

PRACTICAL GUIDELINES FOR THE SAFE USE OF ORGANIC SOLVENTS

Practical Guidelines for the Safe Use of Organic Solvents was prepared by OSH Health Services staff chaired by Mel Tyson, Senior Occupational Health Scientist, Central Region.

Published by:
Occupational Safety and Health Service,
Department of Labour
Wellington,
New Zealand.

Issued November 1992

ISBN 0-477-03509-4

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Introduction

These guidelines give practical advice to people working every day with organic solvents.

Solvents are among the most commonly used chemicals in industry. Some 100,000 New Zealand employees in many different jobs are regularly exposed to a variety of solvents, some of which can have serious health effects. Few industries are absolutely free of solvents.

All solvents should be considered hazardous. How serious the threat is to health largely depends how much, how often and in what way someone is exposed.

Employees in the following industries may be especially at risk:

boat building	dry cleaning
plastics	footwear
printing	painting
photographic	engineering
building	chemical manufacture

These guidelines have been written for both employees and employers, using as little technical language as is possible. They follow the broad provisions of a new law — the Health and Safety in Employment Act 1992 — which applies to nearly all places where people work (see following section).

We encourage you to get together and decide the best ways to stay healthy when using organic solvents in the workplace.

Duties of Employers and Employees

Employers have duties under the Health and Safety in Employment Act 1992 to provide and maintain a safe and healthy work environment. They must also ensure that employees are not exposed to hazards in the course of their work.

Employers must establish systems for identifying and managing hazards. They must involve employees in the development of these systems, including the procedures to be taken in the event of an emergency.

Where there is a significant hazard, the employer must, take action to **eliminate** it. Where elimination is not practicable, the hazard should be **isolated**. If neither of these is practicable, exposure to the hazard must be **minimised**. This may require:

- Ensuring that protective clothing and equipment is provided and used.
- Monitoring employees' exposure to the hazard.
- Seeking the consent of employees to monitor their health.
- With informed consent, monitoring employees' health.

If you are an employee, the Act gives you responsibility for your own safety and health at work. This does not detract from the duties of your employer.

This is not a complete description of employers' duties under the Act and for further information you should see the OSH booklet *A Guide to the Health and Safety in Employment Act 1992* or contact your local OSH office.

What Are Organic Solvents?

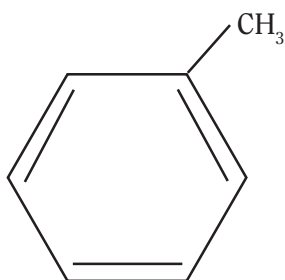
A solvent is any liquid which can dissolve a substance. The name *organic solvent* is used for a large group of these chemicals which come from petroleum-based products. They are often used as degreasing agents and paint thinners. They are also used to manufacture a wide range of other products, e.g. adhesives, fuels, pharmaceuticals and cosmetics.

Many are *volatile*. They give off a vapour and will evaporate quickly at room temperature. Not all give out a strong smell.

Organic solvents are put in classes based on the chemicals in them. Solvents can be members of the same chemical class and behave in similar ways but differ in how harmful they are to people. The word *toxic* is often used when referring to a harmful solvent.

It is not easy to know what these effects on people might be. Solvents used in industry are often mixtures of several chemicals, e.g. methylated spirits is a blend of methanol and ethanol. There may be as many as twenty substances in some organic solvents, e. g. white spirits, turpentine and kerosene.

Even the name *spirit* can confuse people: *methylated spirits* is a mixture of two alcohols and *white spirit* is a petrol-like blend of hydrocarbons. However, they are very different in their toxic effects on people and the kind of hazard they pose in the workplace.



Chemical structure of toluene, a common industrial organic solvent.

How Do You Know What to Look For?

How do you ensure that there will be no ill effects from the solvents used in your workplace? The first step is for both employer and employees to know about and read the Material Safety Data Sheet for each product used.

