

National Occupational Health and Safety Commission

# **INDUSTRIAL ORGANIC SOLVENTS**

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## Foreword

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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.



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# Introduction

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This Guide outlines some of the potential health hazards associated with the handling of industrial organic solvents. It also addresses the control of these hazards.

This Guide should be read in conjunction with the following Worksafe Australia Guides:

- *Atmospheric Contaminants*; and
- *Solvent Vapour Degreasing*.

The National Commission publications, *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (latest edition), and *Guidance Note for Completion of a Material Safety Data Sheet* (latest edition), should also be consulted.

Australian Standards which are relevant to this Guide include:

- *AS 1336 Recommended Practices for Eye Protection in the Industrial Environment*;
- *AS 1716 Respiratory Protective Devices*;
- *AS 1940 Rules for the Storage and Handling of Flammable and Combustible Liquids*;
- *AS 2161 Industrial Safety Gloves and Mittens*;
- *AS 2661 Vapour Degreasing Plant*;
- *AS 2865 Safe Working in a Confined Space*; and
- *AS 2986 Workplace Atmospheres - Organic Vapours - Sampling by Solid Adsorption Techniques*.

Reference should also be made to the Australian Code for the Transport of Dangerous Goods by Road and Rail.

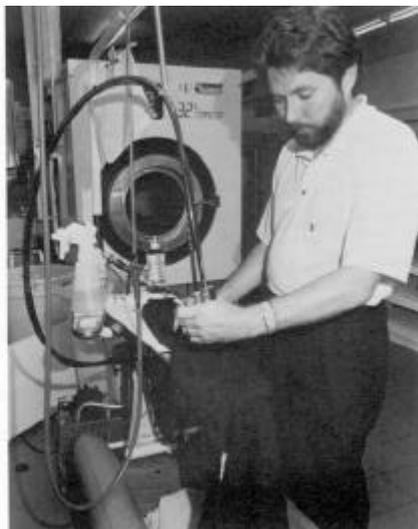
Reference should be made to the manufacturer's specific product information in the form of a material safety data sheet (MSDS). The MSDS should be updated regularly. The MSDS should conform to the National Commission's recommended format and should be freely accessible to all personnel.

Organic solvents are used in the processing, manufacture and formulation of products and substances. Some of these are listed in Table 1.

The use of organic solvents is extremely widespread in industry and, while the degree of hazard may vary, all solvents should be considered potentially hazardous and due care taken in their use.

**Table 1: Some operations and formulations with some associated solvents**

paints and lacquers	toluene, xylene, methyl ethyl ketone
adhesives	cyclohexanes, acetones
antifreeze	ethylene glycol
degreasing	trichloroethylene, perchloroethylene
drycleaning	perchloroethylene
printing	turpentine, white spirits, xylene



*Organic solvents are widely used in the printing and dry cleaning industries*

## Identification

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The basis of classification of the organic solvents is chemical composition. The members of the same class, in general, have similar solvent characteristics and chemical action. However, important variations in toxic effect usually occur within a group.

Confusion may arise over the name of an organic solvent, for example, white spirits, naphtha safety solvent and stoddard solvent are names for the same solvent. Some different organic solvents have similar sounding names, for example, 2-methoxyethanol and 2-ethoxyethanol.

The MSDS should record the approved chemical name of the solvent together with its other names and synonyms.

## Physical properties of organic solvents

The physical properties of an organic solvent have great bearing on the safe handling procedures for that chemical and play a large role in determining the degree of fire and explosion hazard associated with its use. Before handling, reference should be made to the current MSDS, which should be obtained from the manufacturer or supplier. Descriptions of the items on the MSDS can be found in the National Commission publication, *Guidance Note for Completion of a Material Safety Data Sheet* (latest edition). Important properties are listed below.

### **Boiling point**

This is an indicator of how readily the chemical becomes a gas (vapourises). The lower the boiling point, the more readily it vapourises. It should be noted that the boiling point for mixtures may be different from those of the components.

### **Flash point**

The lower the flash point, the greater the flammability. A solvent with a flash point of 23°C or less is highly flammable; a flash point between 23°C and 61°C represents moderate flammability. A flash point of more than 61°C is low flammability.

