National Occupational Health and Safety Commission

ATMOSPHERIC CONTAMINANTS

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Foreword

The National Occupational Health and Safety Commission, Worksafe Australia, is a tripartite body established by the Commonwealth Government to develop, facilitate and implement a national approach to occupational health and safety.

The National Commission comprises representatives of the peak employee and employer bodies - the Australian Council of Trade Unions (ACTU) and Confederation of Australian Industry (CAI) - as well as the Commonwealth, State and Territory governments.

Since its establishment, the National Commission has produced occupational health guides. Before the National Commission was established, a series of similar guides was published by the National Health and Medical Research Council.

This Guide has been reviewed and endorsed by a working group of the National Commission as part of the co-ordinated effort by the Commonwealth, State and Territory governments and employee and employer organisations to make Australian workplaces safe and healthy.

Although this Guide has been endorsed by the National Commission, it is an advisory document only. It is produced and distributed in the interests of providing useful information on occupational health and safety for employers, employees and others. This document does not replace statutory requirements under relevant State and Territory legislation.

This Guide is aimed primarily at workers and managers but should also be useful to occupational health and safety personnel and others. It may be used in conjunction with appropriate training and consultation, in line with good management practice.

Contents

Introduction

Many processes produce airborne substances that may be harmful to the human body.

This Guide summarises the important aspects of the identification and control of workplace atmospheric contaminants. It should be read in conjunction with the National Commission publication, *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (latest edition), and the booklet, *Clean Air at Work*, together with Worksafe Australia Guides on specific contaminants.

Identification

Airborne substances encountered in the workplace may be classified as dusts, fibres fumes, mists, smokes, vapours, gases or biological agents. The following table gives some examples of the types and industry/processes. It is not an exhaustive list.

Atmospheric contaminants

Type	Examples	Industry/Process
Dusts including fibres	silica dust, coal dust, grain dust, asbestos fibres	construction and mining industries, agriculture
Fumes	metal fumes, welding fumes	smelters, welding, foundries
Mists	acid/alkali mists, chrome plating mist, pesticide mist	metal pre-treatment, electroplating, aerial spraying
Smokes	emission from coke ovens	steelworks
Vapours	paint solvent vapours, chlorinated hydro- carbons	spray painting, solvent degreasing, dry-cleaning
Gases	carbon monoxide chlorine, hydrogen sulphide	steelworks, caustic soda manufacture, sewage works
Biological agents	influenza viruses, the Q Fever organism, pollen	health care workers, meatworks, agriculture

The following definitions apply to terms of atmospheric contaminants used in this Guide:

Dusts are airborne solid particles. Dust is generated during grinding, crushing or chipping of hard materials or from the mechanical dispersion of fine powders.

Fibres are airborne solid particles. Fibres are three or more times longer than their width.

Fumes are airborne solid particles condensed from the vaporous state usually through volatilisation of molten metals.

Mists are airborne droplets of substances that are normally liquid at ambient temperatures. Mists may form through condensation of vapour or through spraying of liquids.

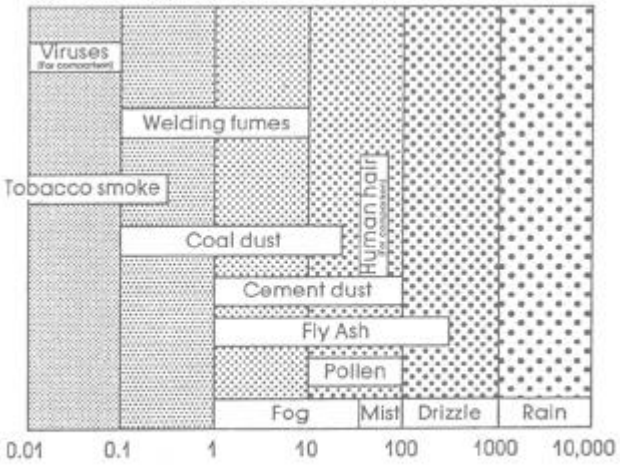
Smoke particles are generated from the incomplete combustion of fuel. Smokes usually contain gases and vapours in addition to solid particles.

Vapour is a molecular dispersion of material in the air. The material is normally liquid at ambient temperature.

Gas is a molecular dispersion of material in the air. The material boils below ambient temperature.