Material Safety Data Sheets

Material Safety Data Sheets (MSDS) should be available at the place of work for all to read. These sheets detail the hazards and set out the precautions for handling the chemical safely. MSDS should follow a design suggested in the *Material Safety Data Sheet Code of Practice*.

Manufacturers and suppliers of chemicals provide Material Safety Data Sheets on each product and each solvent used in the workplace. The firm selling the chemical to the factory is required to supply them with each purchase.

- Check that MSDS come with the product.
- Make sure everyone knows where they are.

How to Use the Material Safety Data Sheet

Individual solvents can be found under a variety of chemical and trade names, so consult the MSDS carefully.

- Look to see what the components of the product are.
 - Check out the toxic properties.
 - Follow the safety precautions.
-

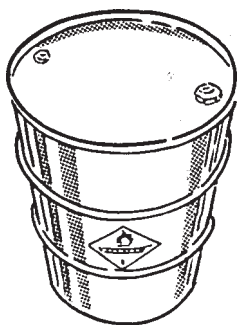
Training

It is important that everyone at work knows the solvent risks and which good work practices will reduce the risk to a low level. Training needs to be a compulsory part of the induction process for all new employees. It needs to cover health and safety issues as well as the use of the emergency facilities. In many cases, further compulsory education for the existing staff members will also be needed.

Training should be specific. Its aim is to ensure each person on the staff:

- Can identify the solvents used in each stage of the process.
 - Can recall the health and safety measures required for each solvent.
 - Works through the Material Safety Data Sheets to interpret how storage, safe use and emergency procedures, including fire drill, will operate in each stage of the manufacturing process.
 - Can carry out the proper first aid procedures for any solvent accident.
-

Physical Properties of Solvents



Keep containers sealed or stoppered when not in use.

Volatility

Many solvents are liquids with low boiling points, which means that they will evaporate and form vapour in the air when containers are left open. Their vapours can be breathed in and lead to health problems.

What to Do:

- Store solvents in strong containers.
- Keep containers sealed or stoppered when not being used.

Flammability

In general, the more volatile solvents are the more hazardous.

Many solvent vapours are highly flammable. They will readily create an atmosphere in which a fire can start: toluene and petroleum ether, for example, have properties similar to petrol.

This makes fire precautions extremely important.

What to Do:

- Work out evacuation routes within the factory.
- Keep evacuation routes free of any cluttering materials.
- Have fire drills often.

Poisonous Gases in Case of Fire

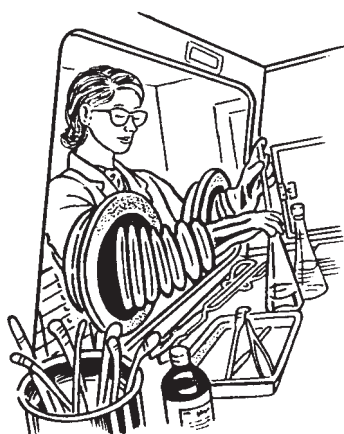
Not all solvents are flammable; chlorinated solvents, such as 1,1,1-trichloroethane and carbon tetrachloride, are generally of very low flammability, and others have even been used as fire extinguishing agents. However, should halogenated solvents be involved in a fire at high temperatures they can produce phosgene, a deadly gas.

Knowledge of what you are dealing with is vital to the proper methods of handling these and other chemicals.

Flash Points

There is a high risk of explosion when flammable solvent is used at temperatures above its flash point.

To reduce the risks:



cupboard.

OR

- Use a non-flammable solvent.

Always take into account any increase in toxicity of a new material.

At all times take special care to:

- Reduce the volume of flammable solvents present as far as possible.
- Prevent spills and leaks.
- Exclude sources of ignition such as naked lights, unsuitable electrical equipment, static electricity hazards, hot surfaces and mechanical friction.
- Reduce the vapour concentration by ventilation/extraction systems.

In addition, even high flash point liquids can catch fire and burn fiercely if they are released as a spray or mist, or are heated above their flash point.

Dangerous Reaction with Metal Powders

Chlorinated hydrocarbons in contact with aluminium, magnesium and their alloys can produce a spontaneous and sometimes explosive reaction. These metals must be excluded when chlorinated solvents are used in a way where the solvent is likely to evaporate to dryness in the presence of metal powder.