**Table 2: Some highly flammable organic solvents (flashpoint of 23°C or below)**

acetaldehyde	diethyl ether	petroleum ether
acetone	ethanol	propanol
acetonitrile	ethyl acetate	pyridine
benzene	n-hexane	tetrahydrofuran
carbon disulphide	methanol	toluene
cyclohexane	methyl ethyl ketone	vinyl acetate
cyclohexene	pentane	

### **Explosive limits**

The lower explosive limit (LEL) is the lowest concentration of solvent in air that will ignite. The upper explosive limit (UEL) is the highest concentration of solvent in air that will ignite. As a rule of thumb, the greater the range between the LEL and the UEL, the greater the fire hazard. For example:

ether	LEL = 1.9%	UEL = 36.0%
1,1,1-trichloroethane, which has had stabilisers added	LEL = 8.0%	UEL = 10.5%

Based on these values only, ether presents a greater fire hazard than the 1,1,1-trichloroethane formulation. However, to determine the fire hazard accurately, flash point and vapour pressure would also need to be considered.

### **Autoignition temperature**

This is the temperature at which the vapour will spontaneously catch fire in air if the concentration is between the levels shown above. Solvents with a low autoignition temperature should not be stored near heat sources. Carbon disulphide, with an autoignition temperature of 90°C, is a good example of this.

### **Vapour density**

A vapour which is heavier than air (vapour density greater than 1) will tend to collect in pools and spread near ground level and in confined spaces. A vapour which is lighter than air (vapour density less than 1) will tend to rise. However, air movements will increase vapour dispersal in either situation.

## Health Hazards

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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 occur only 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.

It should be noted that not all of the health effects listed for a solvent need be experienced by persons who are overexposed, as individuals may differ in their responses to exposure. Not all solvents have the same health effects.

This section gives an overview of exposure routes and general health effects, with some specific examples.

### Exposure routes

The harmful effects of organic solvents follow inhalation of vapour, eye and skin contact with liquid or vapour, or ingestion, which are described below:

- *Inhalation* is usually the most significant route of entry by which organic solvents enter the human body at work.
- Some organic solvents may be *absorbed* through the skin without any noticeable effect on the skin. Others may cause serious damage to the skin itself.

*Ingestion* is of relatively minor significance in occupational exposure to organic solvents.

Toxic atmospheric contaminants may have *local effects* if they harm only the part of the body they come in contact with, or *systemic effects* causing changes to the function of other organs.

## Health effects

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.

The extent of any health effects are dependent on the duration and frequency of exposure and the concentration of the substance. Some examples of health effects are listed below.

### **Respiratory tract**

The vapour of many organic solvents is irritating to the lining of the respiratory tract, affecting the nose, throat and lungs. Asthma-like reactions have been reported with some organic solvents.

### **Skin**

Skin contact often causes drying, cracking, reddening and blistering of the affected area. These signs of inflammation of the skin are called dermatitis and enhance solvent absorption and encourage secondary infection. Dermatitis may be irritant or allergic in nature. Solvent-induced dermatitis may persist for a long time after exposure. Absorption of solvents through the skin may produce systemic health effects.

### **Eyes**

Direct contact with organic solvent vapour or liquid may cause eye irritation. This is usually reversible and permanent eye damage is rare.

### **Liver**

Many organic solvents are potentially toxic to the liver, either alone or in combination with other solvents. For example, liver damage is associated with exposure to carbon tetrachloride, other chlorinated hydrocarbons and ethanol. Consumption of alcoholic drinks may enhance the effects of many solvents.

### **Kidney**

Both short and long term exposure to certain organic solvents has been found to be harmful to the kidney. Carbon tetrachloride, trichloroethane and petroleum distillates, for example, gasoline, jet fuel and turpentine, are among the most toxic.

## ***Cardiovascular system***

Chlorinated hydrocarbon solvents, such as methylene chloride and trichloroethane, may cause harmful effects on the heart. Abnormal heart rhythms have been reported arising from trichloroethylene exposure. Chronic exposure to carbon disulphide is considered to be a contributory factor in coronary heart disease.

## ***Nervous system***

Exposure to organic solvents can result in a variety of serious effects in both the central nervous system (CNS - brain and spinal cord) and the peripheral nervous system (PNS - nerves supplying the rest of the body). The acute effects of organic solvent exposure range from an alcohol-like intoxication to narcosis (stupor or insensibility) which may lead to unconsciousness and eventually death from respiratory failure. Intermediate symptoms include drowsiness, headache, dizziness, dyspepsia (gastric discomfort) and nausea. Long term gross exposure to both n-hexane and methyl n-butyl ketone is associated with degeneration of nerve cells in the PNS, resulting in symptoms such as restless legs, muscle cramps, pains and weakness in limbs and loss of sensation in the limbs. Chronic CNS effects resulting from long term repeated exposures to organic solvents include fatigue, mood disturbance and difficulty in concentrating, memory loss, personality changes and loss of motivation. This damage may eventually become permanent.