If particles, solid or liquid, are sufficiently small and when inhaled can reach the narrowest airways of the lung, they are termed *respirable*. Respirable particles are generally smaller than 10 micrometres. (One micrometre is one millionth of a metre). Larger particles, 10 to 100 micrometres, are termed *inspirable.* When inhaled, inspirable particles are trapped in the upper respiratory passages.

Respirable particles cannot be seen by the naked eye.



Size range of airborne substances
(Particle diameter in microns. There are one million microns in a metre)

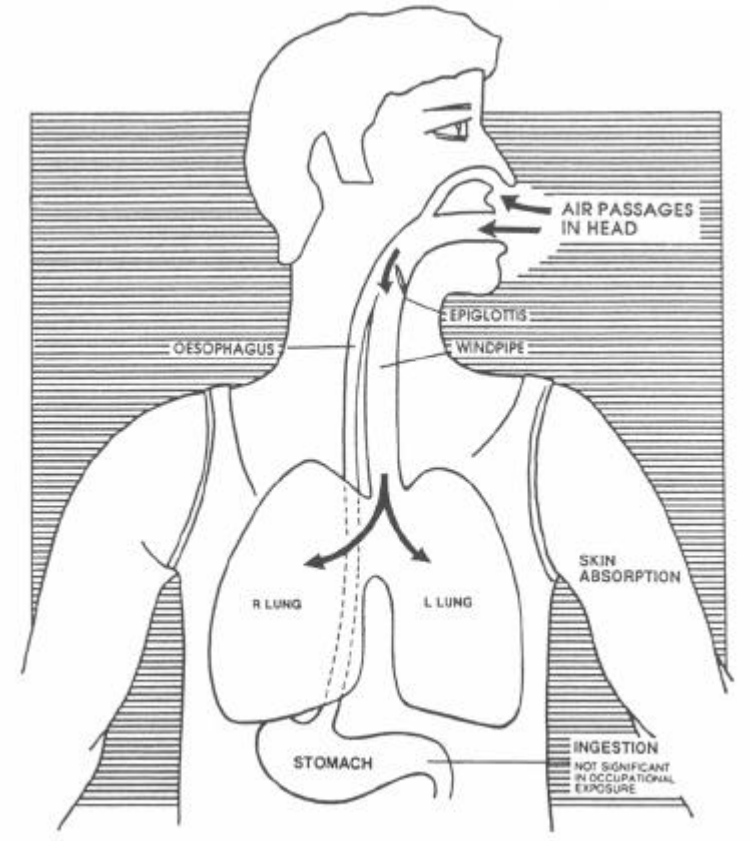
Health Hazards

When considering the hazards associated with any workplace, it is essential to understand the relationship between ‘hazard’, ‘exposure’ and ‘risk’.

‘Hazard’ is the potential for an agent or process to do harm. ‘Risk’ is the likelihood that an agent will produce injury or disease under specified conditions.

Health effects can only occur if a worker is actually exposed to the hazard. The risk of injury or disease usually increases with the duration and frequency of exposure to the agent, and the intensity/concentration and toxicity of the agent.

Toxicity refers to the capacity of an agent to produce disease or injury. The evaluation of toxicity takes into account the route of exposure and the actual concentration of an agent in the body.



Routes of entry of atmospheric contaminants

Common routes of entry into the body

The following are the common routes of entry of atmospheric contaminants into the body:

- *Inhalation* is the most significant route of entry by which harmful substances enter the human body at work. Many occupational diseases caused by chemicals result from breathing air that contains harmful substances. Exposure to hazardous material may be acute or chronic. *Acute exposures* generally refer to single dose, high concentration exposures over short periods, while *chronic exposures* involve repeated or continuous exposures over long periods. These exposures may have acute, immediate effects or chronic, long term effects.
- Toxic atmospheric contaminants may have *local effects*, if they harm only the part of the body they come in contact with, for example, inhalation of silica dust causing pneumoconiosis, or *systemic effects*, causing changes to the function of other organs, as in the case of inhaled particles that are soluble in the fluid of the tissues that line the lung, for example, lead and mercury fumes.
- Some atmospheric contaminants may be *absorbed* through the skin without any noticeable change to the skin, while others may cause serious damage to the skin itself.
- *Ingestion* is of relatively minor significance in occupational exposure to toxic materials.