Health Hazards

Ways Solvents Can Enter Your Body

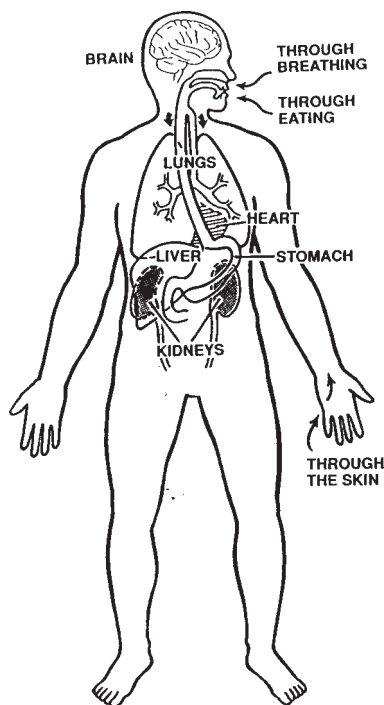
Solvents can be absorbed into the body by three routes. They can be:

- Inhaled into the lungs,
- Absorbed through the skin,
- Swallowed.

Of these three, inhaling a harmful vapour is the most common route.

Inhalation

Once inhaled, the solvent vapours come in direct contact with the blood supply in the lungs and dissolve into the bloodstream. They are then carried by the blood to the body's organs. Here they may damage the organ's ability to function.



Solvents can be absorbed into the body by three routes.

Absorption

If solvents are in contact with the skin, they may pass through and enter the bloodstream and be carried directly to the organs.

Solvents differ in their ability to penetrate the skin's protective fats and oils to reach the bloodstream but all will have a direct effect on the skin and can cause problems such as dermatitis.

Swallowing

Swallowing solvent may seem unlikely but avoid smoking, eating or drinking while handling solvents.

What Are the Warning Signs?

The toxic effects of solvents may be noticed immediately, some time later or both.

Acute Poisoning

The first effects are often similar to drinking too much alcohol and may lead to poor work or a work accident. Effects will vary with the particular solvent, but will usually include:

- A light-headed feeling.
- Slower reaction time.
- Poorer co-ordination, balance and power of reasoning.

This stage can be followed by:

- Nausea and dizziness getting more and more severe.
- Loss of consciousness (referred to as *narcosis* in some of the Material Safety Data Sheets).

What to Do:

- Remove the person or people away from exposure to the vapour.
- Check the first aid instructions in this book and on the product label and MSDS to see if there is anything else to do to help.

Recovery from the effects of acute exposure is usually both complete and fairly rapid once the victim is breathing clear air.

Chronic Poisoning

After years of repeated exposures, the typical later effects are:

- Mood changes.
- Tiredness.

- Weakness.
- Persistent dermatitis.
- Effects on the liver and kidney.
- Solvents can also affect the peripheral nerves, the brain and spinal cord.

Note: *Not all solvents will have all of these effects. Seek professional advice when choosing products containing solvents and when substituting one solvent for another.*

What to Do:

- If you believe you may be suffering the effects of long-term exposure, see your doctor. If there is a problem, you may need to change the way you do your job.

How Solvents Affect the Skin

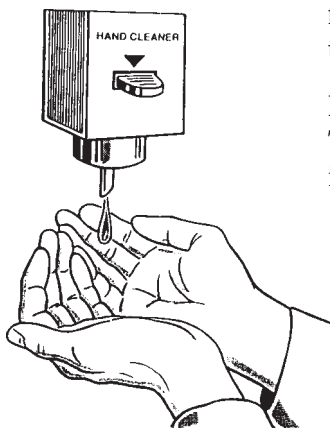
Solvents dissolve the fat contained in human skin and remove the natural protective barrier, promoting the penetration and absorption of solvent and other chemicals which may be present. Even cleaning your hands in a solvent such as turpentine can cause dermatitis, or make it worse.

