by air currents.

Dusts can be generated by a variety of processes found in pottery, sculpture, drawing and painting and may consist of sawdust, plaster, clay dust, glazes, stone dust and pigment dusts from paints, pastels, dyes, etc. Silica dust from clays and stone have long been known to cause a lung disease called "silicosis".

Large dust particles are generally trapped in the nose or mouth. Smaller dust particles are swept out of the respiratory tract by very fine hairs, called "cilia", that line the breathing passages. The most dangerous dusts are those of 5 microns or less, in diameter. They are called "respirable" and are taken right into the air sacs deep inside the lungs where the oxygen we breath is taken into the blood. Here they may cause damage to the tissue resulting in scarring or "fibrosis" which reduces the lungs elasticity and capacity, resulting in the sufferer experiencing breathing difficulties. In some instances particles may even enter the cells in the air sacs. This can result in cellular transformations, which in time may lead to cancer.

Some dusts such as lead and arsenic can be absorbed from the lungs into the bloodstream and so affect other internal organs.

Fumes are very small (often "respirable") solid particles produced when vapourised material condenses.

Fumes from welding and foundry processes can be very toxic and can cause severe lung damage if acute exposure occurs, for example cadmium fumes can cause severe pulmonary oedema, ie. fluid in the lungs.

Metal fumes can be absorbed into the blood stream and produce toxic effects. "Metal fume fever" is a well described occupational illness amongst welders and foundry-workers. This is caused by inhalation of zinc, copper, brass and bronze fumes, and the sufferer demonstrates flu like symptoms.

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Mists are finely divided liquid droplets in air. They may be formed in a spraying process or from the condensation of gases with atmospheric moisture. A spray operator can be exposed to high levels of vapour as the solvent evaporates from the mist droplets.

Inhalation of Gases

Gases can be:

- ?? toxic,
- ?? corrosive,
- ?? asphyxiants.

Toxic gases can be produced in a variety of art processes. Hydrogen sulphide and hydrogen cyanide are produced in some photographic processes. Phosgene is produced by the action of ultraviolet light (from arc welding) on certain chlorinated hydrocarbons used as degreasers. Phosgene attacks the respiratory system.

A number of corrosive gases are produced in kilns during firing. These include the "acid" gases such as hydrogen fluoride, hydrogen chloride, sulphur dioxide and oxides of nitrogen. Formaldehyde, a carcinogen, may be produced from organic matter in the clays and glazes.

Corrosive gases can damage the lining of the respiratory tract causing irritation and on acute exposures, pulmonary oedema.

Asphyxiants such as carbon dioxide and argon are used in arc welding. These can be hazardous in confined spaces because they can displace the air, reducing the oxygen level.

INGESTION

Accidental ingestion can occur through eating, drinking or smoking in the work area and through not thoroughly cleaning hands after contact with toxic substances. Organic solvent vapours can dissolve in the butter or margarine and meat of a sandwich; dust can settle on food and drink, and smoking can add to hand to mouth contact. In addition the heat of the tip of the cigarette is sufficient to convert some solvents to highly toxic gases eg. phosgene.

In addition, if we inhale dusts and particles we will also end up ingesting some of this material as it is cleared from the lungs in our mucous.

SKIN ABSORPTION

Some chemicals can be absorbed through the unbroken skin and into the blood system. These are largely the fat soluble chemicals such as organic solvents like toluene and xylene, and metals such as mercury.

Contact with certain chemicals can lead to direct damage to the skin in the form of:

- ?? dermatitis
- ?? allergic reactions
- ?? chemical burns from corrosive chemicals.

Dermatitis

Dermatitis literally means "inflammation of the skin".

Volatile solvents, frequently used to clean dirty or greasy hands, remove some of the epidermis and the skin's protective oils as well as the grime. Such solvents are petrol, acetone, turpentine and kerosene. A similar result occurs when abrasive substances are used for hand cleaning. Some people use these methods for weeks, months and even years without apparent ill effect. Then the skin, unable to keep pace with the harsh treatment it is receiving, suddenly breaks down.

Dust, from a variety of minerals, is another common cause of contact dermatitis. The problem is aggravated when these dusts are washed from the skin with a volatile solvent. Thus the chances of suffering from contact dermatitis is greatly increased.

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Allergenic Effects

This is the production of adverse reactions mediated by immune mechanisms.

Allergic reactions are not dose dependant. It may take years of exposure to a sensitiser before an allergy develops but once the skin is sensitised the reaction will occur each time contact with the same or closely related substance occurs, even to very small exposures.

Sensitisers are in paints and glazes (nickel and cobalt compounds), in dyes and water based inks (formaldehydes, used as a preservative), in photographic chemicals (chromates) and solvents such as turpentine. (Table 4 lists some common sensitisers responsible for skin and breathing problems).

While allergic reactions are largely dependent on the individual - some people are more easily sensitised than others - some chemicals are potent sensitisers and can cause acute sensitisation in a high proportion of those exposed. This can lead to crippling asthma and other breathing difficulties. Examples of acute sensitisers are di-isocyanates, used in twin pack paints and in polyurethane resins and some chromium compounds (used as colourants).

TOXIC EFFECTS OF THE CHEMICAL ENVIRONMENT

Chemicals vary greatly in their ability to damage the body. The toxicity of a chemical ie. the degree of being poisonous, will depend on a number of factors which include:

- ?? the amount of toxin(s) that enters the body
- ?? how and where those toxins interact with the biological processes in the body
- ?? the effectiveness of the bodies defence mechanisms.

The amount of toxin that enters our bodies depends on a number of factors. These include:

- ?? the way in which we work with materials: sloppy and untidy housekeeping and ignorance of the toxicity of materials may aid increased exposure.

- ?? the duration of exposure - the body is capable of detoxifying and excreting many chemicals given sufficient time but adequate periods of zero exposure are necessary. It should be realised that fine dusts and aerosols may remain suspended in the air for many hours. Hence while a student may be exposed for limited periods, the teacher may be exposed all day, five days a week.

- ?? the frequency and amount of exposure - the same chemicals or group of chemicals occur in a range of products, this is particularly so with solvents, which apart from being used as thinners and cleaning agents occur in aerosol packs, printing inks, permanent markers and varnishes to name just a few. Preservatives such as formaldehyde are present in most paints, dyes, some modelling compounds and photographic solutions.

A single exposure to a high concentration may cause an acute effect; the symptoms appear rapidly after entry into the body and the severity of the effects are often related to the amount that has entered the body ie. the effects are "dose related". An example of acute toxic effect is "welding fume fever" - the flu-like illness a welder can get if exposed to certain metal fumes eg. zinc. Onset of the illness is rapid, within a few hours, and the symptoms usually disappear within 48 hours.

Repeated exposures to small amounts of toxins may cause chronic effects. Chronic diseases may result only after years of exposure to concentrations of materials below those causing short term acute effects. Chronic toxic effects are often poorly understood and tend to produce chronic organ damage, for example to the nervous system, liver, kidneys, etc.

Synergism

Synergism occurs when the effect of two or more chemicals taken together is much greater than simply the additive effect of the chemicals taken together. The combination of barbiturates and alcohol (an organic solvent) is an example and one which often has fatal results. Solvent exposure, smoking and alcohol are common combinations for many

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artists. Tobacco smoke and a number of organic solvents (many of the so-called chlorinated hydrocarbons) act together to paralyse the delicate cilia of the respiratory tract, reducing its defence ability and making the respiratory system more susceptible to damage from agents such as dusts.

Synergism is evident in the combination of smoking and exposure to asbestos dust (present in some talcs and soapstones), leading to a greatly increased rate of lung cancer. Carbon tetrachloride and alcohol have a synergistic damaging effect on the liver.

Reproductive Effects

Some chemicals pose serious reproductive hazards, and can cause sterility and birth defects. These are known as gonadotoxins, mutagens and teratogens.

There are three main periods in which reproduction can be affected: effects prior to pregnancy, effects during pregnancy and effects on the newborn infant and child.

Prior to pregnancy some chemicals eg. lead, may cause loss of sex drive, menstrual disorders, lowered fertility and genetic damage. Xylene and toluene, common organic solvents, are suspected of causing menstrual disorders.

Mutagens cause genetic damage which can result in sterility, spontaneous abortion, and birth defects which can be passed on from generation to generation. It needs to be stressed that mutagens can damage sperm, which is just as capable of causing miscarriage or defects as damaged ova.

Chemicals causing damage during pregnancy can affect either the pregnant woman or the developing foetus. Teratogens effect the growing foetus causing birth defects, and include several organic solvents and heavy metals.

Many chemicals can injure infants and children. Women exposed to certain solvents and metals may absorb them, and then excrete them in the breast milk which may poison a breast fed infant.

Women who are pregnant or planning a pregnancy should take special care to avoid hazardous chemicals such as heavy metals, eg. mercury and lead; solvents (particularly chlorinated hydrocarbons); and many categories of plastics (particularly vinyl chloride). Because chemicals in these categories can cause birth defects in minute amounts it is wise to avoid them completely as a safe exposure limit may not exist.

Cancer Causing Substances

Chemicals that cause cancer are called carcinogens. Carcinogens or "suspected carcinogens" (ie. ones which cause cancer in animals and are suspected of causing cancer in humans) occur in a variety of glazes, inks, dyes and paints; for example pigments or colourants based on arsenic, cadmium, chromium and nickel and solvents, such as benzene, carbon tetrachloride and trichlorethylene.

It is generally accepted that there is no safe level of exposure for a carcinogen. Exposure to carcinogens should be avoided or reduced to the lowest level possible.

Some of the benzidine based dyes have been shown to be contaminated with beta-napthylamine, a potent bladder carcinogen and PCB's (polychlorinated biphenyls) which are suspected mutagens (see reproductive hazards).

Some of these carcinogens such as benzene and carbon tetrachloride have been largely banned but such is the rate that new chemicals appear on the market, mostly untested, that it is reasonable to expect that some will be shown to be carcinogens in the future

The ACTU-VTHC Health and Safety Bulletin Nos 16 and 30 contain lists of known or suspected carcinogens based on the World Health Organisation data.

Effects of Solvents and Solvent Vapours

Our most widespread and common solvent is water, and most of our body processes occur in this watery environment. The solvents that concern the artist from the health point of view are the organic solvents. These are mostly man-made

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and have one particular property in common - they can dissolve fats and oils, unlike water. Fats or lipids occur in most parts of the body; in membranes that enclose a cell, and compartment walls within a cell; in the myelin sheath, (the fatty substance that coats nerve fibres and insulates it electrically); and in our skin to help make it waterproof.

Organic solvents, many of which are quite volatile (which means they easily evaporate into the air), can enter the body through three major avenues: we can inhale them and absorb them into our body through the lungs, they can be absorbed through the skin and they can be ingested.

Organic solvents can dissolve directly in the cells of the lung wall causing tissue damage, and can be absorbed into the blood stream and so reach the other vital organs such as the nervous system, liver, kidneys, and reproductive system, etc.

Organic solvents can interfere with the nerve and brain cells. Certain parts of the brain are more easily affected than others. The critical parts affected are the "cerebral cortex", which regulates long term memory and body movements; the "hippocampus", seat of short term memory; and part of the "cerebellum" which controls co-ordination of movements. So if we expose ourselves to solvents at a sufficient level we can understand why we get "high", lose co-ordination, feel drowsy and tired, nauseous, and suffer from headaches, etc.

Low levels of exposure to certain solvents over long periods may cause "chronic illnesses". Some work related health problems are diffuse illnesses, difficult to define or diagnose. At higher levels of exposure permanent damage can occur resulting in personality disorders, depression, damage to the liver, kidney and other organs. If cell membranes are damaged then the very life of the cell may be threatened. So clearly, chemicals that can hit at the centre of cellular processes, the brain and nervous systems have to be treated with respect and care.

Children and the unborn are particularly at risk because organic solvents so readily damage the developing nervous system.

If we repeatedly get solvents, like alcohol, acetone or white spirit, on our hands it will strip away the natural oils in our skin, the skin will become dry and cracked and less efficient as a barrier against germs and chemicals. Some solvents like toluene, xylene, butanol and styrene also cause non-allergic eczema ie. skin irritation. Other solvents can produce contact skin allergies or allergic contact dermatitis - these are the secondary irritants or sensitisers.

Many solvents are directly absorbed through the skin into the blood stream. That is why it is important to use gloves as well as provide adequate ventilation when handling solvents.

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RESPONSES TO TOXINS

The body can deal with toxins by one or more of three major methods:

- ?? Storage
- ?? Excretion
- ?? Metabolism

Storage

Chemicals can be stored in many parts of the body; lead in the skeleton or arsenic in the hair. Chemicals may accumulate in fat tissue including the fat surrounding the nervous tissue. This can result in acute toxic effects, during dieting or ill health when fat reserves are used. Toxins stored in the fat may be slowly released into the blood for redistribution to other organs. So the effects of a single exposure may be felt for years.

Excretion

The main route of excretion of toxins is via the kidneys into the urine, but excretion also occurs via the lungs, skin, nails, hair and faeces.

Metabolism

Some toxins which are water soluble may be excreted unchanged but many toxins require biotransformation or conversion into compounds that are generally more water soluble. However, conversion may result in a more toxic substance being produced eg. methylene chloride, a common paint stripper, is rapidly metabolised by the lung to carbon monoxide. This strongly binds to the haemoglobin in the blood causing oxygen starvation. Sometimes biotransformation results in a more toxic intermediate produced which can cause damage.

The liver is the principal organ for detoxifying chemicals and as such is very susceptible to damage from biotransformed chemicals and intermediation. Biotransformation also occurs in the lungs, kidneys and intestine.

CONTROL OF HAZARDS

The prevention of injuries and illness involves four basic steps:

- ?? identification of hazards
- ?? assessment of the risks
- ?? selection of the appropriate control(s)
- ?? evaluation of the controls

IDENTIFICATION AND ASSESSMENT

Provision of Information

The prevention of short and long term health effects arising from exposure to chemicals requires a comprehensive control strategy and depends on having enough information to recognise hazards. The Safety and Hazard Audit (appendix one) has been included as a practical aid in this process.

Full chemical and ingredient labelling (not just trade or common names) is essential for the correct identification of a chemical or mixture for hazard evaluation or in the event of an accident. At present there is no legislation requiring manufacturers or suppliers to provide this information.

Obtaining Material Safety Data Sheets (MSDS), wherever possible, is a valuable starting point in tracking down what is in your art materials and their likely health effects.