Atmospheric contaminants may be classified on the basis of their physiological effects, such as:

Irritants	to the respiratory system, for example, chlorine, are usually corrosive in action.
Asphyxiants	reduce the available oxygen in the body. This may be caused *either* by the inhalation of a toxic gas, such as carbon monoxide, which interferes with the oxygen transfer in the body, *or* by the presence of gases, such as a build-up of helium, methane, or carbon dioxide, which reduce the oxygen content of the workplace atmosphere.
Asphyxiation	caused by reduced oxygen is more likely to occur in ‘confined spaces’.
Anaesthetics	such as solvents, cause drowsiness or unconsciousness.

Mutagens	alter the genetic material of cells. Altered reproductive cells, (sperm or ova) may affect future generations, while the other cells (sometic cells) may develop into cancer.
Teratogens	interfere with the normal embryonic development resulting in malformation of the foetus. Damage to the embryo is most likely to occur in the first eight to ten weeks of the pregnancy. Thalidomide is an example of a teratogen.
Carcinogens	induce cancer. An example is asbestos.
Systemic	poisons include toxic metals, such as lead and mercury, and carbon compounds, such as methyl alcohol and carbon disulphide, which affect different organs in the body.
Sensitisers	produce an allergic type reaction in the body. Examples are isocyanates, sulphur dioxide, dusts of grain and flour.

As well as being a general health risk, cigarette smoking is an extra danger for workers who may be exposed to atmospheric contaminants. The cancer causing effect of cigarette smoke increases manifold in the presence of some atmospheric contaminants. This is a synergistic action and asbestos/cigarette smoke is an example.

Where possible, smoking should be discouraged in work areas where the risk of exposure to hazardous atmospheric contaminants exists.

Prevention and Control Measures

To establish appropriate prevention of significant health effects, an evaluation of work practices and conditions must be undertaken by qualified health and safety personnel. These practices should be considered an integral part of management. Good occupational hygiene provides elimination of hazards, where practicable. Engineering controls to minimise the hazard at the source, where practicable, and administrative controls should be adopted.

Evaluation

Environment sampling and analysis should be undertaken at regular intervals by qualified occupational health and safety professionals in accordance with the methods recommended by the appropriate occupational health authority.

Control measures

Prevention and control measures include, but are not limited to, the following:

- elimination/substitution and process modification;
- engineering controls;
- administrative controls; and
- use of personal protective equipment.

Elimination/substitution and process modification

Whenever practicable, a substance which gives rise to a harmful atmospheric contaminant should be eliminated or replaced by one which, while offering suitable technical and engineering properties, has been established to be harmless, ideally, or less harmful than the offending substance.

Although substitution is the most certain and direct method of eliminating or reducing an occupational health hazard, it is not always practicable, so that engineering controls or other measures may become necessary.

Sometimes a less hazardous method of performing a task or modifying a process can be substituted for the original method.

Engineering controls

Engineering control measures may include the following:

- use of mechanical handling methods and automation;
- application of local exhaust ventilation to the point of origin of the contaminant;
- mechanical general ventilation;
- isolation, segregation or enclosure of operations producing the contaminant; and
- dust suppression.

Mechanical handling

Mechanical, automated and remotely controlled methods are often appropriate for the handling of potentially harmful substances in order to minimise the exposure of employees to those substances.

Local exhaust ventilation

Hazardous atmospheric contaminants can often be effectively controlled at their origin by means of a local exhaust system. This system comprises:

- a hood which captures the contaminant at its point of generation;
- a duct system with appropriate airflow;
- an air cleaning system to prevent pollution of the general atmosphere;
- an exhaust fan; and
- a stack or other means of dispersion of the decontaminated air to the atmosphere.