Solvents can cause skin rashes, most commonly on the hands, fingers and the forearms. These rashes can be very irritating. If your exposure is short-term, they are unlikely to last for long and will heal quickly.

Repeated or prolonged exposure may result in chronic irritant dermatitis. This is often slow to heal and may leave the sufferer with a substantially increased risk of repeated attacks.

What to Do:

- Use hand cleansers. Do not wash your hands in a solvent, especially if you have any skin problems.
- Have and use properly designed equipment and a safe system of work.
- Wear protective gloves and clothing where necessary.



Don't clean hands with solvents: use a hand cleanser instead.

How Much Exposure is Bad for You?

The risk of injury or disease increases with **how long** you are exposed to the solvent and **how much** solvent vapour is in the air — its concentration.

As individuals may differ in their responses to solvents, not all of the health effects listed for a solvent need be experienced by exposed persons. However,

a good rule of thumb is that the **longer the exposure** (years) and the **higher the dose**, the **greater the health risk**.

Mixed Exposure

In the workplace there may often be mixtures of solvents, particularly in paints and adhesives.

Exposure to more than one solvent at the same time can give rise to greater health risks. When a mixture of solvents is used, the “safe” level is often unpredictable.

Drinking alcohol during the day may also increase the toxic risk.

Addiction

People can become addicted to some solvents such as trichloroethylene.

Workplace Exposure Standards

In New Zealand, the Workplace Exposure Standards (WES) help define the limits for exposure to airborne substances in the workplace. These give the limits for individual solvents and warn that special care is needed when there is a mixture of solvents. When working out the safe level of solvent vapour in the air, add together **all** the solvents which share the same biological effect.

Do not think of the WES as the boundary between safety and danger. People vary widely and some people may experience discomfort at levels well below the WES. Therefore the level of any airborne contaminant should be reduced to the lowest practicable level **below** the WES.

The booklet *Workplace Exposure Standards and Biological Exposure Indices* is available from GP Books Ltd. and their agents.

Ways to Stop Harmful Solvent Pollution

Eliminate or Substitute

Whenever possible, avoid using a substance that creates harmful vapour.

- Find another process which does not need this solvent.

OR

- Find another substance which has the right chemical properties to do the job and is known to be less harmful.

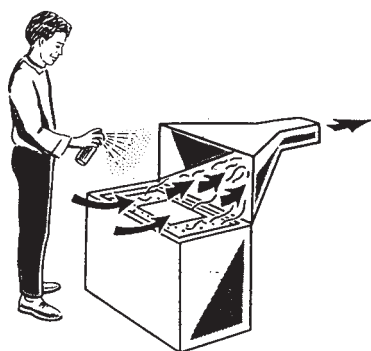
Where these are not possible, engineering or other measures may be needed.

Isolate

The hazard can be isolated in a variety of ways through engineering and/or good organisation of the work areas. The solvent process can be kept apart from other parts of the workplace, either by position or by enclosing it. Also provide good local or general workplace ventilation.

Ventilate

Where the danger is through breathing vapour into the lungs, ventilation is often used to reduce the concentration of the substance. Making air behave properly is technically very difficult, and the ventilation should be assessed by an experienced ventilation engineer.



Reduce the vapour concentration by ventilation and extraction systems.

Local exhaust ventilation removes contaminated air directly from the source. It is far more effective and energy-efficient than ventilation systems, which are designed to produce air changes in the complete room. General room ventilation may still be essential if local exhausting is not 100 percent effective.

General room ventilation must work in with local exhaust ventilation for the most effective removal of atmospheric contaminants.

Good exhaust ventilation ensures that fumes are drawn away from the point of origin and away from the operator — not past the operator. The extraction cowl should be as close as possible to the source of the fumes. Efficient fume extraction leaves fresh, clean air in the breathing zone of the operator.