MSDS sheets should provide information on physical and chemical properties, precautions for use, first aid treatment, protective equipment and procedures for dealing with spills. They can usually be obtained by application to the manufacturer or supplier of the product. Even if you are not familiar with all the technical terms used in a MSDS, it should at least provide you with information on special precautions required when handling a chemical.

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You should refuse to use or handle any chemical or material that is not accompanied by a data sheet or if the information is inadequate. A number of chemical information services are available on a commercial basis and as a next resort these can be referred to. However, without a knowledge of the ingredients in a formulation, chemical information services are not much help (see appendix 3 for the proposed MSDS content and format).

Labelling of Chemicals

The label content on substances should include the following information:

- ?? Guidance concerning hazards
- ?? Procedures for safe handling
- ?? A pictorial symbol indicating the hazard
- ?? A key word indicating the hazard
- ?? Name and address of supplier/manufacturer
- ?? Name of the chemical or constituents

Additional information on the correct handling and storage of a chemical or substance should be provided in a MSDS.

If “in-house” re-packaging is necessary then chemicals should be labelled with their chemical name/formula and common name where required. Hazard warning labels should be used. Below is a suggested scheme:

- ?? Labels should indicate degree of hazard by colour code; eg. red (most hazardous), yellow, blue, black, (least hazardous).
- ?? Include specific warnings and precautions as appropriate; eg. "carcinogen", "skin irritant", "respiratory irritant" "corrosive", "explosive", "flammable", etc.
- ?? Provide personal protective equipment advice symbols eg. “wear eye protection", "wear gloves" (give type), "wear respirators" (give type), "wear dust mask".

Symbols and pictograms are more effective than written words.

Standards and Codes of Practice

Guides to risk assessment and the control of hazards are published by a number of organisations in Australia and include:

Standards Australia.
National Occupational Health and Safety Commission (Worksafe Australia),
State Departments of Labour, WorkCover and Health and Safety Commissions,
Australian Council of Trade Unions - Victorian Trades Hall Council,
A number of trade unions.
Australian Chamber of Commerce and Industry, (formerly the Confederation of Australian Industry).

The bibliography includes a listing of those most relevant for artists.

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Exposure Standards

If exposure to a chemical is to occur, is there a level below which it is safe to work?

An occupational exposure standard is an exposure limit that is the concentration of a single chemical in the air which is supposedly safe for most workers. This concentration is expressed as either parts per million (ppm) or milligrams per cubic metres (mg/m^3). Current recommended "Exposure Standards", applicable to Australia, are available from the National Occupational Health and Safety Commission. Many are based on the Threshold Limit Values ("TLV"), the proprietary name for exposure standards, set by the American Conference of Governmental Industrial Hygienists (ACGIH). It should be pointed out that a number of other countries set their own standards, often using very different criteria to those used by the ACGIH. It should also be stressed that exposure standards are not sharp dividing lines between "safe" and "dangerous" concentrations. THE BEST WORKING PRACTICE IS TO REDUCE CONCENTRATIONS OF ALL CHEMICALS IN THE AIR AS FAR BELOW THE TLV AS POSSIBLE. Exposure to additional chemicals, either simultaneously or sequentially could give rise to greater hazards to health (see section on "synergism").

An Exposure Standard or TLV assigned to a chemical may be expressed in three different ways:

1. as a TIME WEIGHTED AVERAGE (TWA)
   This is the average concentration for an 8-hour working day for a 5 day week which is supposedly safe for most workers.
2. as a SHORT TERM EXPOSURE LIMIT (STEL)
   This is the maximum concentration of a chemical to which most workers can be exposed for a period of 15 minutes before suffering adverse effects.
3. as a PEAK or CEILING VALUE
   Concentrations of a chemical in the air should NEVER exceed this value even for a short period.

Appendix 4 provides exposure standards for the more commonly used art materials.

REMEMBER

?? Exposure Standards have to be treated as relatively unreliable and approximate guidelines as to what is safe and what is dangerous.

?? Not all chemicals have Exposure Standards. This does NOT mean that they are safe to use in any concentration, it only means that no Exposure Standard has been established for those chemicals.

?? UNDER NO CIRCUMSTANCES SHOULD YOU BE EXPOSED TO CONCENTRATIONS OF ANY CHEMICALS AT OR ABOVE THE EXPOSURE STANDARD.

The assessment of risk from exposure to hazards depends the amount, frequency and duration of exposure.

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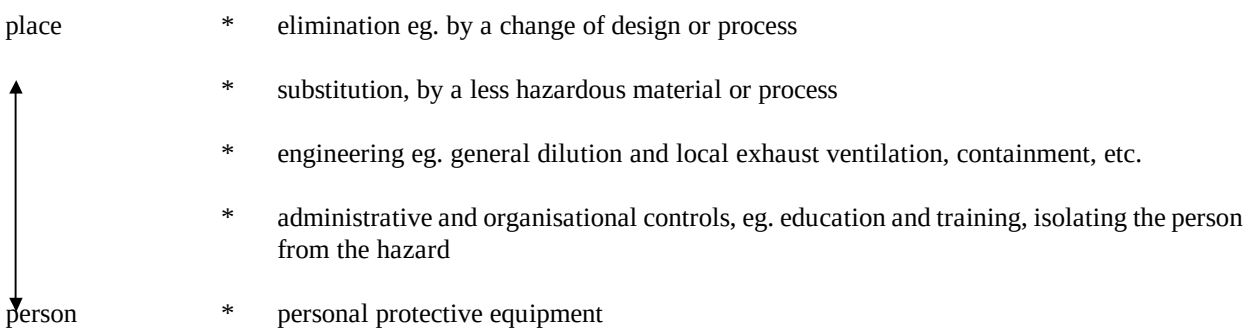
SELECTION OF CONTROLS

Wherever practicable priority should be given to the elimination or control of hazards at their source.

There is an accepted "hierarchy" of control methods which order, in priority, the strategies which can be used to solve health and safety problems. The hierarchy stresses the use of intrinsically safe(r) controls ie. safe place controls in preference to safe person controls ie. controls that do not reply on the person doing the "right" thing.

In reality a blend of strategies may be required, however the control should attempt to maximise safe place controls and minimise reliance on behavioural or safe person controls.

The hierarchy of controls is:



DESIGN CONTROLS

The design stage of a new plant, building or process is the ideal time to prevent exposure, eg. designing a process to use limited quantities of hazardous materials or eliminating them altogether.

There are a number of ways in which process design can reduce occupational exposure to chemicals. A straight forward change is dipping an object in paint rather than spraying it. Using a powder in wetted form will often reduce the dust inhalation hazard and can also reduce the loss of materials. If such process changes conflict with the desired artistic effect then adequate ventilation must be provided.

SUBSTITUTION

Not all chemicals pose the same levels of risk to health, hence replacing dangerous chemicals with safer ones can obviously reduce the hazards, eg.:

?? substitute Zinc White (Pigment White 4) for Flake White (containing lead carbonate),
?? substitute fritted-lead compounds for free lead compounds in glazes,
?? substitute water-based paints for organic solvent-based paints,
?? substitute xylene or toluene for benzene (benzene is a cumulative poison and a carcinogen, causing leukemia).

In the circumstances where a chemical is a known or suspected carcinogen, it is best to eliminate the material from the workplace.

VENTILATION

In many, if not most art teaching and art work situations the only ventilation available is through windows and doors or from the general air conditioning system. This is often referred to as general or dilution ventilation. However, purpose designed local exhaust ventilation (LEV) is required in many areas and include:

?? dark rooms,
?? kiln rooms,
?? some wood and metal working machines (sanders, planers),
?? where there are welding processes (oxy and electric) in a confined space,

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?? air brush work,
?? spray work - paint and glaze,
?? general painting studios and print rooms where general ventilation is inadequate,
?? work with plastics,
?? colour photography.

Local exhaust ventilation involves the removal of contaminated air at or near the point of source and is necessary for highly toxic chemical pollutants. This system provides the most effective ventilation because it prevents contaminants from entering the breathing zone.

Where it has been identified, that local exhaust ventilation can reduce or eliminate an airborne contaminant, expert assistance should be sought. Evidence suggests that much money is wasted in installing improperly designed and ineffective systems.

The following is a series of questions designed to develop an understanding of ventilation systems, effectiveness of their design and maintenance requirements.

Step one - is there a need for a LEV system?

1. Are people aware of the presence of fumes, vapours, aerosols and dusts? - can they be seen or smelt? A spotlight beam can be used to show up fine dusts and aerosols.

2. Is there irritation of eyes, nose or throat?

3. Is there evidence of dust or dried spray around work areas? On the floor? On equipment?

4. When you blow your nose is there evidence of dust or paint spray having been inhaled?

5. Are there complaints of recurrent headaches, dizziness, nausea or lethargy (many organic solvents have narcotic and depressant effects)?

6. Are there skin problems eg. dermatitis; dry or cracked skin or rashes? Skin reactions may be an indication that levels of chemicals in the environment are too high and could be affecting other organs in the body.

If the answers to these questions indicate a need for local exhaust ventilation then expert assistance should be sought.

Step two - checking Design effectiveness and maintenance

General

?? What is the system used for?
?? Does the system appear to remove dust/fume/vapours when the system is in use?
?? Does dust from the process settle on surfaces in the room?
?? If an extractor or hood is used, does it draw airborne contaminants past the operators nose and mouth?
?? Was the ventilation system designed for the particular process?
?? Was the system designed "in-house" or by outside contractors?
?? Is the system subject to regular maintenance?
?? Have measurements of the air flow been taken - when the system was installed? subsequently? are records kept?
?? Are there any monitoring devices built into the system?
?? Is the exhaust near windows or air intakes?
?? Is there provision for fresh air supply to get into the room where the hood is?

Ducting

?? Is the ducting material suitable for the contaminants being carried eg. plastic for acid fume?
?? Does the system show evidence of corrosion?
?? Are there any holes or cracks on the duct work?
?? Have additional branches been added to the system?

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?? Are filters in use?
?? How often are they changed, cleaned, maintained?
?? Are there written procedures for filter maintenance?

Fan

?? Is the fan noisy?
?? Is the fan located near the hood or near the filter outlet? (if the fan is placed so that the ducting is under positive pressure any holes or leaks in the ductwork would allow contaminant back into the work area).

Note that "adequate ventilation" described on an MSDS or product label means ventilation adequate to reduce exposure well below the Exposure Standard.

Some of the principles of exhaust ventilation are shown in the illustrations below. It is important that the exhaust from ventilation systems is not allowed to cross-contaminate air taken into the general ventilation system.

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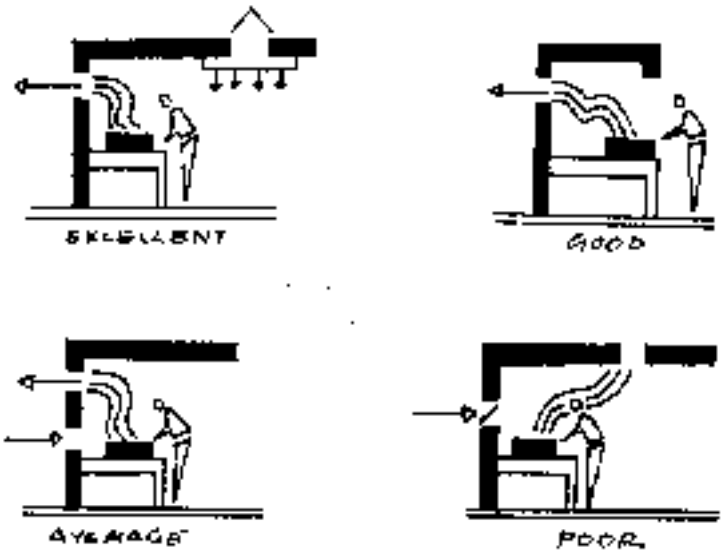
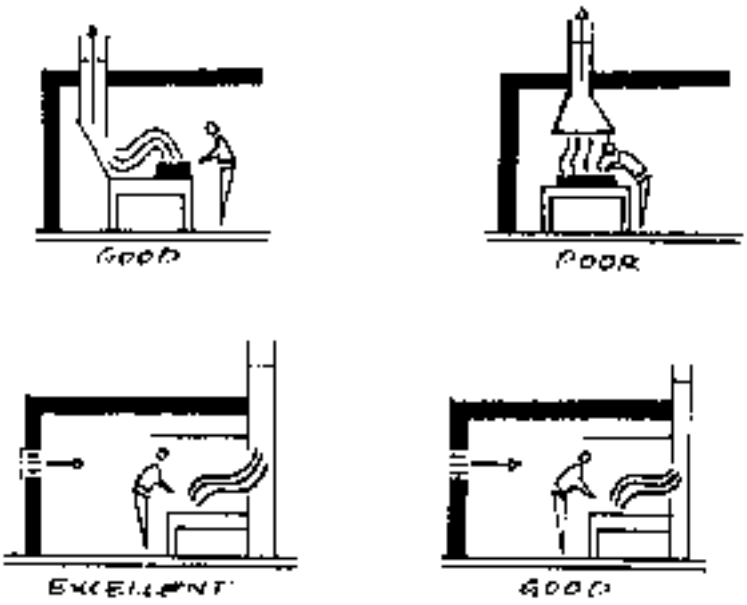
PRINCIPLES OF GOOD VENTILATION



GENERAL AND DILUTION VENTILATION



LOCAL EXHAUST VENTILATION

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PROTECTIVE EQUIPMENT

Personal protective equipment should never be used to permit continued working in a poor environment (and it should be stressed that personal protective equipment should only be used when all other options have been tried and found to fail). However, there will be circumstances where respiratory protective devices, gloves, goggles, face shields and protective clothing are required. Attention should be paid to selection of equipment appropriate to the hazard, correct fit and training in use and maintenance. Personal protective equipment should conform with the relevant Australian Standards viz.

AS1270-1988 Hearing protective devices
AS1337-1984 Eye protectors for industrial applications
AS1715-1991 Selection, use and maintenance of respiratory protective devices
AS1716-1991 Respiratory protective devices
AS2161-1978 Industrial safety gloves
AS3765-1990 Clothing for protection against hazardous chemicals, Parts 1 & 2.