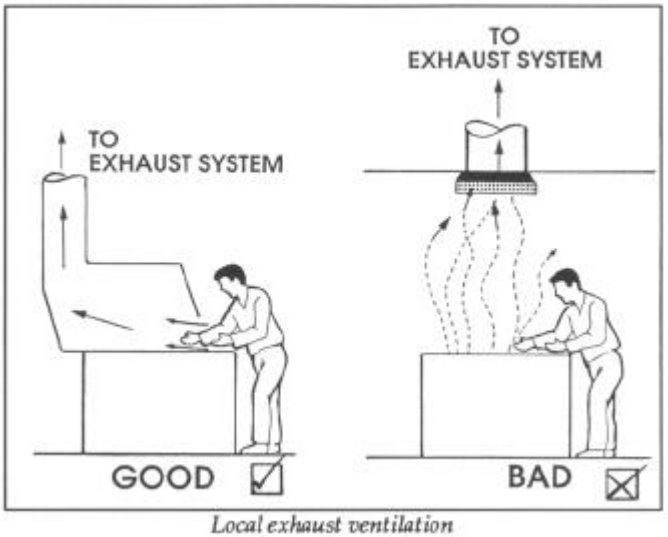
Further details can be obtained from the booklet, *Clean Air at Work, Industrial Ventilation - A Manual of Recommended Practice*, and the book, *Principles of Local Exhaust Ventilation*.

Care in selection, design, installation, operation and regular maintenance is essential to ensure that the system adequately controls contamination at all times.

The design of an effective ventilating system is a highly skilled area of expertise and therefore should only be performed by those competent to do so. Special care in design is important where combustible, inflammable or potentially explosive materials are involved. Inlets and outlets must

not be blocked and must be kept clear at all times.

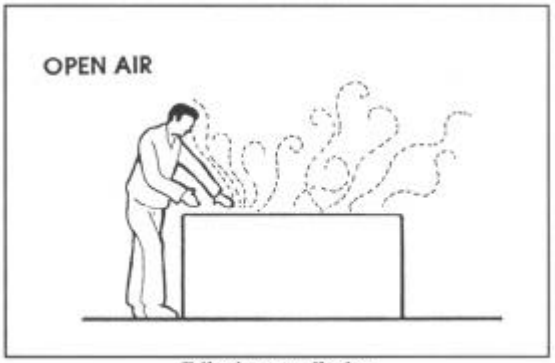
Air from a local exhaust ventilation system should not be recirculated into the workroom. It should be discharged to the outside air, distant from other work areas, air-conditioning inlets or compressors supplying breathing air.



Local exhaust ventilation

General ventilation

General ventilation systems are not usually as satisfactory in the control of health hazards as is the use of ventilated process enclosures or local exhaust ventilation, but they may be useful *to control minor emissions of contaminants of low toxicity.* In designing a mechanical ventilation system where such contamination occurs, particular attention should again be given to fan selection and to the placement of air extractors and fresh air supply openings. In particular, movement of air should be arranged so that clean air streams are drawn past workers and contaminated ones lead away from them. Such systems require rigorous control over all sources of natural ventilation and air movement which may disturb planned air movement, for example, the operation of air-conditioning systems or the opening and closing of doors and windows. Changes or additions to a balanced ventilation system must be implemented in such a way that they will not result in reduced efficiency of the entire ventilation system.



Dilution ventilation

Dilution ventilation

It may be possible to dilute the concentration of contaminants and reduce the levels of contamination which reach personnel by supplying a sufficient volume of clean air. This

method is usually applicable to processes which can be operated in open air or with a skeleton structure and roof.

Such open construction, however, while affording *good* natural ventilation, requires skilled and experienced design to achieve success. In particular, the effects of thermal air movements require specialist consideration.

Note: **General ventilation and dilution ventilation are not as effective as local exhaust ventilation for the control of atmospheric contaminants. They may, however, be useful to control minor contaminant emissions of low toxicity.**

Isolation, segregation and enclosure

Hazardous operations should be isolated or segregated so as to reduce to a minimum the number of employees potentially liable to be exposed to the contaminant.

Isolation may be achieved by conducting hazardous operations in a separate room or building or in a specially sealed area, or at a time when only very few workers are in the vicinity. However, even in these cases personal protective equipment is still required.

It may be necessary for substances to be utilised or produced in totally enclosed and sealed plants which prevent personal contact with the substances and also prevent any release of contaminants into the air of the workshop. If such enclosure is impracticable and the substances are harmful, enclosure to the greatest extent practicable or methods for the reduction of exposure should be adopted.

Except in high pressure or totally sealed systems, a slight negative pressure within the enclosure, provided by means of a suitable ventilation system, should be maintained so as to prevent outward leakage into the general work area during the operation.

Equipment and apparatus used in processes which require enclosure for safe and efficient operation should be designed, constructed, adjusted and maintained to a high standard so as to prevent leakage. Particular attention should be given to points at which hazardous substances enter or leave the system.