## ***Organic solvent exposure and cancer***

Benzene is the only organic solvent which has definitively been proven to cause cancer in humans from industrial use. Human evidence shows that extended exposure to levels of benzene may produce leukaemia.

A number of other organic solvents cause cancer in laboratory animals exposed to the solvents for much of their life. It is suspected, but not proven, that these solvents may pose a risk to workers who have long term exposure to them.

Accordingly, although current information does not provide evidence of human carcinogenicity for solvents other than benzene, this should not lead to a complacent attitude toward organic solvent usage. Appropriate steps should be taken to ensure that unnecessary exposure is avoided, and any such exposure should be minimised to the lowest level workable.

Specific health hazards associated with the commonly used organic solvents are listed in Appendix 1.

## **Prevention and Control Measures**

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Following the identification of a hazard, evaluation of work practices and conditions must be undertaken so that effective prevention and control measures can be implemented. This should be considered an integral part of management's responsibilities.

### **Evaluation**

Environmental 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.

Monitoring of the work environment involves the measurement of atmospheric contaminants at selected locations in the workplace (static, positional monitoring). Personal monitoring involves the measurement of atmospheric contaminants in the breathing zone of the individual worker and is generally preferred since it reflects actual worker exposure. 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.

### **Exposure standards**

Worker exposure to organic solvents should be kept as low as workable. Every attempt should be made to keep exposures well below the exposure standards recommended in the National Commission publication, *Exposure Standards for Atmospheric Contaminants in the Occupational Environment* (latest edition).

The exposure standards represent airborne concentrations of individual chemical substances, including organic solvents, which, according to current knowledge, should neither impair the health of, nor cause undue discomfort to, nearly all workers. Additionally, 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.**

A problem in the application of exposure standards is that they are normally specified for the pure solvent. Many organic solvents consist of complex mixtures of various hydrocarbons. When the body is exposed to two or more solvents, the effect of different hazards may be either *additive* or *synergistic* (a combination that exceeds the sum of individual effects). Heavy or strenuous work can increase the uptake of organic solvent from the atmosphere, and this should be borne in mind when considering exposure standards.

The interaction of any particular mixture of substances should be assessed by either toxicologists, occupational hygienists or physicians from the specific toxicological consideration of all substances involved.

## **Control measures**

Where there is a likelihood of worker exposure to organic solvents, steps should be taken to minimise that exposure as far as workable. A thorough examination of work practices is essential. Procedures should be adopted to ensure that workers are not unnecessarily exposed to the hazard. Control measures include, but are not limited to, the following, which are ranked in priority of their effectiveness:

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

## **Elimination/substitution and process modification**

Organic solvents vary in the degree of risk they pose to health. Whenever workable, a substance that gives rise to a harmful atmospheric contaminant should be eliminated or replaced by one that, 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. Wherever possible, aqueous (water-based) solvents should be substituted for organic

solvents. This is best illustrated by the paint industry with the introduction of water-based paints.

## **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;
- isolation, segregation or enclosure of operations producing the contaminant; and
- mechanical general ventilation.

### ***Local exhaust ventilation***

Hazardous atmospheric contaminants can often be effectively controlled at their source 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 dispersing the decontaminated air into the atmosphere.

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

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

The design of an effective ventilation 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 re-circulated into the workroom. It should be scrubbed, if possible, and discharged into the outside air, distant from other work areas, air conditioning inlets or compressors supplying breathing air.

### ***Dilution ventilation***

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

For further information on ventilation, refer to the Worksafe Australia Guide, *Atmospheric Contaminants*.

### ***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.

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, for example, lids on degreasing operations. If such enclosure is unworkable and the substances are harmful, enclosure to the greatest extent workable, or methods for the reduction of exposure, for example, by scheduling work for a time when only very few workers are in the vicinity, should be adopted. However, even in these cases, protective equipment is still required.