Respiratory Protective Devices

Great care must be taken with the selection of air-purifying respirators. No respirator is suitable for all applications. Selection, education and maintenance play a critical role if respirators are to protect rather than give a "false sense of security". They must be personally fitted, and chosen to suit the workplace conditions. A filter designed to stop dust, for example, will be ineffective against chemical fumes. Canister and cartridge respirators contain chemicals designed to adsorb or neutralise particular vapours and fumes - so it is essential to ensure that protection against a contaminant encountered in the workplace is by means of the appropriate canister.

All respirators need to be inspected by the user before being worn. Therefore all users need to know what to look for when inspecting their respirators. The following is a checklist of things to look for before using a respirator:

1. Ensure that the correct cartridge or canister has been selected for the job. Check that it is fitted correctly (cartridges should have an arrow on them to indicate which side goes towards the face). Check that the cartridges/canisters are undamaged and that the filter to facepiece seal is good.

2. Check the facepiece for cleanliness and damage (that it is not cracked, torn, split, perished or distorted).

3. Check that the valves are intact, not perished and are working correctly. Check the valve seal for dirt or other obstruction.

4. Check that all the straps are present and in a good condition and that the clips or fasteners are undamaged.

Respirators should be tested for fit before use. This is achieved using "negative pressure test" which consists of sealing the filter with a plastic film, inhaling gently until the mask collapses slightly and holding your breath for 10 seconds. If the fit is not adequate, air will leak in and the mask will resume its normal shape. Similarly a positive pressure test can be done by closing off the exhalation valve(s) and gently breathing out, causing the mask to expand. If there is a leak the mask will collapse to normal.

Respirators should be inspected regularly for defects, and cleaned and stored properly. It is very important that the respirators should be sanitised after each use to prevent infection. After cleaning, the respirator should be stored in a sealed plastic bag; this will prolong the life of the cartridge which will continue to adsorb contaminants even if not worn.

The filters and cartridges should be replaced regularly - how often will depend on the concentration of the contaminant and the working load. The manufacturers' recommendations should be followed.
Disposable particulate masks require no maintenance or cleaning, however the same factors for selection and fit still apply.

Half or full facepiece respirators should not be worn if:
?? facial hair interferes with the seal,

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?? contact lenses are worn,
?? there is a complicating medical condition (eg. emphysema, pulmonary disease, coronary artery disease, breathing difficulty when wearing a respirator, claustrophobia).

Gloves

Gloves are one of the most important ways of preventing skin damage and skin absorption of chemicals. However, there is no one glove that will protect against all chemicals. For correct selection for the particular chemical class see Table 3 and consult the manufacturer/supplier specifications. Do not use gloves if they swell. Permeation may occur with consequent skin absorption of the chemical.

Eye/Face Protectors

Chemicals can be corrosive and irritating and face shields and/or goggles should be used when handling acids, alkalis or various organic chemicals. Ensure selection is appropriate to the use: choose an impact resistant plastic face shield/g]asses for protection against flying particles; a chemical resistant plastic face shield for handling chemicals; the correct shade of eye-piece for the particular welding process.

CHEMICAL HAZARDS - SUMMARY

Chemical hazards fall into four main areas:

1. Chemicals can be poisonous, or "toxic"

   This means they are absorbed by the body, through the skin, gut or lungs, and then exert a short-term effect (such as making us unconscious) or a long-term effect (such as giving us liver disease or cancer). The study of toxic effects - how the body reacts to different chemicals and why - is called toxicology.

2. Chemicals can be primary irritants, and/or "sensitisers"

   Chemicals can exert long-term skin effects (dermatitis and allergic contact dermatitis) and lung effects (asthma). Sensitisation is an allergic reaction by the body to chemical insult. A familiar example is hay fever, which occurs in people who become allergic, or sensitised, to pollen in the air. Once sensitised, they suffer an attack of asthma every time they encounter pollen. In the same way, we can become sensitised to chemicals. Some chemicals such as toluene di-isocyanate (TDI), used in the manufacture of polyurethane foams, are potent lung sensitisers, and cause crippling occupational asthma.

3. Chemicals can be corrosive

   Chemical burns are usually caused by acids such as sulphuric acid or by alkalis such as caustic soda. These burns can be just as bad as those inflicted by fire. A splash of corrosive liquid in the eye can blind for life.

4. Chemicals can be explosive or flammable

   Chemicals can burn, causing devastation with their flames and heat, or more insidiously, through the toxic fumes they emit when on fire. Polyurethane foams, for example, burn very easily, and within seconds give off toxic black fumes. Solvents and solvent-based art materials pose a major fire hazard, as do many types of compressed gases. Organic peroxides, used as "catalysts" in some plastics, are potentially explosive.

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TABLE 2: COMMON SOLVENTS AND THEIR HAZARDS

How to Use this Table.

The table below lists common solvents and symptoms which may be experienced following "acute exposure" (ie. one-off exposures to relatively high concentrations) and, in certain instances, following "chronic exposure" (ie. repeated exposure to lower concentrations).

Because the toxic effects of some materials are not fully evaluated and the susceptibility of individuals varies, exposure should always be kept to a minimum and avoided if possible.

The solvents are grouped according to chemical class so that relative toxicity and flammability can be compared within the class. Chemicals in the same class often have similar solvent properties, therefore safer substitutes may be found by using this table.

For more information, the sources listed in the bibliography should be consulted.

Current Occupational Exposure Standards can be obtained from the National Occupational Health and Safety Commission (Worksafe Australia). OES's for common artist chemicals are listed in Appendix 4.

Solvent Warning

The Australian Council of Trade Unions - Victorian Trades Hall Council Occupational Health and Safety Unit have published the following warnings about solvents:

?? Most solvents are narcotics. They have an immediate depressing influence on the Central Nervous System, acute exposure can cause faintness, dizziness, unconsciousness and finally death.
?? Solvents dissolve the oil in our skin eventually causing dermatitis. Dryness, cracking and blistering result.
?? Long term effects include damage to the liver.
?? Benzene and carbon tetrachloride are human carcinogens. Trichlorethylene, perchloroethylene, dichloroethane and chloroform are known animal carcinogens.
?? Genetic toxicity has been demonstrated for some chlorinated ethanes. Foetal damage and spontaneous abortions are suspected to be related to exposure to solvents.

Warning signs that people may be at risk are indicated by the answers to the following questions:

?? Do you often suffer headaches? If so, how many times a week?
?? Do you ever feel dizzy or faint?
?? Do you suffer from skin irritation, rashes or spots?
?? Do you suffer from aches and pains in muscles or joints?
?? Do you find it hard to breathe at night, or when exerting yourself?
?? If you suffer from any of these complaints, do you find they improve over weekends or when on holidays?

If any of these questions describe conditions applicable to you, then you should immediately try to find the cause, through medical examination.

Source: The Health and Safety Bulletin No. 48 (ACTU-VTHC) Guidelines on Working with Solvents.

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Abbreviations:

chem	chemical
CNS	central nervous system
CVS	cardiovascular system
derm	dermatitis
GI	gastro-intestinal system
irr	irritating to eyes, skin or upper respiratory system
perm	permanent
PNS	peripheral nervous system
resp sys	respiratory system
skin*	the substance is absorbed through the skin
URT	upper respiratory tract.

SOLVENT CLASS	COMMENTS	ORGAN EFFECTED	SYMPTOMS
ALCOHOLS	ONE OF SAFER CLASSES		
ethanol (denatured, ethyl or grain alcohol)	One of safer classes Identify denaturant	eyes, nose, skin, CNS	irr, headache, drowsiness, fatigue, tremors.
methanol, (wood or methyl alcohol)	Use ethanol when possible: skin*	eyes, skin, CNS	blurred vision, optic nerve damage, blindness
n-propyl alcohol	skin*	eyes, skin, CNS, URT	irr, drowsiness, derm
isopropyl alcohol (rubbing alcohol)	One of least toxic in class	eyes, skin, URT CNS	irr, drowsiness, dizziness
isobutyl alcohol	skin*	eyes, skin, URT CNS	irr, drowsiness, dizziness
isoamyl alcohol (fusel oil)	skin*	eyes, skin, URT CNS	irr, narcosis, derm nausea, diarrhoea
diacetone alcohol	Most toxic in class	eyes, skin, resp sys	irr, corneal tissue damage, narcosis
ALIPHATIC HYDROCARBONS			
pentane(s)	Extremely flammable	eyes, skin, URT lungs	irr, derm, chemical pneumonia
n-hexane	Avoid use: extremely flammable	skin, URT, CNS PNS	irr, peripheral neuropathy, perm CNS damage
heptane	Good substitute for n-hexane	skin, resp sys, lungs, PNS	narcosis, derm, nausea, chemical pneumonia
'benzine' mixture	Can contain hexanes, pentanes, and or VM&P naphtha	skin, CNS lungs	irr, narcosis, derm

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SOLVENT CLASS	COMMENTS	ORGAN EFFECTED	SYMPTOMS
petroleum spirits (petroleum ethers)	Mixture of aliphatic hydrocarbons; may contain benzene; extremely flammable	eyes, skin URT, CNS lungs, PNS	irr, narcosis, derm
gasoline	Do not use: may contain benzene and/or lead; extremely flammable	skin, URT, CNS, PNS	irr, derm, narcosis chem. pneumonia pulmonary oedema
VM&P Naphtha	One of least toxic	skin, CNS, lungs	irr, derm, narcosis
Mineral Spirits (White Spirits, Stoddard solvent)	Odourless paint thinner or mineral spirits with reduced aromatics preferred	skin, CNS, lungs	irr, derm, narcosis
kerosene (paraffin)		skin, lungs, URT, CNS	irr, narcosis, lung haemorrhage, chem. pneumonia
AROMATIC HYDROCARBONS	TRY TO AVOID AS A CLASS		
benzene (benzol)	Do not use: cancer agent; skin* extremely flammable	skin, CNS blood, chromosomes liver, kidneys	derm, narcosis, leukemia, aplastic anaemia
toluene (toluol)	skin*	CNS, liver URT, kidneys skin	derm, narcosis, muscular weakness liver & kidney damage
xylene (xylol)	skin*	skin, URT, CNS, liver GI, blood	irr, narcosis, derm, derm. stomach pain
coal-tar naphtha	Do not use: cancer agent; mixture of aromatics; can contain benzene; skin*	kidneys, lung skin, URT, CNS	irr, narcosis, light sensitivity burning, cancer
styrene (vinyl benzene)		skin, CNS, liver lungs	irr, derm, narcosis liver and blood damage
nitro-benzene	highly toxic, skin*	resp. system	asphyxiation
CHLORINATED HYDROCARBONS	TRY TO AVOID AS A CLASS. May produce phosgene gas and other toxics when heated or exposed to ultraviolet radiation.		
carbon tetrachloride	Do not use: suspected	skin, CNS, liver	irr, narcosis,

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	cancer agent: skin*	kidneys, stomach	hepatitis, kidney failure, stomach pain
SOLVENT CLASS	COMMENTS	ORGAN EFFECTED	SYMPTOMS
chloroform (trichloromethane)	Do not use: suspected cancer agent: skin*	skin, heart, kidneys, eyes, CNS	irr, narcosis, liver damage, cardiac arrest
methylene chloride (dichloromethane)	Forms carbon monoxide in blood and stresses hear Avoid if possible: suspected cancer agent	skin, URT, CNS CVS	irr, narcosis, numbness, heart arrhythmias
tetrachlorethane	Do not use: suspected cancer agent: skin*	skin, CNS blood, liver kidneys, PNS	tremors, limb numbness, liver dysfunction narcosis, delirium, convulsions
methyl chloroform (1,1,1-trichloroethane)	One of least toxic in class	skin, CNS heart	derm, narcosis, heart, arrhythmias dizziness
1,1,2-trichlorethane	Do not use: suspected cancer agent: skin*	CNS, eyes, URT, liver kidneys	irr, narcosis, liver liver & kidney damage
ethylene dichloride (1,2-dichloroethane)	Do not use: suspected cancer agent: skin*	skin, CNS, liver lungs	irr, narcosis, liver & kidney damage, pulmonary oedema
trichloroethylene	Do not use: suspected cancer agent: skin*	SKIN, CNS resp sys heart liver, kidneys	irr, vertigo, visual disturbance derm, nausea, heart arrhythmias
perchloroethylene (tetrachloroethylene)	Do not use: suspected cancer agent: skin*	skin, CNS, liver, URT, heart	irr, narcosis, heart arrhythmias liver damage, flushing after alcohol consumption
ESTERS			
methyl acetate	Extremely flammable	eyes, skin, URT	irr, narcosis
ethyl acetate	Least toxic in class	eyes, skin, URT, CNS	irr, narcosis
isopropyl acetate		eyes, skin, URT, CNS	irr, narcosis
amyl acetate		eyes, skin, URT, CNS	irr, narcosis

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ETHERS	DO NOT USE: many form explosive peroxides with air, extremely flammable	eyes, skin, URT	irr, narcosis derm
SOLVENT CLASS	COMMENTS	ORGAN EFFECTED	SYMPTOMS
GLYCOL ETHERS (CELLOSOLVES AND THEIR ACETATES)	TRY TO AVOID AS A CLASS		
cellosolve (2-ethoxy ethanol, ethyl cellosolve, ethylene glycol mono-ethyl ether)	skin*	skin, eyes, URT, CNS, kidney, liver reproductive sys, blood	mild irr to eyes & URT loss of appetite, narcosis kidney failure.
methyl cellosolve (ethylene glycol monomethyl ether, 2-methoxy ethanol)	skin*	skin, eyes, URT, CNS, kidney liver reproductive sys, blood	irr, narcosis, renal failure pulmonary oedema, fatigue, anaemia
butyl cellosolve (ethylene glycol monobutyl ether, 2-butoxyethanol)	skin*	skin, eyes, CNS, kidneys, liver, lungs blood, reproductive sys	irr, narcosis, renal failure, pulmonary oedema, fatigue, anaemia
KETONES			
acetone	Least toxic in class extremely flammable	skin, URT, CNS	irr, narcosis, derm
methyl ethyl ketone (MEK)		skin, URT, CNS, PNS	irr, narcosis, derm
methyl butyl ketone (MBK)	Do not use: skin*	skin, URT, CNS, PNS	irr, narcosis, perm CNS damage peripheral neuropathy
methyl isobutyl ketone		skin, URT, CNS	irr, narcosis, derm
OTHERS			
turpentine	Use mineral spirits or odourless paint thinner when possible skin*	skin, eyes, URT, lungs, CNS, kidney , bladder	irr, dermatitis, narcosis pulmonary oedema, convulsions kidney and bladder damage
carbon disulphide	Do not use: extremely flammable	CNS, PNS, CVS, eyes, kidneys, liver, reproductive sys.	irr, psychological, neurological & CVS disorders, psychosis,

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			arteriosclerosis
morpholine	Avoid if possible: skin*	eyes, skin resp. sys.	irr, cough visual disturbance

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SOLVENT CLASS	COMMENTS	ORGAN EFFECTED	SYMPTOMS
tetrahydrofuran	Do not use: extremely flammable	skin, CNS, liver, kidneys	irr, narcosis, liver & kidney damage
dioxane	Do not use: suspected cancer agent	eyes, skin, liver kidneys	irr, drowsiness, dizziness, stomach pain, liver and kidney damage
dimethylformamide (DMF)	Avoid if possible: skin*	skin, CVS, liver, kidneys	nausea, vomiting liver damage, high blood pressure, facial flushings, dermatitis
tetrachlorodifuoro-ethane (Freon 112)	Emits phosgene gas when heated	lungs, skin	irr, pulmonary oedema
trifluorotri-chloroethane (Freon 113)	Emits phosgene gas when heated; other freons act similarly	CVS, CNS, lungs.	irr, cardiac arrhythmias cardiac arrest

Adapted from Common solvents and their hazards - Centre for Occupational Hazards, New Year.