Dust suppression techniques

Wet methods of working, involving the use of a suitable liquid, usually water, can often be adopted in the control of dust. Water may be used in operations such as crushing, screening, drilling,

grinding or cutting stone, and for keeping wet any accumulations of finely divided material on benches and floors so that they do not release dust clouds when disturbed.

There are, however, distinct limitations associated with the use of water. Many finely divided materials are difficult to wet, even in bulk, and almost all airborne particles in the respirable size range (whether dust, fibres or fumes) are almost impossible to wet once dispersed. Moreover, the wetted particles may be redispersed in respirable form by the generation of mist or spray, or dust if the collecting liquid dries out. Drying out can occur quickly if a wetted paste is subject to heat, for example, by machining or friction. Dust suppression with water should not be used where the dust contains, or consists of, chemicals that can react with the water and generate dangerous, toxic or irritating gases. Electrical safety must be maintained.

Servicing and maintenance

All machinery, plant and other production equipment must be properly maintained where its condition may effect the severity of the hazard. Hoods, ducts, fans and collectors of exhaust ventilation systems, respirators and all other protective clothing and devices should be inspected, cleaned and serviced regularly. Defective parts must be replaced and all repairs made immediately.

Persons concerned with the maintenance of process, plant and equipment are often exposed to a greater potential hazard from harmful substances than are normal process workers. This is especially true in the maintenance of enclosed or automated plants and of associated exhaust and other ventilation systems. Appropriate tests must be carried out and precautions must be in place *before* maintenance commences. In these circumstances, if the normal engineering controls cannot be applied, the use of personal protective equipment is usually unavoidable. Use of properly designed 'Permit to Work' systems is desirable in achieving the highest standard of safety for maintenance personnel. Reference should be made to Australian Standard AS 2865.

Environmental and personal hygiene

Cleaning of walls, floors, ceilings, overhead structures, windows, tables, ledges, machinery and other equipment should be effected either by vacuum cleaning using cleaners fitted with High Efficiency Air Filters (HEPA) for removing hazardous particles or by wet methods; HEPA filters must comply with a minimum of 99.97 per cent efficiency requirements of Australian Standard AS 1324, *Air Filters for Use in Air Conditioning and General Ventilation*, Section 4.3.1. Dry

sweeping or blowing are not acceptable. Whenever the nature of the work requires it, floors, benches or tables should be covered with an impervious material which can be hosed or wetted easily.

Any spills should be cleaned up promptly. Material safety data sheets (MSDS) should be consulted because in some cases, specific cleaning methods or materials may be necessary. Waste materials should be removed and disposed of by methods suitable to the type of hazards that may be produced.

Employees should have ready access to clean working clothes, protective clothing, adequate washing and laundry facilities and, in some of the more hazardous situations, showers and changing rooms. Splashes by irritant or sensitising substances must be washed off immediately with soap and water. Contaminated clothing must be removed.

Personal protective equipment

In certain circumstances, personal protection of the individual employee is necessary. Personal protective devices should be regarded as being supplementary to substitution and engineering control and should not be used in preference to them because they do nothing to eliminate the hazard.