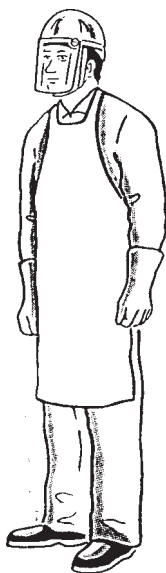
Ways to Control Harmful Solvents

Use Personal Protective Equipment

The best thing to do is to **prevent** exposure to hazardous substances if at all practicable. Where you cannot, **control it**. Prevention or adequate control must, so far as is reasonably practicable, be secured by means **other than personal preventive equipment**. If prevention or adequate control cannot be achieved by other means, suitable personal protective equipment must be provided. In addition, take all the other practical precautions you can.

Protect the Skin

Solvent-resistant gloves, boots and aprons are made from a range of synthetic materials with varying permeability to solvents. The type of glove chosen needs to protect against the specific solvent or mix of solvents being used. Unfortunately, very few glove materials are available which offer full eight-hour protection and mechanical strength. Gloves which swell and distort allow solvents to penetrate to the skin in less than one hour of use. At higher



Use personal protective equipment when exposure to solvents cannot be avoided by other means.

temperatures the break-through time is much shorter. Seek expert advice when choosing gloves. A table is provided overleaf which attempts to match the appropriate protective material to the type of solvent.

When selecting the right glove for the job:

- Choose materials listed good or excellent, not those with a fair or poor rating.
- Choose gloves which are long enough to protect the worker for the application at hand.
- Select the glove thickness best suited for the application. If the job calls for maximum sensitivity and dexterity, the lighter weight gloves are best. Heavy-duty applications require a thicker glove.

When exposure to the liquid solvent cannot be avoided:

- Wear cotton overalls.
- Wear solvent-resistant boots and apron.
- Use a face visor to protect the face and eyes from splashes.

The need to wear this gear throughout the day would suggest that the solvent is being mishandled.

When do You Need a Respirator?

If you cannot reduce solvent vapours in the air to an acceptable level and there is a chance of exposure in an emergency, use an approved respirator.

What to Do:

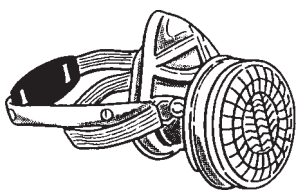
- In areas of high vapour concentration, always use full face respirators with an independent air supply.

Cartridge-type respirators with the appropriate solvent cartridge are effective only for concentrations below ten times the WES levels, even for short durations. If in doubt, always wear a full face respirator fed with fresh air.

- Make sure the respirator fits properly.

Respirators are only effective when they have been properly fitted and maintained. The person selling the respirator should be trained in “fit testing” and be able to offer appropriate advice. For example, half face respirators are not suitable for bearded users.

For routine industrial use, respirators should be issued on a personal basis. This ensures that an initial correct fitting will provide a continuing good fit. It also eliminates the possibility of infection being transferred from person to person through the facepiece. Personal issue also helps the wearer anticipate when to replace the cartridge.



A cartridge-type respirator is suitable for some applications but not in confined spaces.

GUIDE FOR SELECTING GLOVE MATERIALS					
Solvent	Viton	Nitrile	Butyl	Natural Rubber	PVC
Acetone	P	P	E	G	P
Amyl acetate	P	P	E	F	P
Cyclohexane	E	E	P	P	F
Dimethyl formamide	P	F	E	P	P
Ethyl acetate	P	P	G	P	P
Ethanol	G	E	E	E	G
Hexane	E	E	P	P	F
Isopropanol	E	G	E	E	G
Kerosene	E	E	P	P	F
Methanol	F	E	E	E	E
Methyl cellosolve	P	F	G	P	-
Methylene chloride	G	P	F	P	P
Methyl ethyl ketone (MEK)	P	P	E	G	P
Methyl isobutyl ketone (MIBK)	P	P	G	F	F
Perchloroethylene	E	F	P	P	P
Petroleum distillate	G	E	P	P	P
Propyl acetate	P	P	G	P	F
Stoddard solvent (white spirits)	E	E	P	P	F
Styrene	G	P	P	P	P
Toluene	E	F	P	P	P
Trichloroethylene	E	F	P	P	P
Turpentine	E	E	P	P	F
Xylene	E	F	P	P	P

KEY: E: Excellent, G: Good, F: Fair, P: Poor, - No Data

- Take care to maintain the respirator and cartridges.
- Store cartridges in sealed containers when not in use.