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TABLE 3: TYPES OF GLOVES FOR CHEMICALS

This table should be used as a general guide. If in doubt consult manufacturers specifications, (see also ACTU-VTHC, Health and Safety Bulletins Nos. 49 and 50).

CHEMICAL CLASS	GLOVE MATERIAL
AROMATIC HYDROCARBONS eg. styrene toluene xylene benzene	Nitrile Viton*
REFINED PETROLEUM SOLVENTS eg. petroleum ethers petrol hexane mineral spirits	Neoprene rubber Nitrile Viton*
TURPENTINE	As for petroleum solvents
CHLORINATED HYDROCARBONS eg. methylene chloride 1,1,1 trichloroethane chloroform	Nitrile Viton*
KETONES eg. acetone methyl ethyl ketone (MEK)	Natural rubber or latex Butyl Rubber
ALCOHOLS eg. ethanol methanol propanol	Any of the above
ACIDS (dil) ie. <10%	Any of the above
ACIDS (conc)	Neoprene rubber Viton* Butyl rubber
ALKALIS	Any of the above
POLYESTER RESIN	Nitrile Viton*
PAINT & VARNISH REMOVER	Nitrile Viton*
LACQUER THINNERS	Butyl
OILS	Nitrile
ALDEHYDES eg. formaldehyde succinaldehyde	Nitrile

Aromatic and halogenated hydrocarbons will attack all types of natural and synthetic gloves. Do not continue to use if gloves swell. Note that permeation can occur even if there is no visible damage to the gloves.

Sources: AS2161-1978 and selected manufacturers "Chemical Resistance Charts".

* Viton is a DuPont trademark.

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TABLE 4: PRINCIPAL SKIN IRRITANTS/SENSITISERS FOUND IN INDUSTRY AND LIABLE TO BE FOUND IN ART MATERIALS

DYE INTERMEDIATES

Aniline and compounds
Chloro compounds
Nitro compounds
Acridine and compounds
Naphthalene and compounds
Benzidine and compounds
Benzanthrone and compounds
Naphthylamines

DYES

Paraphenylenediamine
Aniline black
Paraminophenol
Chrysoidine
Bismark brown
Nigrosine
Aminoazotoluene
Aminoazobenzene
Idanthrene violet, R.R.
Isonamine, A.S.
Pyrogene violet brown
Orange Y
Safranine
Sulphanthrene pink
Rosaniline
Crystal and methyl violet
Malachite green
Auramine
Metanil yellow
Brilliant indigo, 4G
Erio black
Hydron blue

PHOTOGRAPHIC CHEMICALS

Para-phenylenediamine and derivatives
Hydroquinone
Paraminophenol hydrochloride
Metol
Pyrogallol
Dichromates
Formaldehyde
Aliphatic amines

RUBBER ACCELERATORS AND ANTI-OXIDANTS

Hexamethylenetetramine (methenamine)
Diphenylguanidine
Mercaptobenzothiazole
Tetramethythiuram monosulphide and disulphide (Thirams)
Para-toluidine
Ortho-toluidine
Phenyl-ß-naphthyamine

OILS

Cutting Oils (the inhibitor or antiseptic they contain)
Honing Oils (cellosolves, eugenols)
Essential oils of plants and flowers
Sulphonated oils
Linseed Oil
*Mustard Oils
Coconut Oil
*Cashew Nut Oil

COAL TAR AND ITS DIRECT DERIVATIVES

(some are extremely carcinogenic)
Acridine
Anthracene
Phenanthrene
Carbazole
Pyridine
Fluorene
Naphthalene

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Tung Oil

*Phenol
*Cresol

NATURAL RESINS

Pine rosin
Wood rosin
Burgundy pitch
Japanese lacquer
Dammar
Copal

SYNTHETIC RESINS

Alkyd
Vinyl
Acrylic
Phenol formaldehyde
Urea formaldehyde
Melamine formaldehyde
Sulphonamide formaldehyde
Chlorobenzenes
Chlorodiphenyls
Chlorophenols
Cumenes
Expoxies
Polyesters
Urethanes (di-isocyanates)

PLASTICISERS

Propylene stearate
Butyl cellosolve stearate
Diamyl naphthalene
Dibutyl tin laurate
Dioctylphthalate
Methyl cellosolve oleate
Methyl phthalylethylglycol
Phenylsalicylate
Stearic acid

* compounds which also act as primary irritants (see glossary)

NB Much of this list was compiled over 30 years ago and no doubt many new chemicals could be added.

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CERAMICS

Dust Control

Ceramics is an area where dust from clays and glaze materials pose a particular problem. "Potters Rot" or silicosis of the lungs is an age old occupational disease of potters but only in recent times has the hazardous nature of many of the glazes been recognised. All staff (teaching and ancillary) should be aware of the dangers of the long term inhalation of ceramics dusts.

Some fairly obvious control measures include:

1. Work only wet clay - don't allow waste to dry out, use plastic bins for soaking down waste clay.

2. Wet mop work areas. Do not dry brush work surfaces.

3. Vacuum wherever possible; this should be with a vacuum cleaner (approved by the appropriate Workcover authority) capable of retaining the very fine respirable dust that is produced in ceramics studios. A wet-dry type vacuum cleaner or vacuum polisher may be appropriate depending on the floor surface.

4. Floors, shelves and work surfaces should be sealed to facilitate wet cleaning. Keep equipment and materials off the floor as far as is practical to allow hosing out and wet cleaning of floors. Avoid spraying areas that could cause dust to be created.

Glazing and Glazes

1. Handle glaze materials in a booth with local ventilation or use an appropriate respirator. Always mop up spills immediately; do not dry sweep/brush.

2. All glazes and glaze materials should be stored in washable clearly-labelled sealed containers. Label with appropriate hazard warning labels.

3. Glazing should be undertaken in a room separate from the main work area. If this is not possible all glazing and glaze mixing should be done in one designated area of the room used for that purpose alone. These activities should take place near a wall or window to ease the installation of exhaust ventilation.

4. Spray glazing should be done in a spray booth fitted with local exhaust ventilation. Glaze spraying may be done outdoors provided an appropriate dust respirator is worn.

Kiln Operation

1. Ensure a permit to work system is in operation. (This could be a user-approved system where the user has demonstrated a knowledge and understanding of kiln operation, safety and procedures, etc.).

2. Ensure operating instructions, warning signs and emergency procedures are clearly posted.

3. Always use protective gloves and aprons.

4. Ensure that the goggles and face shields are whole and undamaged and provide good visibility.

5. Ensure all the kilns are ventilated (all kilns when fired produce a variety of toxic and corrosive gases). Kilns should be provided with acid-resistant, heavy duty stainless steel canopies with mechanically assisted ventilation especially for electric kilns (ie. built in electric exhaust fans). Fans should operate at all times while the kiln is firing. Kiln emissions should be exhausted to the outside atmosphere at a point not likely to pollute any other work or living space and meet Environment Protection Authority regulations.

6. Ensure ventilation equipment for the kilns is properly designed to prevent gases escaping into the work areas.

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7. Ensure that there is adequate handling equipment for loading and unloading kilns.

8. Ensure that there are safety shut offs on gas-fired kilns.

9. Ensure there is a planned maintenance program for kilns and that it is followed.

Raku Firing

The particular nature of Raku Firing exposes the operators to a number of hazards:

1. radiant heat from kiln and pottery
2. from hot shards if pot is dropped
3. from highly toxic fumes given off when the glowing-hot pot is placed in sawdust, paper or other material.

Use protective gloves, apron or face shield. Wear leather footwear.

Machinery

Ensure that all machines (eg. pugmill, dough mixer) are adequately guarded. Check with your local WorkCover/Department of Labour inspector if you are uncertain. All electrical equipment, particularly potters wheels, should be supplied with electricity via earth leakage circuit breakers.

Use of a lidded mixing box · escaping. The disposable respirator onents

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TABLE 5: TOXIC EFFECTS OF GLAZE MATERIALS

Glaze materials are listed for their degree of toxicity by their different routes of entry (the skin, by inhalation or ingestion). Toxicities are graded low, moderate or high. The latter should be treated with extreme care.

This information has been adapted from Potters Beware, by R. Perry and should be referred to for further information.

MATERIAL	SKIN	INHALATION	INGESTION
ALUMINA Al_2O_3	LOW Non-Toxic	MODERATE Powder forms can cause aluminosis, a form of dust disease of lungs.	LOW Non-Toxic
ANTIMONY OXIDE Sb_2O_3	MODERATE Dermatitis skin ulcers Absorbed through skin.	HIGH Prolonged exposure to fumes or dust can cause lung and heart disease, liver and kidney damage. Vaporises at high temperature.	HIGH 1.3 to 3 grams may be fatal. Acute poisoning causes violent vomiting diarrhoea and collapse.
ASBESTOS	LOW Asbestos corns	HIGH Asbestosis (fibrosis), lung cancer, mesothelioma, stomach and intestinal cancer.	Possibly HIGH Suspected cause of intestinal cancer.
BARIUM CARBONATE $BaCO_3$	LOW skin and eye irritation	HIGH These soluble salts may gain access to the body by inhalation or ingestion.	HIGH
BARIUM CHLORIDE $BaCl_2$		The barium ions act as a muscle stimulant. Acute poisoning causes colic, vomiting and diarrhoea, severe muscle pains and convulsions with progressive paralysis. Chronic poisoning is most likely. Death can occur through excessive stimulation to the heart muscle. Barium compounds are thought to cause metal release.	
BARIUM SULPHATE $BaSO_4$		This is insoluble and non-toxic. It is used in diagnostic radiology.	
BERYLLIUM CARBONATE $BeCO_3$	MODERATE Dermatitis Skin ulcers	HIGH Prolonged exposure to dust or fumes can cause severe respiratory damage.	HIGH
BERYLLIUM OXIDE BeO and other Be compounds.	eye irritation	Be and compounds are suspected carcinogens	
BISMUTH compounds	LOW Skin irritation	MODERATE Similar toxicological properties as lead. Bismuth compounds may be rendered soluble by food acids.	MODERATE May cause kidney kidney damage.

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MATERIAL	SKIN	INHALATION	INGESTION
BORAX $Na_2B_4O_710H_2O$ BORIC ACID H_3BO_3	LOW But toxic if absorbed through broken skin	MODERATE Acute irritation of respiratory tract chronic poisoning	HIGH for infants Lethal dose adult 10 gm, infant 100 milligrams. Rapidly absorbed. Symptoms delayed vomiting and diarrhoea, skin rash, convulsions.
BORAX FRITTS	These melt from 750 degrees C to 1180 degrees C are insoluble and are used as non-toxic alternatives to lead in earthenware glazes. For example:-		
BORO-CALCITE $CaO_2B_2O_36H_2O$	This is the natural mineral COLEMANITE, used as an alternative to lead.		
GERSTLEY BORATE $Na_2O_2CaO5B_2O_36H_2O$	This is impure colemanite which also contains sodium and some magnesium.		
CADMIUM OXIDE CdO	LOW	HIGH Acute inhalation dangerous. Respiratory distresses Symptoms appear after 4 to 5 hours and can be fatal Chronic inhalation and ingestion may cause anaemia, kidney and liver damage. Associated with prostate and lung cancer. Vaporises during firing. Metal release - leached like lead with food acids.	HIGH As little as 10 mg. causes acute symptoms resembling food poisoning.
CERAMIC FIBRE (Alumina and silica melted and blasted by high velocity gases into light fibres).	MODERATE Skin irritation	Possibly HIGH Hazards not yet established Risks appear high from chronic inhalation, probably similar to fibreglass.	LOW Unknown. Ingestion unlikely.
CHROME OXIDE Cr_2O_3	MODERATE Corrosive, Destructive to all body cells. Dermatitis.	HIGH Acute irritation of lungs Chrome asthma, allergies. Prolonged exposure may cause liver and kidney damage. Dangerous mixed with lead as it increases the solubility of lead.	HIGH 1/2 to 5 gram fatal. Severe stomach pains vomiting, diarrhoea, Death usually from kidney failure.
CHROME YELLOW LEAD CHROMATE $PbCr_2O_3$	MODERATE Irritation. Allergies skin ulcers	HIGH As for lead inhalation. Chronic inhalation may cause lung cancer.	HIGH Acute gastroenteritis, giddiness, muscle cramps kidney damage. Delayed lead poisoning.
CHROMITE IRON CHROMATE $FeCrO_4$	MODERATE Irritation Allergies skin ulcers	HIGH Lung irritation. Nasal ulcers. Prolonged exposure may cause	HIGH Acute ingestion may cause chromium poisoning.

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allergies and lung cancer.