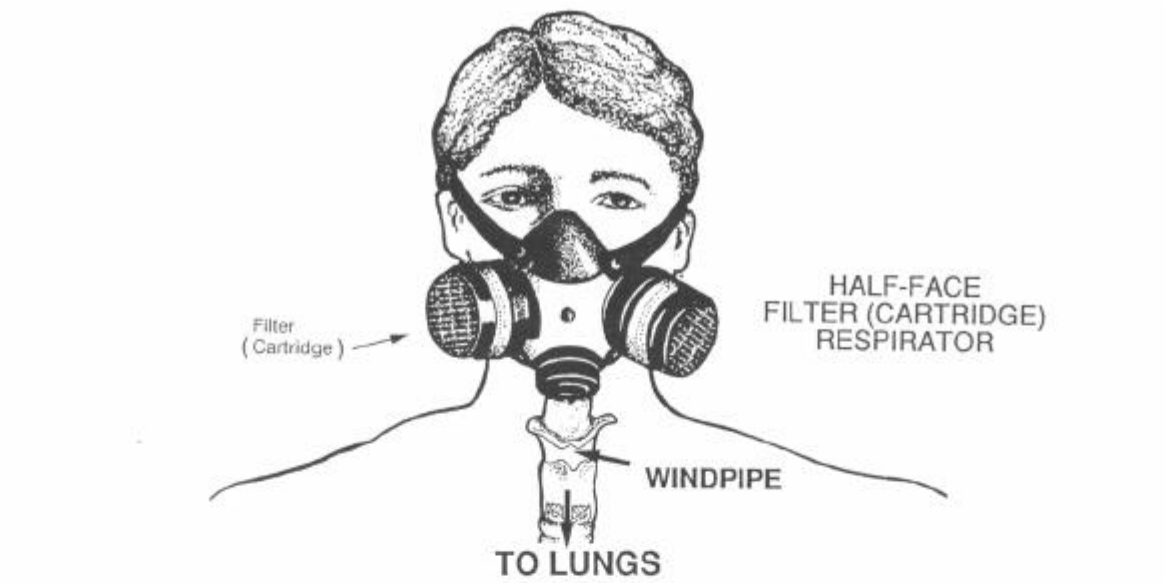
Personal protective equipment must be appropriately selected, individually fitted and workers trained in their correct use and maintenance. Personal protective equipment must be regularly checked and maintained to ensure that *the worker is being protected*.

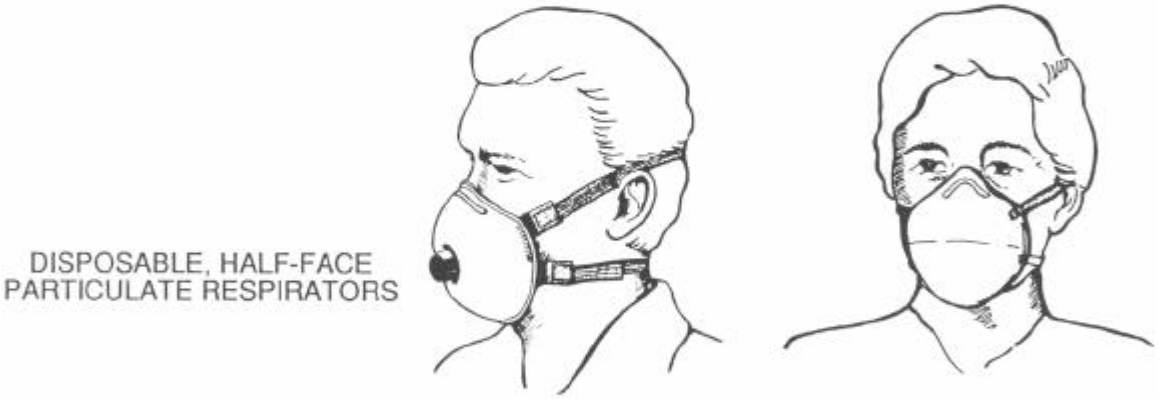
Respiratory protective devices

Where elimination, substitution and engineering controls are not feasible or do not reduce the atmospheric concentration of the contaminants to acceptable levels in relation to the recommended exposure standards, when exposure is of an emergency nature or is intermittent and of short duration, approved and suitable respiratory protective devices should be provided and used, as outlined in Australian Standard AS 1716. Such devices are of two main types:

- *air purifying devices* with dust filters and/or gas absorbers (canister or cartridge types); and
- *supplied air devices* (hose fed natural breathing and blower types, air line respirators and self-contained breathing apparatus supplying half or full-face masks, hoods and the like and clean-air supplied suits).

The selection, use and maintenance of personal respiratory protective devices should be in accordance with the requirements of Australian Standard AS 1715. The specification for the





Some examples of respiratory protection

design, construction, performance and testing of respiratory protective devices is set out in Australian Standard AS 1716.

The cleaning and maintenance and, where appropriate, the disinfection of all respiratory protective devices should be done regularly by a person specially trained for this task. This should not be entrusted to the employee using the device, unless specially trained.

Other protective devices

In order to protect the skin and eyes against the effects of harmful atmospheric contaminants, appropriately selected equipment such as overalls with sleeves to the wrists, gloves, mittens, aprons, goggles, safety spectacles, face shields, hats or hoods and safety boots should be provided and used.

Where there is a risk of absorption of a hazardous substance through the skin, the use of protective clothing is essential. The protective clothing selected must be appropriate to the hazardous substance in question.