## **Administrative controls**

The following administrative controls should be adopted:

- avoid contact with skin and inhalation of vapour;
- do not enter confined spaces where vapour may have collected;
- do not lean over vessels containing liquid;
- do not assume an empty vessel is safe;
- do not eat, drink or smoke in the workplace;
- wash hands prior to eating, drinking or using the toilet;
- sign-post confined spaces where solvent vapour concentrations may build up; and
- established procedures for working in confined spaces in accordance with Australian Standard AS 2865 and relevant State and Territory requirements.

## **Environmental and personal hygiene**

Any spills should be cleaned up promptly. MSDS should be consulted as, 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 work clothes, protective clothing, adequate washing and laundry facilities and, in some of the more hazardous situations, showers and change rooms. Splashes by irritant or sensitising substances must be washed off immediately with soap and water. Contaminated clothing must be removed.

Smoking in the presence of some volatile solvents increases the risk of fire and explosion.

## **Personal protective equipment**

In certain circumstances, personal protection of the individual may be required as a supplement to other preventive action. It should not be regarded as a substitute for other control measures and must only be used in conjunction with substitution and elimination measures.

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 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 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.

### ***Skin protection***

Solvent-resistant gloves conforming to Australian Standard AS 2161, for example, viton and PVA gloves, together with clean cotton overalls, solvent-resistant boots and apron should always be worn. The type of glove chosen needs to be effective against the specific solvent being used.

Barrier creams may be used in some circumstances. An appropriate occupational health professional should be consulted regarding the suitability, selection and use of barrier creams. Barrier creams should only be used for protection, and not for treatment after any skin damage has taken place.

Barrier creams should be used as substitutes for protective clothing only when gloves, sleeves, or face guards cannot be worn. Any creams used for these purposes must be able to provide adequate and safe protection for the skin against the particular agents involved.

Most creams are formulated to be either water-repellent or oil-repellent. The water-repellent types offer little protection against oils or solvents.

Excessive use of some cleansers, for example, detergent types, can severely dry out the skin. The use of organic solvents, such as kerosene, to remove materials from the skin should be actively discouraged. This

practice can cause or aggravate dermatitis.

### **Eye protection**

Safety glasses, goggles or faceshields conforming to Australian Standard AS 1336 should be worn when organic solvents are being used.

### **Storage**

Organic solvents should be stored in a proper flammable liquids storeroom. The following points should be noted:

- solvents should be stored in a cool place, away from any potential ignition sources;
- the storage area should be well ventilated to prevent the build-up of solvent vapour;
- where workable, storage areas should be isolated from the workplace and firmly secured;
- amounts stored should be regularly monitored and kept to a minimum;
- appropriate bunding should be used where necessary;
- solvents should be stored away from food, drink and therapeutic substances;
- the storage area should be equipped with the appropriate fire-fighting devices;
- the storage area should be readily accessible to emergency vehicles and personnel; and
- smoking must be prohibited in and around storage areas.

Organic solvents should be stored separately from other classes of chemicals. Specific details on segregation are available in some State and Territory legislation and in the Australian Code for the Transport of Dangerous Goods by Road and Rail. Containers should be clearly labelled to show the chemical contents, hazards and storage precautions. Reference should be made to the MSDS for further information.

## Signs

Areas where organic solvents are stored should be placarded appropriately in accordance with National Commission guidelines and the provisions of Australian Standard AS 1319.

Tanks, pipelines and supply valves should be labelled clearly in appropriate languages, in accordance with the provisions of Australian Standard AS 1319. Labels on tanks, pipelines and supply valves should indicate, where appropriate, the nature of the contents, their strength and temperature, and also the nature of the hazard and its emergency treatment.



*Appropriate storage and signage are important aspects of managing organic solvents*

## Labelling

Containers for storage and transport should bear warning labels to indicate the hazardous nature of the substance and the procedures to be adopted in case of emergency. The design of warning labels should consider both the non-English speaking worker and the illiterate, by having a pictorial warning in addition to written information.

## Health examination

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

## Education and training

All employees working with organic solvents must be informed of the hazards from exposure to the contaminants and the precautions necessary to prevent damage to their health. Employees should be trained in appropriate procedures to ensure that they carry out their work so that as little contamination as possible is produced, and in 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 ensuring that all personnel understand instructions, especially newly recruited employees and those with English-language difficulties, where they are known.

Before handling any materials, MSDS should be obtained from the suppliers.

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

Ensure that all personnel understand the safety procedures associated with the storage and handling of organic solvents. This should include a program on the use and maintenance of respiratory protective equipment.