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MATERIAL	SKIN	INHALATION	INGESTION
COBALT OXIDE Co_3O_4 COBALT CARBONATE $CoCO_3$	LOW Repeated skin contact may cause allergic dermatitis	MODERATE Many cause breathing difficulties and coughing while exposed. Possible lung fibrosis.	LOW Gastric upset chronic ringing in ears. May cause goitre especially in children.
COBALT SULPHATE $CoSO_4 7H_2O$		Cumulative	Cumulate
COPPER OXIDE CuO	LOW Irritation Eczema.	MODERATE Acute metal fume fever. Dust may cause lung and liver damage. Cumulative	MODERATE Acute symptoms resemble food poisoning Cumulative
COPPER CARBONATE (MALACHITE) $CuCO_3$	Will decompose in hot water. Carbonate is more toxic than oxide. Copper volatilises during firing. It also increases lead solubility, therefore dangerous is mixed with lead.		
COPPER SULPHATE $CuSO_4$	MODERATE Corrosive. Absorbed through skin causing acute haemolytic anaemia.	HIGH Acute poisoning causes metal fume fever. Chronic lung damage.	HIGH 1 gram fatal. Corrosive poison. Gastro intestinal & nervous system symptoms. Can lead to coma and death.
FLUORSPAR Calcium Fluoride CaF_2	LOW Irritation	HIGH Acute lung irritation, chronic inhalation may cause anaemia. Toxic fluorine fumes during firing.	MODERATE Gastric, circulatory nervous system problems. Skin rashes.
GUM ARABIC	LOW	MODERATE Can cause asthma	LOW
HYDROFLUORIC ACID HF	HIGH Progressive destruction of tissue. Intense pain.	HIGH Asphyxia, pulmonary oedema. Convulsions.	HIGH Corrosive poison, burning of mouth. Pain-collapse.
IRON OXIDES Black-ferrous FeO Red-ferric Fe_2O_3	Have no significant hazard and are apparently harmless on their own, but with nickel and chromium fumes can cause metal fume fever and suspected lung and liver damage.		
IRON SULPHATE Crocus Martis $FeSO_4$	LOW Irritation	LOW Irritation by toxic oxide fumes during firing	LOW Large amounts may poison, esp. in children.

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MATERIAL	SKIN	INHALATION	INGESTION
RED LEAD Lead Oxide Pb_3O_4	LOW	HIGH	HIGH
WHITE LEAD Lead Carbonate $2PbCO_3.Pb(OH_2)$	Lead is dangerous in all its forms - the metal, its oxides, salts and organic compounds. Lead absorption is cumulative and occurs mainly through inhalation of dust and fumes and also by ingestion. Ingestion can be from foods and liquids which were contained in vessels lined with lead glazes. Absorption through the skin is only significant in the case of organic lead.		
NAPLES YELLOW Lead Antimonate $Pb(SbO)_4$	The symptoms of lead poisoning are slow and insidious, presenting with tiredness, lack of appetite, insomnia, irritability, digestive disturbances, stomach pains, metallic taste in mouth, pains to joints and muscles. Lead absorbed through the lungs into the blood is deposited in the bones. Children are more readily affected, especially their central nervous system. Intellectual impairment and permanent brain damage can result.		
GALENA Lead Sulphide PbS	Raw lead was prohibited in British potteries in 1949. It has been replaced by the following fritts as silicates:-		
CHROME YELLOW Lead Chromate $PbCr_2O_3$	LEAD MONOSILICATE ($PbOSiO_2$), LEAD SESQUISILICATE ($2PbO_3SiO_2$) and LEAD BISILICATE (PbO_2SiO_2). These fritts are less likely to produce metal release because of their reduced solubility. Fritted lead bases can be made harmful by the addition of certain materials including:		
LITHARGE Lead Monoxide PbO	BARIUM, CHROME, COPPER, COBALT, SODA ASH and unfritted BORON increase the solubility of lead and can cause metal release. Metallic glazes with these combined metals should not be put inside pots which are to contain food or dink - eg. fruit juices, milk, vinegar - which can render the toxic metals soluble. Lead compounds vaporise around 1150 degrees C so should not be used above that temperature. China painters who use lead-based colorants should not “tip” their brushes in their mouths.		
LITHIUM CARBONATE Li_2CO_3 LEPIDOLITE Lithium Mica LITHIUM FELSPAR Petalite $LI_2OA1_2O_38SIO_2$	LOW Irritation	MODERATE Irritation. Lepidolite due to mica may cause silicosis.	MODERATE Lithium carbonate is used medically. As with most drugs exceeding the therapeutic dose is toxic
MAGNESIUM CARBONATE $MgCO_3$	No recorded significant hazard, but avoid inhalation of the very light fine powder form.		

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MATERIAL	SKIN	INHALATION	INGESTION
MANGANESE DIOXIDE MnO_2 MANGANESE CARBONATE $MnCO_3$	Not significant	HIGH Acute-metal fume fever. Chronic inhalation of dust or fumes or ingestion may cause manganese poisoning or "manganism" - a serious disease affecting the central nervous system. Early symptoms are fatigue, loss of appetite, weakness in the legs, tremors of the hands, muscular spasms and leg cramps, loss of co-ordination, with symptoms resembling Parkinson's disease. Chronic poisoning can be from heavy exposure for three months, but usually takes one to three years. If removed from the source before permanent disability, some improvement will occur. Iron deficiency appears to increase Manganese absorption.	HIGH
POTASSIUM PERMANGANATE Condys Crystals. $KMnO_4$	Not significant Contains manganese. Stains skin and may give a reaction. A concentrated solution burns skin.	HIGH	HIGH
NICKEL OXIDE NiO NICKEL CARBONATE $NiCO_3$	HIGH Irritation Nickel itch precedes allergic dermatitis.	MODERATE Irritation of upper respiratory tract. Not considered to cause systemic poisoning. (Nickel Carbonyl Ni $(CO)_4$ is highly toxic.)	MODERATE Nausea, vomiting & giddiness.
POTASH Potassium Carbonate K_2CO_3 SODA ASH Sodium Carbonate (washing soda) Na_2CO_3	MODERATE Corrosive Skin & eye	MODERATE Severe irritation. May cause oedema of the lungs	HIGH Very caustic Damage to mouth and oesophagus.
RUTILE Titanium Oxide TiO_2	No significant hazards.		
SILICON CARBIDE SiC	No significant hazards		

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MATERIAL	SKIN	INHALATION	INGESTION
SELENIUM Se	MODERATE Compounds may cause dermatitis and allergies	MODERATE Irritant, garlic odour of breath Volatilises easily. May cause liver damage and pulmonary oedema after acute exposure	MODERATE Acute gastritis.
	Absorbed through skin, lungs, mouth and the placenta. Chronic inhalation or ingestion may result in nervousness, apathy, nausea, anaemia, liver and kidney damage.		
STRONTIUM CARBONATE $SrCO_3$	LOW Skin irritation	LOW Similar toxicological properties as Calcium	LOW
TALC $3MgO.4SiO_2.H_2O$	LOW	LOW Chronic inhalation - "talcosis" (similar to silicosis). If contaminated with asbestos can cause lung cancer.	Possibly HIGH "if contaminated with asbestos can cause stomach & intestinal cancer.
TIN OXIDE Stannic Oxide SnO_2	Apparently NON-TOXIC. Prolonged inhalation can cause "stannosis" - shadows in lungs but with no ill effects. Prolonged use can also cause dermatitis		
VANADIUM PENTOXIDE V_2O_5	HIGH Severe skin and eye irritation allergies.	HIGH Acute and chronic lung problems. Inhalation and ingestion may cause intestinal and heart problems with palpitations. The tongue turns dark green, but this is usually temporary. As little as 1 microgram per gram of tissue can cause serious disturbances.	HIGH
VERMICULITE	Not significant	HIGH May contain asbestos causing asbestosis, mesothelioma and lung cancer.	Possibly HIGH If asbestos contaminated may cause intestinal & stomach cancer.
ZINC OXIDE ZnO	Not significant	MODERATE Acute metal fume fever. No chronic poisoning reported.	LOW Gastric problems
ZINC CHROMATE Zinc Yellow $ZnCr_2O_3$	MODERATE Irritation, ulcers, allergies	HIGH Irritation to nose and lungs, allergies, lung cancer.	HIGH As for Chromium poisoning
ZIRCONIUM OXIDE ZrO	LOW Nodules under skin	HIGH Nodules in lungs thought to be allergic reactions.	LOW
ZIRCONIUM SILICATE $ZrSiO_4$	LOW Possible allergies	HIGH Chronic inhalation can cause silicosis.	LOW

There are 14 trace elements believed to be essential for animal life these are:-

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CHROMIUM, COBALT, COPPER, MANGANESE, MOLYBDENUM, NICKEL, SELENIUM, ZINC, FLUORINE, IODINE, IRON, and SILICON. Most of these materials are used by potters. The margin between the body's required dose and the toxic dose varies. This seems to depend partly on the body's ability to excrete them. Most are cumulative to a certain degree.

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GRAPHIC & COMMERCIAL ARTS

This art form encompasses a range of art disciplines and overlaps with painting, printing and photography.

Hazardous materials and processes specific to the graphic arts include:

- ?? Solvents (for wash-up, thinning, etc.). See Solvent Table.
- ?? Paints (water, acrylic, oil based). See Painting Section.
- ?? Inks (printing and drawing). See Printing Section.
- ?? Extenders and Driers (for modifying inks and paints).
- ?? Marker Pens - contains dyes and solvents.
- ?? Pastels, Crayons - may contain toxic pigments.
- ?? Adhesives (water and solvent based; hot melt waxes and plastics)
- ?? Photocopiers (black and white and colour).
- ?? Photochemicals/processes. See Photography Section**.**
- ?? Airbrush Work.
- ?? Aerosol Sprays (paints, sealers, fixatives, varnishes and adhesives).

The risks from using these materials will vary widely depending on the particular material and the method of application, which may be:

- ?? by hand (pen, brush, swab, felt),
- ?? by spray (aerosol can, airbrush),
- ?? photographically,
- ?? mechanically (printing press, screen press).

Paints

With water based paints the major concern is with the pigment. However, preservatives may be used and people can be sensitive to these. Oil, alkyd or lacquer based paints contain toxic solvents. If possible replace with water based paints (see painting and printing sections).

Solvents and Diluents

Solvents are used in markers, varnishes, fixatives and inks; for cleaning, thinning and washing up. All solvents should be handled with caution. This includes widely used solvents such as turpentine and petroleum distillates. Many will cause skin damage (contact or allergic dermatitis). Most are toxic if inhaled or ingested (cause organ damage) and most cause narcosis if sufficient is inhaled. Many solvents are highly flammable. Long term low level exposure may cause organ damage and a range of diseases. Solvents to avoid are:

- ?? Chlorinated hydrocarbons - methylene chloride, trichlorethylene, carbon tetrachloride.
- ?? Glycol ethers - these are a group of chemicals which can cause reproductive damage, kidney damage, and anaemia.
- ?? Aromatic hydrocarbons - toluene, xylene (benzene, now largely eliminated from the workplace, is a carcinogen but may be a minor contaminant in mixed solvents such as lacquer thinners).

Airbrush and Aerosol Sprays

These are more hazardous because the fine droplets can be readily inhaled unless there is adequate ventilation or an effective respirator is worn. Avoid using solvent based materials for spraying and printing unless there is an effective ventilation system. It is safer to use water based materials. This not only protects you but also the environment. If you can't find an alternative to the spray can at least find a brand that does not use CFC's (chlorinated fluorinated hydrocarbons are associated with ozone depletion in the upper atmosphere).

Vehicles and Binders

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Drying oils, egg yolk, gums and casein and essentially non-toxic. Gum arabic can cause asthma.

Siccatives or Driers

These are usually metallic salts used to assist drying of paints and varnishes. They may be lead oxide, manganese oxide and cobalt linoleate. Lead and manganese driers are more toxic than cobalt.

Adhesives (See also plastic hazards section under Sculpture)

Solvent based adhesives eg. rubber gum, aerosol adhesives and plastic glues should be treated with the same caution as for solvents and used only in well ventilated areas or with local exhaust ventilation.

Water based adhesives may contain dermatitic agents and toxic preservatives.

Hot melt adhesives are generally safe unless overheated, when the plastic can decompose and produce toxic fumes and gases.

Chemically reactive adhesives are the instant glues or "super glues". They are sensitisers and dermatitic agents and should only be used in well ventilated areas.

Epoxy resins - two pack glues, contain hardeners which cause dermatitis and occupational asthma. Use in well ventilated areas.

Photocopiers

The major hazard of photocopiers is the potential for build up of ozone gas, produced by the copying process, in poorly ventilated areas. Ozone is highly toxic and photocopiers should be properly ventilated. Large photocopiers may require local exhaust ventilation to be fitted to remove toxic gases and excess toner powder.

Photographic Processes (See also photographic section)

A large proportion of photochemicals are toxic by inhalation and car, cause skin damage (dermatitis, acid and alkali burns) and eye damage. Use only in well ventilated areas, use gloves, and protective clothing in dark rooms.

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PAINTING AND PRINTING

The major health effects associated with paints, printing inks, etc. arise from the pigments, vehicles and additives. Pigments can be organic or inorganic and the vehicles can be oil, water or polymer emulsion. Minor quantities of additives will be present as stabilisers, preservatives, driers, etc.

Pigments

The organic pigments are most often synthetic materials but may also be naturally occurring compounds such as indigo and alizarin. The inorganic pigments are usually metals or metal salts and are often derived from minerals (eg. ochre, which is a clay coloured by iron oxide).

The elements of inorganic pigments determine their toxicity. A great variety of metals are found in pigments, but those of greatest concern are antimony (antimony orange, Naples yellow), arsenic (emerald green, Paris green, cobalt violet), - lead (flake white, chrome yellow), manganese (manganese pigments and umbers), mercury (vermillion cinnabar), molybdenum (molybdate orange) and selenium (cadmium red). Almost all these metals are toxic to the central nervous system: arsenic, antimony, chromium, molybdenum and selenium are liver toxins; cadmium, chromium, lead, molybdenum and mercury are kidney toxins and antimony, cadmium and cobalt exert a toxic effect on the cardiovascular system. In addition to this, lead chromate (chrome yellow) is a suspected carcinogen.

Metal salts are also found in driers. One of these, cobalt naphthenate, is a suspected carcinogen of the connective tissue.

A few organic compounds (eg. diarylide) are of particular concern since they are based on the compounds benzidine and dichlorobenzidine, two known bladder carcinogens. If the pigment is ingested, it may be converted by the body into these original carcinogenic compounds.

Since many pigments are toxic and may cause cancer, it is important to handle them carefully, avoiding any possibility of entry into the body. When pigments (including metallic powders, eg. bronze, silver) are being ground or mixed, especially in the initial stages, the operation can be particularly dusty. At this stage dust should be controlled using local exhaust ventilation or, if this is not available, a mixing box and/or the protection of a respirator, until the paste is completely formed.