Appropriate selection should take into account the nature of the substance, the degree of exposure and the nature of the work. This is particularly important with impermeable plastic coveralls used under hot/tropical conditions for heavy work out-of-doors. Work practices must take into consideration this requirement.

Where eye protection is required, reference should be made to Australian Standards AS 1336 and AS 1337. Where gloves and mittens are required, reference should be made to Australian Standard AS 2161.

Australian Standard Handbook, *Manual of Industrial Personal Protection* HB9 - 1986, is a useful general reference.

MSDS should be consulted.

Education and training

All employees working with substances which produce harmful atmospheric contaminants must be informed of the hazards from exposure to the contaminant and the precautions necessary to prevent damage to their health. They should be made aware of the need to carry out their work so that as little contamination as possible is produced, and of the importance of the proper use of all safeguards against exposure to themselves and their fellow workers. Adequate training, both in the

proper execution of the task and in the use of all associated engineering controls, as well as of any personal protective equipment, is essential.

Employees exposed to contamination hazards should be educated in the need for, and proper use of, facilities, clothing and equipment and thereby maintain a high standard of personal cleanliness. Special attention should be given to ensure all personnel understand instructions, especially newly recruited employees and those with English-language difficulties, where they are known.

Before handling potentially hazardous substances, MSDS should be obtained from the suppliers of such materials.

A management representative should be nominated as responsible for personal protective equipment supply, maintenance and training.

Monitoring

Monitoring may be used for the evaluation of a hazard and for assessing the effectiveness of control measures. The design and implementation of a monitoring program should be carried out by, or in consultation with, a properly qualified person.

Monitoring of the work environment involves the measurement of atmospheric contaminants at selected locations in the workplace, that is, static, positional monitoring. Personal monitoring involves the measurement of atmospheric contaminants in the breathing zone of the individual worker. Biological monitoring involves measurement of the concentration of a contaminant, its metabolites or other indicators in the tissues or body fluids of the worker. In some cases, biological monitoring may be required to supplement static or personal monitoring.

In the control of health hazards due to a specific contaminant, where it has been demonstrated that the exposure of the employee to the contaminant is approaching the relevant exposure standard, or where biological monitoring indicates that an unacceptable exposure is occurring, *immediate action must be taken to reduce the health hazard* and intensive monitoring should continue.

The exposure standards represent airborne concentrations of individual chemical substances which, according to current knowledge, should neither impair the health of, nor cause undue discomfort to, nearly all workers. In certain cases the exposure standards are believed to guard against narcosis or irritation which could precipitate industrial accidents.

Except where modified by consideration of excursion limits, exposure standards apply to long term exposure to a substance over an eight hour day for a normal working week, over an entire working life.

The exposure standards do not represent 'no effect' levels which guarantee protection to every worker.

Records of the results of any monitoring should be maintained and employees should be informed of these results.

Health assessment

In some occupations, health assessment may form part of a comprehensive occupational health and safety strategy. Where employees are to undergo health assessment, there should be adequate consultation prior to the introduction of any such program. Where medical records are kept, they must be confidential. In some cases, it is valuable to be able to relate employee health and illness data to exposure levels in the workplace.

First Aid

General facilities should be provided in accordance with the requirements of the Worksafe Australia Guide, *Occupational Health Services*.

Specific first aid facilities should be provided according to the nature of the atmospheric contaminants that may be present in the workplace.

Further Reading

American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation, *Industrial Ventilation - A Manual of Recommended Practice*, 20th Edition, American Conference of Governmental Industrial Hygienists, Lansing, Michigan, 1989.

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- AS 1336-1982 *Recommended Practices for Eye Protection in the Industrial Environment*, Sydney.
- AS 1337-1984 *Eye Protection of Industrial Applications*, Sydney.
- AS 1338-1981 *Filters for Eye Protectors*, Sydney.
- AS 1715-1982 *Selection, Use and Maintenance of Respiratory Protective Devices*, Sydney.
- AS 1716-1984 *Respiratory Protective Devices*, Sydney.
- AS 2161-1978 *Industrial Safety Gloves and Mittens (excluding Electrical and Medical Gloves)*, Sydney.
- AS 2865-1986 *Safe Working in a Confined Space*, Sydney.
- Handbook HB9-1986 *Manual of Industrial Personal Protection*, Sydney.

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