## Transport

The transport of organic solvents is governed by the respective State and Territory legislation. Reference should be made to the Australian Code for the Transport of Dangerous Goods by Road and Rail. This will provide a classification of all dangerous goods by both type of risk and severity of risk. It also prescribes the type of packaging to be used and the labelling of such packages, containers and vehicles.

## Spills or leaks

In cases of spills or leaks:

- where safe to do so, close off the source of the spill or leak, taking appropriate precautions to avoid exposure;
- mechanically confine the spill or leak, for example, cordon off the area or isolate the ventilation;
- avoid inhalation of vapour and contact with skin and eyes;
- wear appropriate personal protective equipment;
- do not allow smoking, naked lights or ignition sources;
- transfer the material from damaged to other containers or remove as appropriate;
- absorb or contain spill or leak residues with sand, earth or some other appropriate absorbent;
- do not allow the spillage to enter drains, waterways or water storage; and
- depending on the size and location of the spill, notify the fire brigade, police and/or emergency contact.

Refer to the MSDS for any specific instructions, including disposal procedures.

## Fire and explosion hazard

The flammable and explosive characteristics of most organic solvents are generally well known. Solvents vary greatly in the degree of fire/explosion risk they convey; this can be determined largely by examination of the following physical characteristics:

- flash point;
- explosive (or flammability) limits; and
- autoignition temperature.

In case of fire, wear self-contained positive-pressure breathing apparatus. Avoid skin contact. Keep containers cool with water spray to prevent expansion or rupture.

Refer to the MSDS for extinguishants allowed. The MSDS will also provide information on incompatibility, products of combustion, decomposition and polymerisation for the specific organic solvent.

## **First Aid**

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Safety shower and eyewash stations must be available at workplaces where there is significant use of organic solvents. First aid procedures for specific solvents used in workplaces should also be available. Reference should be made to the MSDS. If in doubt in an emergency, use the shower or eyewash for at least 15 minutes.

### **Ingestion**

Refer to first aid instructions for the specific solvent. If in doubt, contact a poisons information centre or obtain medical advice immediately. Induction of vomiting may or may not be required, and may be harmful with certain solvents.

### **Eyes**

Wash the eyes immediately and thoroughly with copious amounts of clean water. If irritation persists, seek medical advice.

### **Skin**

Remove contaminated clothing and shoes. Wash skin with soap and water. Launder clothing before re-use. Seek medical advice if redness, blistering or irritation occurs.

### **Inhalation**

Remove the patient to fresh air. If breathing has stopped, administer artificial respiration. Oxygen may be given, but only under supervision of a trained person. Transfer to a hospital immediately by ambulance if available.

# Appendix 1

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## Common organic solvents

### **Acetaldehyde**

Synonyms: acetic aldehyde; aldehyde; ethanal; ethyl aldehyde.

Toxic by inhalation. Irritant to skin, eyes and mucous membranes. Over-exposure can result in CNS narcosis and pulmonary oedema (water in the lungs).

### **Acetone**

Synonyms: dimethyl ketone; 2-propanone; methyl ketone; dimethylformaldehyde.

Vapour irritant to eyes, nose and throat. Vapour is narcotic at high concentrations. Practically non-harmful by ingestion.

### **Amyl acetate**

Synonyms: n-amyl acetate; pentyl acetate.

Irritant to eyes and respiratory tract. Vapour is narcotic at high concentrations.

### **Benzene**

Synonyms: benzine; coal naphtha; mineral naphtha; pyrobenzol.

Toxic by inhalation. Liquid irritant to skin and eyes. CNS narcotic and anaesthetic. Human carcinogen. Can damage blood components and cause severe anaemia and bleeding.

### **Carbon disulphide**

Synonyms: carbon bisulphide; carbon sulphide.

Toxic by inhalation and ingestion. Irritant to skin and eyes. CNS narcotic and anaesthetic. Causes psychiatric symptoms. Can be absorbed through the skin with toxic effects. Can cause coronary heart disease. Embryotoxic (toxic to the embryo) in animals.

### ***Carbon tetrachloride***

Synonyms: tetrachloromethane; perchloromethane; carbon tet; CTC.

Toxic by all exposure routes. CNS narcotic. Irritant to skin and eyes. Repeated skin contact leads to dermatitis. Harmful to liver and kidney. An animal carcinogen.

### ***1,2 Dichloroethane***

Synonyms: ethylene dichloride; dichloroethylene; ethylene chloride.