Accidental ingestion can occur when pigment present on the skin is transferred to food, cooking utensils or cigarettes. Some pigments can be absorbed directly through the intact skin and many of them can be absorbed directly through damaged or abraded skin. Gloves will protect both these routes of entry and against the possibility of dermatitis from some of the pigments, eg. these that contain chromium. Certain black pigments, based on carbon black, have been implicated as skin carcinogens. Solvents in the inks can defat the skin and cause dermatitis and should therefore be guarded against using appropriate protective gloves.

Since the artist or art worker may not know the chemical composition of the pigments in the inks and paints used and since this information is very often difficult to obtain, it is strongly suggested that precautions be taken to avoid inhalation and skin contact when using any of these materials.

There are several ways to obtain information on pigment composition. The "Colour Index" is a multi-volume cross-referenced publication, dealing with the trade name of the pigments, pigment numbers, manufacturers and chemical composition, (see Bibliography).

If the trade name of the pigment (not the ink) or the pigment number is known, then a Colour Index number can be obtained and from that the chemical composition can be found. However, if this information is not known, then the pigment number or chemical composition may be obtained from the manufacturer. (Difficulty in obtaining the co-operation of certain manufacturers is sometimes experienced).

Remember, it should be school, college and workplace policy to have Material Safety Data Sheets with every product supplied for use at your place of work.

Paint solvents and propellants

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These should be regarded as potentially hazardous. Try to establish the nature of the carrier, solvent or diluent; refer to MSDS's, the solvents table and texts on toxicology to establish the appropriate precautions and controls when using (see Table 2 - Solvent Hazards).

Epoxy Paints

Two pack epoxy paint systems rely on the highly toxic di-isocyanates as the crosslinker (see hazards of plastics). DO NOT USE 2 pack spray systems without very efficient LEV or an air supplied respirator.

PRINTING

The printing processes most commonly practiced by artists and craftsmen are etching, aquatint, silkscreen printing and lithography. The carbon are photo-printing technique is also used in various institutions.

Etching

Acids

The main hazard associated with etching concerns the preparation of acid etch solution from concentrated acid. Protective clothing and goggles should be worn when mixing the etch. Slowly add acid to water, not vice-versa, stirring constantly. Both mixing and etching should be carried out only with local exhaust ventilation. Shields over acid trays give added protection from fumes and splashes. An etch should never be disposed of before being thoroughly diluted or neutralised with sodium bicarbonate. Special safety carriers should be used for carrying acids. Acid should be stored in an isolated area away from other chemicals, especially alkalis.

Aquatint

Rosin dust used in aquatint is both highly toxic and highly flammable. Inhalation and skin contact should be avoided. Ensure that all parts of aquatint boxes are plastic rather than metal to reduce the risk of spark production. Use only explosion-proof motors. The use of spray lacquers for aquatinting plates may result in the production of highly concentrated solvent and propellant mist. It is therefore, essential that adequate ventilation be used when these are employed.

Ammonium hydroxide used in the aquatinting process is a highly corrosive alkali. The vapour irritates the eye and respiratory system whilst the liquid itself causes severe burns. Strong concentrations of the vapour may also burn the skin.

Carbon black, the pigment used in black printing inks, is a suspected carcinogen, and contact should be avoided.

Silkscreen Printing

Pigments

Silkscreen inks contain the same pigments as oil paints. (see Tables 6, 7, 8 for hazardous components).

Solvents

The main hazard associated with silkscreen printing arises from the presence of solvent in inks, bases, thinners, retarders and general silkscreen wash fluids. Inks may contain 40-70% solvent, bases around 80% and thinners and retarders 100%. Manufacturers should be required to provide information regarding the exact nature and amount of solvents contained in any particular product. See table 2 and note the following general points:

?? When mixing inks, avoid leaving cans or large amounts of ink on the palette for long periods of time. All through the mixing, printing and drying stages toxic solvent vapour is constantly evaporating from the inks into the atmosphere. A well ventilated work area is therefore essential. High velocity local exhaust ducts located close to the source of fumes are more effective and less energy consuming than general ventilation. Vapours should be drawn away from, never towards, the printmaker.

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?? After mixing, clean up the area completely. Never leave unused ink or solvent-soaked rags lying around the studio. Rags should be disposed of in a closed steel waste bin to minimise fire and explosion hazards. All substances containing solvent should be stored in flameproof cupboards.

?? During printing, avoid letting the screen dry out to the point where an excessive amount of clean up solvent will have to be used. It may be worthwhile considering the use of acetone as a substitute cleaning solvent. Acetone does, however, present a considerable fire hazard.

?? In photo-screen printing a light sensitive emulsion containing poisonous potassium dichromate and ammonium dichromate chemicals is sometimes used.

?? Suitable protective clothing, especially for the hands, should always be used when handling toxic chemicals.

Silkscreen Equipment

Process camera lamps operate at 3,000 watts. Hand contact should be avoided, even when cold, as this could cause shattering when in use. Exposure to mercury vapour lamps in printing down tables can cause skin burns and conjunctivitis in the eyes.

Lithography

Various desensitising etches contain potassium dichromate, nitric acid and phosphoric acid. These should be handled with extreme care.

Lithographic crayons and lithographic tushe contain lamp black, so skin contact should be avoided.

Some talcs (french chalk), or talc/resin mixtures contain asbestos, which can cause asbestosis, lung cancer and mesothelioma (a rare cancer). Asbestos-free cosmetic or baby talc should be used.

The following is a list of potentially hazardous chemicals which may be encountered in lithographic processes. Advice should be sought from the manufacturer regarding the safe handling of any particular chemical:

Acetic acid
Alcohols
Ammonium nitrate
Aromatic and
aliphatic hydrocarbons
Carbolic acid
Cellulose
Chrome alum
Di-acetone alcohol
Di-isobutyl ketone
Epoxy resins
Ethyl acetate
Ethyl cellosolve
Ethylene glycol
Gum arabic
Gum rosin
Hydrofluoric acid
Isopropyl alcohol
Isopropane
Ketones
Methanol
Methyl cellosolve
Methylene chloride
Phosphoric acid
Sodium di-chromate
Toluene
Xylene
Zinc chloride
Zinc nitrate

Carbon Arc

The carbon arc is used as a light source in photo-printing techniques. When in use, toxic carbon monoxide, nitrogen oxide, ozone and metal fumes are produced. Dangerous amounts of fumes can be inhaled without noticeable initial discomfort. Carbon arcs should therefore be directly vented to the outside by an overhead canopy hood.

Large amounts of ultra-violet light are also produced by carbon arcs, necessitating the use of ultra-violet absorbing goggles and hand shields. Walls should be painted with ultra-violet absorbing zinc oxide paint to reduce reflection of ultra-violet light.

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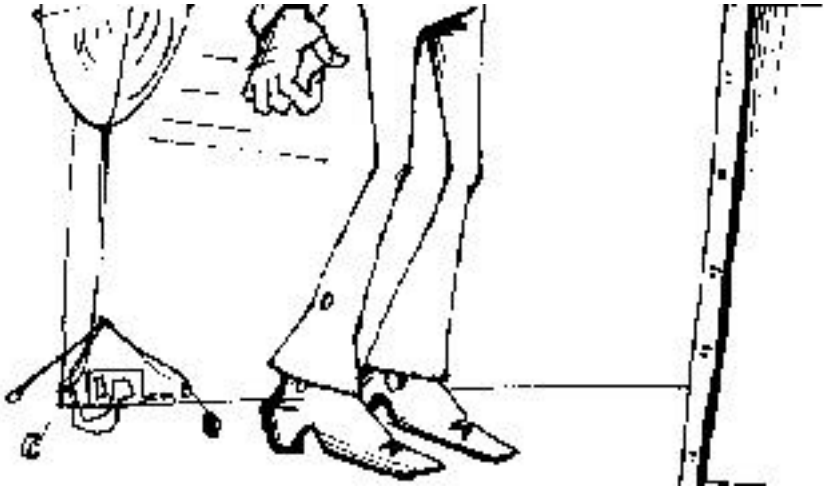
It should be note  ese may increase rather than redu

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TABLE 6 HAZARDS ASSOCIATED WITH SPECIFIC TYPES OF PAINTS

TYPE OF PAINT	POSSIBLE HAZARDOUS COMPONENTS
HOUSE PAINTS	
Primer	Lead pigments, tin compounds
Emulsion	Ammonia, mercury, lead, formaldehyde
STEEL PAINT	
Primer	Chromates, phosphoric acid.
Anti-fouling paints	Organic tin and mercury compounds, arsenic and copper compounds.
OTHER TYPES OF PAINT	
Epoxy paints	Epoxy resin, amines
Polyurethane	Isocyanates
Bituminous paints	Bitumen
Water Based (tempera, poster)	Pigments Preservatives, eg. formaldehydes, phenol, mercury

Solvents and aerosol propellents should be regarded as potentially hazardous. Try to establish the nature of the carrier, solvent or diluent and refer to solvents table (Table 2) and textbooks on toxicology to establish the appropriate precautions and controls when using.

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TABLE 7: HAZARDOUS COMPONENTS OF SOME ORGANIC PIGMENTS

(Numbers in brackets refer to Colour Index Classification)

COMMON NAMES	USE AND HAZARDS
YELLOWS	
Pigment Yellow 1 & 3 Hansa Yellow (11680, 11710)	May promote cancer
Pigment Yellows 12 & 14 - Diarylanilide (21090, 21095) or Benzidine Yellow	May contain cancer causing benzidine, and polychlorinated biphenyls (PCB's) which cause choracne and cancer.
ORANGES	
Pigment Orange 5 (12075) Dinitroaniline Orange May cause genetic damage.	Used in children's paints and crayons
Pigment Orange 13 (21110) & Pigment Red 38 (21120) Diarylide Orange & Red Pyrazolone Orange & Red Benzidine Orange	Used in children's toys and craft paints SUSPECTED CARCINOGEN
REDS	
Pigment Red 1 (12070) Para Red, Paranitroaniline Red blood if ingested	Suspected genetic damage. Binds with
Pigment Red 3 (12120) Toluidine Red Hansa Red	Binds with blood if ingested
Pigment Red 49 (15630) Lithol red May contain soluble Barium or B-Naphthylamine. Causes bladder cancer	May cause allergies Highly toxic
Pigment Red 53 (15585:1) (15585:2) Red Lake C (May contain soluble Barium)	Highly toxic by inhalation and ingestion.
Pigment Red 60 (16105:1) Pigment Scarlet Lake	SUSPECTED CARCINOGEN
Pigment Red 81 (45160:1) Rhodamine 6B May contain ARSENIC	Used in fluorescent "Day glow" paints and inks Can cause lung cancer if containing arsenic.
Pigment Red 83 (58000:1) Alizarin Crimson	May cause allergies
VIOLETS	
Pigment Violet 1 (45170:2) Rhodamine B	Used in fluorescent "Day glow" paints and ink SUSPECTED CARCINOGEN May contain arsenic.
BLUES	
Pigment Blue 1 (42595:2) Victoria Pure Blue B	SUSPECTED CARCINOGEN
Pigment Blue 2 (44045:2) Victoria Blue B	SUSPECTED CARCINOGEN
Pigment Blue 15 (74160) Phthalocyanine blue May be contaminated with PCB's Phthalo Blue Thalo Blue	SUSPECTED CARCINOGEN (see Pigment Yellow 12)

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COMMON NAMES	USE AND HAZARDS
GREENS	
Pigment Green 1 and 2 Brilliant Green (42040:1)	Highly toxic if ingested. May contain soluble Barium
Pigment Green 7 (47260) Phthalocyanine Green May be contaminated with PCB's Phthalo Green	SUSPECTED CARCINOGEN
Pigment Green 10 Nickel-Azo-Yellow Dermatitis Green-gold	Allergies to nickel
BLACKS	
Solvent Black 5 (50415) or Acid Black 2 (50420) cause dermatitis Nigrosine Black	May contain nitrobenzene which can
Pigment Black 6 (77266) Lamp Black	May contain polycyclic aromatics (PAH's) which cause skin cancer

...their unhealthy coloring and the melancholic fits... are caused by the injurious qualities of the colors that they use.

Moreover painters when at work wear dirty clothes smeared with paint, so that their mouths and noses inevitably breathe tainted air;...

But for their liability to disease there is a more immediate cause, I mean the materials of the colors that they handle and smell constantly, such as red lead, cinnabar, white lead, varnish, nut-oil and linseed oil, which they use for mixing colors; and the numerous pigments made of various mineral substances.

Ramazzini

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TABLE 8 COMPONENTS OF COMMON INORGANIC PIGMENTS THAT MAY BE HAZARDOUS

(Bracketed numbers in lift hand column refer to Colour Index Classification)

Code:
1. Extremely toxic and/or carcinogenic - avoid use.
2. Highly toxic - and/or associated with cancer. Replace if possible
3. Moderately toxic - use with caution.
4. Low toxicity - use with normal care.