You need to remove the cartridge from the respirator after each use and store it properly. If you don't put the cartridge away after each use, it will keep on absorbing any solvent in the air and become exhausted.

Working in a Confined Space

Solvents may build up to a dangerous level in confined spaces such as vessels, tanks, tankwagons, underground chambers, enclosed drains, unventilated rooms and ovens. The hazards are potentially lethal.

What to Do:

- Never attempt such work without training.
- An experienced and responsible person must supervise the work.
- Plan the work properly before going in.
- Get your employer's permission.
- Wear an air-fed respirator when entering a confined space.

For further information, see the OSH booklet *Safety in Confined Spaces*.



Never work in a confined space unless you have been trained and follow the proper safety procedures.

Measurement of Exposure

Atmospheric (Air) Sampling

Where sampling is necessary to measure the concentrations of solvents in air, it will normally be best to contact a specialist in industrial hygiene for advice on which method to use.

Exposure to solvents will be most accurately measured by personal sampling. The personal sample should be collected as close as possible to the "breathing zone" so that it gives an accurate reading. Use miniature equipment carried by the worker during normal work operations.

Biological monitoring is unlikely to be used as a routine screening procedure. Consider using it if exposure is excessive or a potential health hazard, particularly as a result of skin absorption.

Biological testing requires specialist skills, so seek advice from a qualified person such as an occupational health physician.

Labelling and Storage

Labels

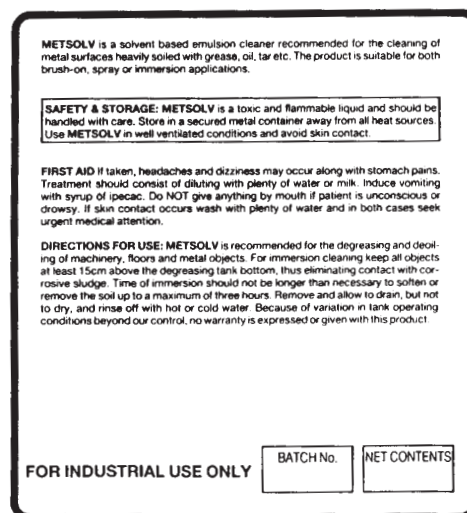
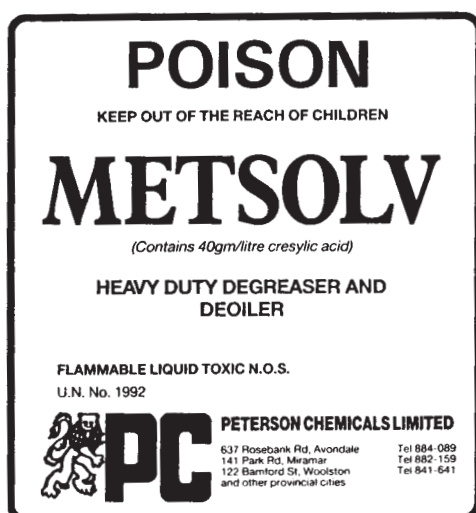
The main purpose of a label is to tell people what the product is. However, labels often have other important information about the contents of the product and the way it is to be handled, transported and used. More information about labels is set out in NZS 5433:1988 *Code of practice for the transport of hazardous substances on land*. These requirements are specifically covered by the Dangerous Goods Act 1974 and the Toxic Substances Act 1979 and the associated regulations.

What to Do:

- Label all containers so that at all times employees and management know what substances they are working with.
- Ensure there are warning labels to indicate the hazardous nature of the substance and the procedures to be used in an emergency.
- Show a poison symbol on the container to warn people who cannot read or understand English.



Display a poison symbol on label to warn people who may not understand English.



Sample label for a product containing solvents.