Liquid irritant to skin. Vapour irritant to eyes and mucous membranes. High concentrations of vapour may produce dizziness and unconsciousness. Repeated skin contact leads to dermatitis. Animal carcinogen.

### ***Dichloromethane***

Synonyms: methylene chloride, methylene dichloride; methane dichloride.

Anaesthetic at high vapour concentrations. Liquid irritant to eyes and skin. Vapour irritant to eyes, nose and throat. Repeated skin contact leads to dermatitis. An animal carcinogen.

### ***N, n-dimethylformamide***

Synonyms: dimethylformamide; DMF; N-formyldimethylamine.

Moderately irritating to skin, eyes, throat and respiratory tract. Harmful by inhalation and skin absorption. Teratogenic (produces physical defects in unborn) in animals.

### ***1,4-dioxane***

Synonyms: dioxane; 1,4-diethylene dioxide; diethylene ether; glycol ethylene ether.

Irritant to eyes, nose and respiratory tract. Harmful to liver and kidney. CNS narcotic. Animal carcinogen.

### ***Epichlorhydrin***

Synonyms: propane, 1-chloro-2,3-epoxy; chloropropylene oxide.

Highly toxic by all exposure routes. Vapour irritant to eyes, skin and respiratory tract. Harmful to kidney. Animal carcinogen.

### ***Ethyl acetate***

Synonyms: ethyl ethanoate; acetic ether; ethyl acetic ester.

Irritant to mucous membranes, particularly eyes, gums and lining of respiratory tract. Causes drowsiness and dizziness at high concentrations. Repeated skin contact may cause dermatitis.

### ***Ethanol***

Synonyms: ethyl alcohol; grain alcohol; potato alcohol; alcohol; spirit.

Liquid and high concentrations of vapour cause irritation to eyes, skin and mucous membranes. Prolonged exposure causes drowsiness and dizziness. Large doses can cause alcohol poisoning.

### ***Ethyl ether***

Synonyms: diethylether; solvent ether; ether.

Liquid and vapour irritant to skin, eyes and mucous membranes. Primary effect of exposure is narcosis and general anaesthesia. Hepatotoxic (toxic to the liver).

### ***Ethylene glycol***

Synonyms: 1,2-ethanediol; 1,2-dihydroxyethane.

monoethylene glycol; glycol; glycol alcohol.

Toxic by ingestion. Irritant to skin and eyes. Harmful to kidney following ingestion.

### ***2-ethoxyethanol (acetate)***

Synonyms: ethylene glycol monoethyl ether (acetate); 2-EE(A).

Liquid irritant to eyes. Vapour irritant to respiratory tract and mucous membranes. Harmful by ingestion. Reproductive and foetal toxicity reported from animal tests.

### **Formaldehyde**

Synonyms: formol; methylene oxide; methyl aldehyde; formic aldehyde.

Irritant to eyes, skin and respiratory tract. Can cause primary and allergic contact dermatitis. Animal carcinogen.

### **Hexane**

Synonyms: n-hexane.

Mild skin and eye irritant. Vapour is narcotic at high concentrations. Prolonged occupational exposure to high concentrations results in motor neuropathy (impaired function in the nerves that control muscle).

### **Methanol**

Synonyms: methyl alcohol; wood alcohol; wood spirit; wood naphtha.

Irritant to skin, eyes and mucous membranes. Inhalation of vapour can result in headaches, lack of co-ordination and unconsciousness. Ingestion may lead to damage to nervous system, blindness and death.

### **Methyl n-butyl ketone**

Synonyms: MBK, 2-hexanone; MNBK; hexan-2-one.

Irritant to eyes, nose, upper respiratory tract. CNS narcotic. Prolonged occupational exposure to high concentrations results in motor neuropathy.

### **Methyl chloride**

Synonyms: monochloromethane; chloromethane.

Toxic by inhalation. Weak CNS narcotic and anaesthetic. Causes altered behaviour.

### **Methyl ethyl ketone**

Synonyms: MEK; 2-butanone; butan-2-one; methyl acetone.

Irritant to eyes, nose and throat. Inhalation of vapour can result in headaches, dizziness and possible nausea. Prolonged skin exposure may lead to dermatitis.

### **2-methoxyethanol (acetate)**

Synonyms: ethylene glycol monomethyl ether (acetate); 2-ME(A).

Harmful by ingestion. Irritant to eyes, skin. Vapour is toxic. Reproductive and foetal toxicity reported from animal tests.