COMMON NAMES	HAZARDOUS COMPONENTS
WHITE	
Chinese White - Pigment White 4	Aluminium Silicate (4)
Mixed White	
Zinc White - Pigment White 7	Zinc Oxide (4)
Cremnitz White - Pigment White 19 (77005) Flake White Pigment White 1 (77597) White lead - Pigment White 2 (77633)	Lead carbonate/lead hydroxide (1)
Lithopone - Pigment White 5 (777115)	Barium sulphate (4) Zinc Oxide (4)
Titanium White Pigment White 6 (77891)	Barium sulphate (4)
Titanium White - Pigment White 6 (118991)	Titanium dioxide (4) Zinc oxide (4)
YELLOWS	
Barium yellow	Barium chromate (1)
Chrome yellow or orange	Lead chromate (1)
Golden yellow	Zinc chromate (1)
Lemon yellow - Pigment Yellow 31	Chromium (1)
Strontium yellow - Pigment Yellow 32	Strontium chromate (1)
Zinc yellow - Pigment Yellow 36	Zinc chromate (1)
Cadmium yellow - Pigment Yellow 35/37 (77117, 77119)	Cadmium sulphide (1) Barium sulphate (4)
Cobalt yellow - Pigment Yellow 40 (Aureolin) (77357)	Cobalt (potassium cobaltnitrite) (3)
Naples Yellow	Lead, antimony (1)
ORANGES	
Cadmium Orange	Cadmium selenide (1) Cadmium sulphide (1) Barium sulphate (4)
Molybdate Orange - Pigment Red 104 (77605)	Lead chromate (1) Lead molybdate (1) Lead sulphide (1)
Orange Mineral - Pigment Red 105 (77578)	Lead tetroxide (1)

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COMMON NAMES	HAZARDOUS COMPONENTS
REDS	
Cinnabar - Pigment Red 106 (77766) Chinese Vermilion - Pigment Red 106 (77766)	Mercuric sulphide (3)
Cadmium Lithopone Red Cadmium Red - Pigment Red 108 (77202)	Cadmium sulphide (1) Cadmium selenide (1) Barium sulphate (4)
Cadmium Vermilion Red Mercury cadmium Red - Pigment Red 113 (77201)	Cadmium sulphide (1) Mercuric sulphide (3)
VIOLETS	
Cobalt Violet - Pigment Violet 14 (77360)	Cobalt (3), arsenic (1)
Manganese Violet	Manganese (3)
BLUES	
Cerulean blue - Pigment Blue 35 (77346) Cobalt blue - Pigment blue 28 (77346)	Cobalt oxide (3)/Tin oxide (4) Copper sulphide (2)
Thenards blue - Pigment blue 28 (77346) Manganese Blue - Pigment Blue 33 (77112)	Cobalt oxide/Aluminium oxide (3) Barium, manganese (3)
GREEN	
Chromium oxide - Pigment Green 17/18 (77288/9) Green viridium Guignets green	Chromium (1) Chromium (1)
Cobalt green - Pigment Green 19 (77335)	Cobalt oxide (3) Zinc oxide (4)
Veronese green - Pigment Green 21 Victoria green - Pigment Green 4 (42000:2) Scheele's green Pigment Green 22 (77412)	Arsenic (copper aceto-arsenite) (1)
BROWNS	
Burnt umber - Pigment Brown 7 (77491) Raw number - Pigment Brown 7 (77492) Manganese brown Mars brown	Manganese dioxide (3) Iron oxides (4)
BLACKS	
Lamp Black - Pigment Black(77266) Carbon Black Pigment Black (77266)	Almost pure carbon Impurities (2)

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AEROSOL ART

Aerosol paints, varnishes and fixatives have been widely used in industry and are increasingly finding their way into the artists' collection of materials.

Aerosol paints consist basically of three groups of components:

1. solvent(s)
2. propellant(s)
3. colourant(s)

Varnishes and fixatives use a resin polymer with or without a colour. There may also be small amounts of driers, preservatives etc.

TYPICAL AEROSOL COMPOSITIONS

RUST OLEUM TOP-COAT:	Propellant 10-29% Toluene 5-10% Xylene 10-29% Methylene Chloride 10-29%
MICADOR FIXATIVE:	Propellant (propane/butane) 30% Polymer 10% Methylene chloride (30% Ethanol/Methanol 30%
NO-NAME:	Propellant 35% Xylene 10-15% Toluene 20-30% VM&P Naphtha 7-15%

Solvents

A wide range of solvents are used in aerosols - refer to Chemicals and the Artist, Table 2. Most solvents are narcotics, affecting and damaging the nervous system. They can also damage the liver, kidney, heart and skin.

Propellants

Aerosol paints can use two groups of chemicals as propellant:

1. Hydrocarbons eg. propane, butane. These can act as simple asphyxiants, and can cause drowsiness and loss of co-ordination. They are highly flammable.

2. Halogenated hydrocarbons eg. freon. These compounds are relatively non-toxic but are environmentally unfriendly. They are heavier than the air and are simple asphyxiants.

Colourants

A large range of organic and inorganic pigments (or colours) may be used - refer to Chemicals and the Artist section on painting.

How To Protect Yourself

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Signs that you are being exposed to toxic chemicals when using these sprays are:

- ?? nausea
- ?? drowsiness
- ?? headaches
- ?? dizziness
- ?? chest and breathing problems
- ?? irritation of eyes, nose, throat
- ?? evidence of inhaled paint spray when you blow your nose

The various components that make up aerosol paints can get into your body by one or more of three routes:

1. Through the nose and mouth, into the lungs and then into the bloodstream. With aerosols this is the most likely route into the body.

2. Through the skin by absorption.

3. By ingestion and absorption through the gut.

Once inside the body these chemicals can damage various organs.

Remember many solvents have narcotic and depressant effects.

Find out what is in your aerosol sprays. First of all READ THE LABEL. Often this will not provide sufficient information about the ingredients. Further information can be obtained by writing to the manufacturer asking for a Material Safety Data Sheet. These provide information on the contents of the can, precautions for use, first aid treatment, protective equipment, emergency procedures etc.

There are a number of possible control measures you can use (see Section 4).

1. Select a safer type of spray. The MSDS may give you the information to select a safer solvent. Use a safer spray technique such as airbrush with water based paints.

2. Ventilate. Use natural or forced ventilation or use local exhaust ventilation. Local exhaust ventilation systems are purpose designed extraction systems such as a spray booth or an elephant trunk.

   If you're working indoors try placing a fan behind and to one side of you, so that spray is blown away from your breathing zone (but not into someone else's).

3. Reduce the dangers of administrative and organisational methods eg. improve the work organisation and reduce the number of people spraying in one area, eg. modify the workplace.

   Limit your time of exposure and give your body time to recover.

4. Provide and use personal protective equipment eg. respirators, gloves. Make sure the respirator is suitable for aerosol sprays (many are not). Check that they fit correctly and are regularly maintained. A combination particle and vapour cartridge is necessary. "Throw-away" types are not suitable.

5. Educate yourselves about the materials and processes you use. Don't be frightened to ask questions and seek information from other sources such as Libraries, WorkCover, Department of Labour, Poisons Information Centre, etc.

The important thing to remember is that aerosol paints can be used safely; get to know your material and use the appropriate precautions. Also remember that safer substitutes and ventilation are better controls than relying on protective equipment because they are more fail-safe and don't rely on you doing the "right thing".

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PHOTOGRAPHY

The photographic process involves the use of light on chemically sensitised materials to produce an image and can involve the use of a wide range of chemicals.

Photographers should be familiar with the processes they use, including the chemicals they work with, their hazards and what preventative measures should be taken.

People who suffer from any type of skin disease or from allergic conditions such as hay fever or asthma should be particularly careful as experience has shown that their skin tends to be more sensitive. Colour processes are more likely to cause skin irritation and dermatitis than black and white.

For the regular and constant use of photographic chemicals, there is good case for an initial general medical examination. This is to recognise any medical conditions that might have a direct bearing upon specific aspects of the work such as hypersensitivity to a certain chemical or defective vision or colour blindness. This medical should be followed by regular (annual) checks. Remember, it should be school, college and workplace policy to have Material Safety Data Sheets with every product supplied for use at your place of work.

Guidelines for Safe Photographic Work

- ?? Avoid inhalation of chemicals by providing adequate ventilation (see ventilation section). Fifteen (15) room changes of air per hour for black and white are recommended. Use local exhaust ventilation (LEV) for colour processing.
- ?? Colour processing requires the use of several toxic chemicals; wear gloves and goggles, ensure adequate ventilation.
- ?? Toners can involve use of heavy metal compounds (gold, platinum, vanadium). These are toxic. Hydrogen sulphide (H_2S) is released when potassium sulphide (H_2S) is treated with acid. [H_2S is only slightly less toxic than hydrogen cyanide (HCN)].
- ?? Use gloves when handling powders or liquids, respirators when pouring powders; tongs when developing papers etc.
- ?? Exercise extreme caution with acids and alkalis - wear protective equipment (face shield, gloves, apron etc.), add acids slowly to water.
- ?? Do not eat, drink or smoke in the darkroom.
- ?? Label all chemicals clearly and fully.
- ?? If the darkroom is used by children ensure chemicals are kept out of reach.
- ?? Store chemicals at a convenient height, not where they can be knocked over.
- ?? Mix and pour chemicals slowly and carefully.
- ?? Electric radiators should not be used in the darkroom.
- ?? Electric contacts should not be touched with wet hands and should be checked regularly.
- ?? Keep the darkroom clean and organised. Even minor spills should be immediately mopped up.
- ?? In case of chemical splashes in the eye, wash for at least 15 minutes. If stinging persists, consult a doctor. Eye-wash stations in the darkroom should be provided.
- ?? In case of accidental skin contact wash the area with soap and copious amounts of water.
- ?? Wash away used chemical separately with large amounts of cold water. (Hot water could produce a reaction).

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TABLE 9: TOXIC PHOTOGRAPHIC CHEMICALS

This is a list of the more toxic chemicals found in photography.

Abbreviations:

carc	carcinogen (known or suspected)
CNS	central nervous system
corr	corrosive/caustic
CVS	cardiovascular system
irr	irritating
skin*	substance absorbed through skin
URT	upper respiratory tract irritant
derm	dermatitis
GI	gastro-intestinal tract
resp sys	respiratory system

NAME	HEALTH EFFECTS
DEVELOPERS	
Phenidone	(least toxic), irr
Para-phenylene diamine	Irr, resp sys, derm, skin
p-Aminophenol	Irr, skin, eyes
Hydroquinone	Irr, resp sys, CNS, derm. GI, skin, eyes
Potassium hydroxide	Caustic, irr, URT, skin, eyes
Pyrocatechol	Irr, causes cyanosis, derm, skin*
Sodium hydroxide, carbonate	Caustic, irr, skin, eyes, resp sys.
Metol (elon)	Irr, URT, skin, eyes, derm.
Borax	CNS, URT, skin, eyes, GI.
STOP BATHS	
Acetic Acid	Corr, irr, URT, skin, eyes
Potassium chrome alum	Carc, resp sys, derm
FIXERS	
Hypo (sodium thiosulphate)	Irr - can release SO_2
Sodium sulphite	Irr, resp sys, CNS
Acetic Acid	Corr, irr, URT, skin, eyes
Boric acid	Irr, URT, skin
Ammonium thiosulphate	as for hypo
Alum (potassium aluminium sulphate)	Irr, skin
STABILISERS/HARDENERS	
Acetic Acid	Corr, irr, URT, skin
Chrome alum	Carc, resp sys, derm.
Formaldehyde	Carc, irr, URT, skin, eyes, derm.
Methyl alcohol	Irr, CNS, optic nerve damage, skin*
TONERS	
Potassium bromide	CNS, skin
Sodium sulphide	Irr (release H_2S with acid)
Ammonium Alum	Irr, skin
Ferric Alum	Irr, skin
Sulphuric acid	Corr, irr, URT, skin, eyes
Vanadium chloride	Irr, URT, eyes
Thiocarbamide (thiourea)	Car, derm, skin
Selenium oxide	Corr, irr, URT, GI, derm.

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Oxalic acid	Corr, irr, URT, eyes, GI

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NAME	HEALTH EFFECTS
BLEACHES/REDUCERS/DYE BLEACHES	
Ammonia	Irr, URT, skin, eyes
Hydrochloric acid	Corr, irr, URT, skin, eyes
Hydrogen peroxide	Corr, irr, URT, skin, eyes
Perchloric acid	Corr, irr, URT, skin, eyes
Potassium thiocyanate	Can release HCN with acid
Potassium bromide	CNS, skin
Potassium cyanide	Highly toxic, URT, irr, skin*
Potassium ferricyanide	Can release hydrogen cyanide when heated or treated with acid, skin*
Sulphuric acid	Corr, irr, URT, skin eyes
Thiocarbamide (thiourea)	Carc, skin, derm.
Ammonium persulphate	Irr, skin, eyes, (releases SO_2 when heated).
INTENSIFIERS	
Hydrochloric acid	Corr, irr, URT, skin, eyes
Lead acetate	Highly toxic, CNS
Potassium dichromate	Carc, resp sys.
Silver nitrate	Corr, irr, skin, eyes
Potassium ferricyanide	(see above)
Uranium nitrate	Carc, corr, CNS
Chromic acid	Highly corr, URT, skin, eyes
Mercuric chloride, iodide	Highly toxic, corr, CNS, GI skin eyes
MISCELLANEOUS	
Acetone	Highly flammable, CNS, irr, URT, skin, eyes
Carbolic acid (Phenol)	Highly toxic, irr, liver, kidney damage, skin*
Ethylene diamine	Irr, URT, skin, eyes, derm.
Ethylene glycol	Irr, CNS, URT, kidney damage, CVS, skin*
Freons (fluorocarbons)	Irr, do not heat.
Glycol ethers (cellosolves)	Reproductive hazard, irr, URT, skin, eyes, derm, kidney damage, skin*
Glutaraldehyde	Highly irr, URT, skin, eyes.
Urea peroxide	Explosive - do not heat.

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PROPRIETARY PHOTOGRAPHIC CHEMICALS

Commercial Product	Hazardous Component(s)
ID11	Hydroquinone 4-methylaminophenol sulphate (metol) Borax
Microphen	Hydroquinone Borax/Boric acid
Bromophen	Hydroquinone
Perceptol	4-methylaminophenol sulphate (metol)
Hypan Rapid Fixer	Acetic acid Borax
Ridfix	Not given
Hypan Hardener	Aluminium Chloride Acetic Acid
Ilford Cibachrome	
Developer additive	Cinammic Acid Disulphide
Developer Part A	None
Part B	Hydroquinone Acetic Acid 2 ethoxy ethanol (ethylene glycol monoethyl ether)*
Cibachrome P-30 Fixer	N-methyl-2-pyrrolidone
Cibachrone P-30 Bleach	
Part A	p-toluene sulphonic acid
Part B	p-toluene sulphonic acid 2 ethoxy ethanol*
Part C	----
Agfa - Gevaert Copyproof	
Activator	Ethylene glycol 2-Methylaminoethanol Sodium sulphite Sodium thiosulphate Trisodium phosphate
Developer	Hydroquinone 2-Methylaminoethanol Sodium sulphite Sodium thiosulphate
Copychrome A	Citric acid Ferric nitrate
Copychrome C	Urea peroxide

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* Major hazard

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SCULPTURE

Perhaps more than any other art activity sculpture encompasses the greatest range of materials, processes and equipment; and consequently a wide range of hazards are encountered from working with wood, stone, metals, plastics, clay etc. and from the tools and equipment used.

STONE DUST

The precautions to be taken when working with stone, plaster, cement etc. are similar to those covered in the ceramics section (see also dust control; personal protection, equipment for eyes, and respiratory system).

Avoid using materials that may contain asbestos (soapstone, serpentine, kaolin, talc, fibro-cement sheeting).