Storage

Store bulk quantities (more than 5 litres) of solvent or substances containing a significant percentage of flammable solvent in a flameproof cabinet or storeroom.

What to Do:

- Store in a cool place, away from ignition sources.
- Keep storage area well ventilated to prevent solvent vapour accumulating.
- Isolate the storage area from the workplace.
- Have the floor with raised edges around it to contain spills.
- Equip the storage area with appropriate fire fighting equipment.
- Keep the quantity outside the storage area to a minimum.
- Prohibit all smoking in and around the storage area.



Prohibit smoking in and around solvent storage areas.

First Aid

Emergency Facilities

All employees should know the first aid for any chemical they use. First aid procedures for specific solvents used in the workplace should also be available. Refer also to the MSDS.

Emergency washing facilities such as a shower or hose attachment should be available close to the work area to wash contaminated skin or clothing. An eye fountain should also be available close to employees to dilute eye splashes in emergencies.

Skin Exposure

Aim to dilute the solvent immediately:

- Remove contaminated clothing, using *appropriate* gloves if available.
- Wash contaminated skin with lots of soap and water from a shower, hose or bucket.



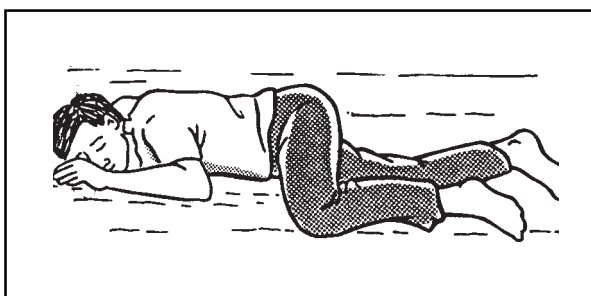
An emergency eye wash fountain should be available, close to where people are working.

Inhalation

To help a victim of over-exposure to solvent vapours:

- Immediately remove the victim from the atmosphere in which the over-exposure occurred.
- Keep the victim warm and quiet.

If unconscious, if breathing is distressed, or if victim is cyanosed (blue in colour):



- Ensure the airway is open — press the head backwards and lower jaw forwards so that the chin juts out.
- Place the victim in the recovery position.
- Support breathing by mouth to mouth resuscitation. Use CPR if necessary.
- Seek medical attention urgently

Place a victim of solvent inhalation in the recovery position.

Swallowing

- If conscious, give plenty of water to drink. Do not cause vomiting.
- If unconscious do not give anything by mouth. Remove false teeth, clean mouth of solvent, mucus and vomit. Follow instruction for unconscious victims given above.
- Refer to first aid instructions and the MSDS for specific solvents. For additional information ring the National Poisons and Hazardous Chemicals Information Centre, listed in the emergency services section of the telephone directory.
- Obtain medical attention urgently.

Splash Protection

If the solvent gets into the eye:

- Wash immediately with clean running water, lifting both lids repeatedly while doing so and keeping the eye open.
- Continue to wash the eye **without break for at least 15 minutes**. If the irritation still persists after this, seek medical attention without delay.
- If the affected person is wearing contact lens, the eyes should be flushed constantly until the person is able to remove the contact lens.

Where to Find More Information

Information concerning the methods of using solvents safely are available from many sources. Some are listed below and anyone using solvents should be able to contact these people for information.

- All **employers** should have a working knowledge of the materials being handled.
 - **Material Safety Data Sheets (MSDS)** should be available at the place of work for all involved people to read.
 - The **manufacturer or the distributor** of the solvent should have provided the MSDS when delivering the solvent. If these cannot be found, ask the supplier to send replacement MSDS and all the information necessary to use the solvent safely.
 - **Occupational health services** operated or contracted by the employer will have full information and knowledge of the hazards posed by the solvents and the correct methods of controlling the risk.
 - Local branches of the **Occupational Safety and Health Service** of the Department of Labour (OSH) are available to answer questions or provide “broad brush” advice on request. See over page for a list of addresses.
 - The appropriate **union** will have full information and knowledge of the hazards posed by the solvents and the correct methods of controlling the risk.
-