### **Perchloroethylene**

Synonyms: tetrachloroethylene; 1,1,2,2-tetrachloroethene; 'perc'.

Irritant to skin, eyes, nose and throat. CNS effects. Prolonged skin exposure may lead to dermatitis. Animal carcinogen.

### **Styrene**

Synonyms: vinyl benzene; cinnamol; styrole; styrolene.

Irritant to eyes, mucous membranes, respiratory tract and eyes. Inhalation of high concentration can produce CNS depression.

### **Toluene**

Synonyms: methyl benzene; toluol; phenyl methane.

CNS narcotic. Irritant to eyes. Prolonged skin contact may lead to dermatitis. Vapour irritant to mucous membranes and respiratory tract.

### **1,1,1-trichloroethane**

Synonyms: methyl chloroform; methyl trichloromethane.

Irritant to skin and eyes. CNS narcotic. Exposure can cause irregular heart action.

### **Trichloroethylene**

Synonyms: ethylene trichloride; 1,1,2-trichloroethene; 1-chloro-2,2-dichloroethene; 'trich'; 'TCE'.

Strong skin and eye irritant. Inhalation of high concentration causes narcosis and anaesthesia. Chronic exposure associated with liver damage. Exposure can cause irregular heart action.

### ***Xylene***

Synonyms: dimethylbenzene; xylol.

Toxic by inhalation and ingestion. Liquid and vapour irritant to eyes, skin and mucous membranes. CNS narcotic. Embryotoxic in animals.

This list is by no means comprehensive and does not cover the common mixed solvents such as turpentine, white spirits or surgical spirits.

Repeated exposure to some mixtures of organic solvents over a prolonged period of time is reported to lead to altered moods and cerebral functioning. Information on mixed solvents can be found in the relevant MSDS.

## Appendix 2

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### Common classes of organic solvents

#### *Aliphatic hydrocarbons*

pentane; n-hexane; cyclopropane; cyclohexane; cyclohexene.

#### *Aromatic hydrocarbons*

benzene; toluene; xylene.

#### *Chlorinated hydrocarbons*

methylene chloride; chloroform; carbon tetrachloride; ethylene dichloride; methyl chloroform (1,1,1-trichloroethane); trichloroethylene; tetrachloroethylene.

#### *Alcohols*

methyl alcohol (methanol); ethyl alcohol (ethanol); n-propyl alcohol (propanol); n-butyl alcohol (butanol).

#### *Glycols and glycol ethers*

ethylene glycol; diethylene glycol; propylene glycol; ethylene glycol monomethyl ether (2-methoxyethanol); ethylene glycol monoethyl ether (2-ethoxyethanol).

#### *Ethers*

ethyl ether; 1,4 dioxane (dioxane).

#### *Esters*

ethyl acetate; methyl formate; amyl acetate.

#### *Ketones*

acetone; methyl ethyl ketone (MEK); methyl isobutyl ketone; methyl n-butyl ketone (MBK).

## **Aldehydes**

acetaldehyde; formaldehyde (formalin); furfural; glutaraldehyde.

## **Others**

carbon disulphide; pyridine; amides; amines; turpentine; white spirits; kerosene; mixed hydrocarbons.

## **Uses of organic solvents**

Important uses of organic solvents include:

- cleaning (degreasing) agents to remove oils and grease from machinery, metals, plastics and textiles;
- dry cleaning;
- constituent of paints, varnishes, lacquers, thinners, waxes, floor and shoe polish, inks, adhesives, motor fuels, antifreeze mixtures, pharmaceutical products and preservatives;
- manufacture of artificial rubber, leather, plastics, textiles and explosives;
- therapeutic, pesticide, fumigant and disinfectant formulations;
- extraction of fats, oils and medicinal materials from seeds, nuts and bones; and
- use in various chemical reactions and laboratory procedures.

## Further Reading

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- AS 1716 *Respiratory Protective Devices*, Sydney.
- AS 1940 *Rules for the Storage and Handling of Flammable and Combustible Liquids*, Sydney.
- AS 2161 *Industrial Safety Gloves and Mittens*, Sydney.
- AS 2661 *Vapour Degreasing Plant*, Sydney.
- AS 2865 *Safe Working in a Confined Space*, Sydney.
- AS 2986 *Workplace Atmospheres - Organic Vapours - Sampling by Solid Adsorption Techniques*, Sydney.