WOOD DUST

Many wood dusts cause skin and respiratory irritation and allergies. Long term exposure to some wood dusts may be responsible for nasal and sinus cancer. The CSIRO provides an information service on toxic timbers and their health effects.

Preserved woods, in particular, should be handled with care. Wood preservatives are highly toxic.

Machine tools should be fitted with dust extraction systems or failing that tools should only be used in areas where other people will not be subjected to dust and flying particles. Note that the majority of tools can be fitted with commercially available dust extraction systems.

Sawdust represents a fire and explosion hazard; proper dust collection is important - collect in a safe place and dispose of regularly.

PLASTICS

Work with plastics can involve serious health risks from the resins, solvents and other components. The following general and specific precautions and health risks are a general guide only.

General Precautions

1. Use good dilution ventilation, local exhaust ventilation or an approved respirator when pouring, mixing, handling and finishing plastics.

2. Avoid skin contact by wearing protective clothing, gloves and protective goggles.

3. Note that unreacted chemicals may be released from plastics when cut or sanded. DO NOT HEAT or BURN plastics without adequate ventilation or respiratory protection: a number of highly toxic gases can be produced including hydrogen cyanide, plastic monomers, carbon monoxide, and nitrogen oxides.

4. Store flammable solvents safely - away from sources of ignition (includes acetone, lacquer thinners, petroleum spirits, styrene).

5. Organic peroxides pose a fire and explosion hazard; contamination with metals, metal compounds, amines and reducing agents seriously reduce their stability.
   DO NOT MIX DIRECTLY WITH ACCELERATORS.

Specific Precautions

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Polyurethane

Di-isocyanates are a family of chemicals which are used in paints, varnishes, and rigid and flexible foam plastics. They are highly toxic by inhalation; persons with any history of allergies, heart problems or respiratory difficulties should not be involved in using polyurethane foam or paint systems. Use LEV and air supplied respirators. Note that organic gas respirators may not adequately remove di-isocyanates to below the exposure limit [for all isocyanates the exposure limit is $0.02mg/m^3$].

Amine hardeners are irritants and sensitisers. Aliphatic amine hardeners should be replaced by less hazardous types eg. aromatic amines or amides.

Organic-tin compounds can cause damage to liver and central nervous system.

Epoxy

Epoxy resins are respiratory irritants, potent skin sensitisers and suspected carcinogens.

Amine curing agents are highly toxic by inhalation and are potent skin sensitisers.

Resin solvents vary in toxicity - glycidyl ethers induce testicular atrophy in animal studies and are potent skin sensitisers.

Polyester/Acrylic

The styrene solvent and cross linkers eg. methyl methacrylate (MAA) are highly toxic by inhalation.

Accelerators and peroxide catalysts are irritants and many are skin sensitisers.

Fibreglass is a skin and respiratory irritant.

Silicone and natural rubber.

Two component systems may contain methylene chloride or hexane as solvents.

People with heart problems should avoid methylene chloride containing resins.

Single component systems release acetic acid**,** methanol or formaldehyde on curing

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TABLE 10: HAZARD OF PLASTICS

PLASTIC TYPE

	POLYSTYRENE	POLYVINYL-CHLORIDE (PVC)	PERSPEX, ACRYLICS PLEXIGLAS
USE	Moulding, rigid foams	Plastic sheets, hot melt adhesive	Rigid sheet 'safety glass' casting
MONOMER	Unsaturated polyester	vinylchloride (VC)	Methylmethacrylate (MAA)
OTHER COMPONENTS	styrene (as solvent and cross-linker) peroxide, initiators, promoter eg. N,N, dimethyl aniline		ketone solvents peroxides
FLAMMABILITY HAZARD	High. Peroxides are highly reactive and shock sensitive	High	High
TOXIC COMBUSTION PRODUCTS	Styrene vapour	Hydrochloric acid, phosgene. Unreacted VC may be released on heating or working	MAA monomer
HEALTH EFFECTS	styrene: skin, CNS, liver, lungs. dimethyl aniline: skin inhalation, binds to red blood cells	Vinyl chloride monomer: liver carcinogen, skin, eye, respiratory, CNS	skin, eye respiratory CNS

PLASTIC TYPE

	POLYURETHANES	FORMALDEHYDES BASED THERMO-SETS eg. Formica Bakelite Melamite	EPOXY RESINS eg. "Araldite"
USE	Rigid and flexible foams	2-component thermoset adhesives, heat resistant plastics	2-component thermoset adhesives, casting
MONOMER	various polymers	formaldehyde	epoxy compounds
OTHER COMPONENTS	di-isocyanates (as cross) linkers), fluorocarbons (as foaming agent), organo-tin compounds	urea, melamine, resorcinol, phenol	amine hardeners, solvent
FLAMMABILITY HAZARD	High	Low - Moderate	Low
TOXIC COMBUS-TION PRODUCTS	carbon monoxide nitrogen oxides hydrogen cyanide, monomers	formaldehyde, hydrogen cyanide, phenol when heating or working	
HEALTH EFFECTS	di-isocyanates: skin, respiratory, strong sensitiser, organic-tin: CNS, liver	formaldehyde: carcinogen, eye, skin, respiratory	resin: skin, respiratory, suspected carcinogen. amine: skin, respiratory dermatitis.

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PLASTIC TYPES

	ACRYLATES	SILICONES Single and two compound systems
USE	'super' glues	adhesives, sealants mold and mold release
MONOMER	methyl-2-cyanoacrylate	silicone
OTHER COMPONENTS		acetic acid, methylenechloride, methanol, peroxides
FLAMMABILITY HAZARD	low	low
TOXIC COMBUSTION PRODUCTS		
HEALTHY EFFECTS	toxic vapours, skin, eye, respiratory, can bond skin	silicone is inert, see solvents table.

PLASTIC TYPES

	THERMOPLASTICS eg. polyesters	POLYAMIDES eg. nylons	POLYETHYLENES eg. polythene
USE	Hot melt adhesives, sheet, film, fibre		
MONOMER	ethylene glycol, terephthallic acid	diamines, dicarboxyllic acids	ethylene
OTHER COMPONENTS			
FLAMMABILITY HAZARD	High	High	High
TOXIC COMBUS-TION PRODUCTS		ammonia, hydrogen cyanide	
HEALTH EFFECTS	These polymers are largely biologically inert on their own.		

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TABLE 11: HAZARDS OF PLASTIC ADDITIVES

-Including stabilisers, colourants, fillers, reinforcements, accelerators, inhibitors, solvents and plasticisers.

ADDITIVE	USE	HEALTH EFFECT
Aluminium Oxide	Fire retardant	-
Antimony trioxide	Fire retardant	Skin, respiratory, kidney, liver
Asbestos	Filler	respiratory, carcinogen, asbestosis
Fused silica	Filler	respiratory on prolonged exposure
Calcium carbonate	Filler	-
Clays	Filler	respiratory, silicosis
Talc	Filler	respiratory, silicosis
Fibreglass	Reinforcement	skin, eye, respiratory, (may cause asbestos-type illnesses)
Pigments	Colourant	see pigments/dyes table
Styrene	Solvent	see solvents
Methylene chloride	Solvent	see solvents
Phthalates	Plasticisers	eye, URT, liver, kidney

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MACHINERY AND EQUIPMENT

It goes without saying that all machine tools/power tools should be adequately guarded. WorkCover advisors, Department of Labour Inspectors, etc can provide assistance and advice on guarding problems.

Hearing protection may be required with some tools and processes.

The following is a series of questions designed to raise an awareness of problems associated with machinery, tools etc.

	Machinery and Equipment	**What might go wrong**
1.	Is equipment or machinery difficult to operate?	Fatigue and errors.
2.	Are controls a hard to reach?	Increased risk of hair/clothing caught in machinery. Falls while reaching.
3.	Does movement of controls require excessive effort?	Fatigue, strains.
4.	Can controls be moved without placing hands, wrist, arms, or body in unusual positions?	Strains, sprains in arms, back, tendonitis, tenosynovitis, carpal tunnel syndrome.
5.	Are emergency shut offs accessible from locations where an operator might get caught?	Increased severity of accident if not accessible.
6.	Are lockouts provided and are they foolproof?	Possible injury/accident.
7.	Are the functions of all controls labelled or readily apparent?	Accidental starting by other people.
8.	Are the functions of controls logical and compatible with operator stereotypes or expectancies?	Mistakes in emergencies, eg. starting machine instead of stopping.
9.	Are foot pedals used to operate equipment?	Tripping machine while hands are in point of operation.
10.	Are foot pedals guarded?	Objects falling on pedal, accidental trip.
11.	Are foot pedals used by standing operators?	Fatigue from standing on one foot.
12.	Are all guards and safety devices in use and in good working condition?	Trapping, entanglement, impact, contact
13.	Do guards interfere with operation or maintenance in any way?	Removal because in the way.

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Hand Tools

1.	Are tools difficult to hold?	Fatigue, sore hands, dropped tools,
2.	Are tools too heavy?	Loss of control.
3.	Are there sharp edges?	Cuts.
4.	Are there pinch points?	Cuts, pinches
5.	Is use of tool difficult (eg. hard to squeeze, twist, slippery etc.)?	Fatigue, errors.
6.	Does tool vibrate?	Fatigue, “white finger disease”, Raynaud’s Disease,
7.	Are power tools noisy?	Hearing damage.
8.	Does use require unusual or uncomfortable hand wrist arm, shoulder or body position?	Tendonitis, carpal tunnel syndrome tenosynovitis, synovitis, medial nerve disease, muscular pains in arms, neck back.
9.	Are tools fitted with dust extraction system?	Exposure to dust and grit from woods, metals, abrasives.

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WELDING SAFETY

Oxy-acetylene and electric-arc welding are the methods most commonly used by metal sculptors.

Oxy-acetylene Welding and Cutting

The main hazards associated with oxy-acetylene welding arise from:

(a) use of compressed gas
(b) creation of fumes and gases
(c) radiation, fire and explosion.

Electric Arc Welding

The main hazards associated with electric-arc welding are:

(a) electric shock
(b) creation of gas and fumes
(c) radiation, fire and explosion.

See Table 12 for information of toxic welding by-products. Good ventilation is essential wherever fumes are produced. In confined spaces local exhaust ventilation or respiratory protective equipment should be used.

1. Learn all the necessary safety precautions for welding and related processes and follow these precautions meticulously.

2. Use and maintain appropriate safety equipment and clothing.

3. Never weld inside confined spaces without adequate ventilation or the use of supplied air respirators.

4. Always know what materials you are working with, particularly when you are working with scrap metals. Have them analysed if possible. If not possible, do not use.

5. Be adequately trained in all procedures. Until such training is completed work only with properly trained people.

6. Be aware of all fire hazards. Work away from flammable materials, know the correct fire extinguisher for the job and how to use it.

7. Never weld in an area where degreasing or other cleaning operations involving organic solvents are being performed. This is particularly important if chlorinated solvents are present because phosgene or other dangerous gases may be formed. Organic solvents are a potential fire and explosion hazard.

8. When working outdoors, position yourself upwind of the fumes and gases produced.

9. Report any defective equipment and hazardous working conditions to supervisors.

10. Follow all manufacturers' recommendations for the use, storage and maintenance of equipment.

Safety Checklist

1. Ensure that the gas cylinders are placed in a suitable stand or on a trolley.

2. Ensure that all the joints are checked for gas-tight fit after assembly.

3. Ensure that there are clear notices stating where the cylinders are kept.

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4. Ensure that the

5. Ensure that the

6. Ensure that the

7. Ensure that the

8. Ensure that the

9. Ensure that the

Check the follo

l0. Ensure that the

11. Ensure that the attached to the welding torch.

12. Ensure that the t the UV light from the electric arc do r

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Welding Health Quiz

Questions

1. Do you know what "metal fume fever" is? What are the symptoms?

2. Can you accurately identify the metal that you are welding?

3. Do you know if the metal contains cadmium? Is it Cd plated?

4. List three commonly produced toxic substances produced by electric welding.

5. What are the health effects of breathing in Ozone?

   If you are unable to answer all of the questions above it is suggested that you look at the answers. Perhaps the questions and answers can be included in the course syllabus on welding health and safety.

The course in welding safety should include information on:

(a) occupational health and safety rules,
(b) metal fumes and toxic gases produced by the welding process,
(c) protective equipment required (goggles, gloves, clothing),
(d) point of weld ventilation systems,
(e) fire laws and rules.

Answers

1. (a) A 24 hour flu like fever with a rapid onset caused by inhalation of metal fumes, in particular Zinc (Zn).
   (b) Aches and pains, headaches, nausea, weakness and tiredness/

2. If you cannot accurately identify the metal then use a known substitute or be aware that some very toxic fumes could be generated, for example cadmium.

3. Cadmium fumes when inhaled can cause pneumonia and liver damage. Acute exposures have caused deaths.

4. Ozone, nitrogen oxides, metal fumes.

5. Ozone inhalation can cause irritation of the respiratory tract, headache and at high levels (0.05ppm) visual disturbances. Ozone is produced by the electric arc in oxygen and is a special hazard in MIG and TIG welding.

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TABLE 12: TOXIC FUMES AND GASES IN WELDING

PROCESS	FUMES CREATED
All welding processes the particular metal being welded. steels contain manganese, nickel,	Metal oxide fumes, the exact nature of which depends on Iron is the most common but least harmful. Stainless cobalt, or chrome. Aluminium alloys often contain beryllium. Some filler wires contain vanadium.
Welding galvanised metal. Galvanised and plated parts should be stripped before welding.	Zinc, magnesium.
Welding lead painted metal.	Lead.
Welding plated metal.	Chrome, cadmium, nickel (depending on plating).
Welding/cutting painted or plastic-coated parts.	Impossible to predict but high risk of danger.
Manual metal arc welding	Depends on the type of electrode used so these should be checked. Fluoride fumes are often produced.
Gas shielded arc welding, (with copper coated electrode).	Copper.

PROCESS	GASES CREATED
All welding and cutting.	Nitrogen oxides from intense heat.
Gas shielded arc welding, TiG MiG; and plasma.	Argon, helium, carbon dioxide.
Electric arc welding Plasma cutting.	Ozone may be produced by ultraviolet light, especially at very high temperature or with MiG.
Flame cutting and welding.	Carbon monoxide.
Welding parts degreased in chlorinated solvents. eg. Genklene, Trike, Perchlor. (Avoid if possible. Definitely not recommended).	Phosgene

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