Topic 5 Section 4

Managing Work Hazards

Contents

Identifying Hazards

Definition of Risk and Hazard

The Workplace Health and Safety Advisory Standard for Risk Management 2000 clearly states that risks and hazards are not the same thing:

- Hazard: anything in the workplace that has the potential to cause harm. It may include energy, manual tasks, substances, plant and equipment, and work processes, or any other aspect of the work environment.
- Risk: the likelihood that death, injury, or illness may result because of the hazard.
- Incident: a situation in which the potential for harm becomes reality.
- The difference between risk and hazard is shown in the following examples:

Hazard	Risk
Confined space	The likelihood that a worker might suffer poisoning by carbon monoxide because he or she is using a petrol-operated pump in a trench (i.e. an inadequately ventilated space).
Electricity	The likelihood that a worker might be electrocuted because he is exposed to electrical wires while using a drill that has inadequate insulation on the power cable.
Manual handling	The likelihood that a worker might suffer back strain while lifting 40-kg bags.
Noise	The likelihood that workers or others in the area might suffer permanent hearing damage because they are working near someone continuously using a jack-hammer with a noise level greater than 85 dBA.

Construction workplaces may potentially contain a large number of hazards. The most common types are listed on page 6.

Note!

If you see a situation in the workplace that leaves you with any doubts about safety, consult your supervisor before going ahead with the task.

Methods of Identifying Hazards

There are several methods of identifying hazards in the workplace:

- inspections
- accident/incident reports
- employee consultation.

Inspections

Walking through an area, or doing the walk-around inspection of a vehicle, are commonly used as methods for identifying hazards. You can gain more value from inspections by:

- using a checklist, to ensure that you have covered all aspects of the operation and all likely problem areas
- using an independent observer, such as a person who does not normally work in the area being inspected. This person may be able to spot workplace hazards better than people who work there every day.

Accident/Incident Reports

Most employers and workplaces have some type of system for recording workplace accidents, injuries and incidents. Past records may therefore be useful sources of information about the kinds of hazards that may be expected when people are performing particular classes of work.

However, past records cannot be used to predict all types of accidents that may occur in the future. There are several reasons why this is true:

- an accident or incident may not yet have happened, even though it is a possible consequence of existing work practices, equipment or technology
- changes in work practices, equipment or technology may create new kinds of hazard that cannot be predicted from past occurrences
- people may take corrective action to fix the problem
- managers may insist on the use of changed work practices that remove the source of the problem.

Employee Consultation

The workers on the job are often the people who have the most intimate knowledge of the work processes and the working environment; therefore, they are often the best source of information about the associated hazards. Consulting employees is therefore a very effective way of compiling a list of hazards.

The process of identifying hazards may lead to other useful information and ideas, such as:

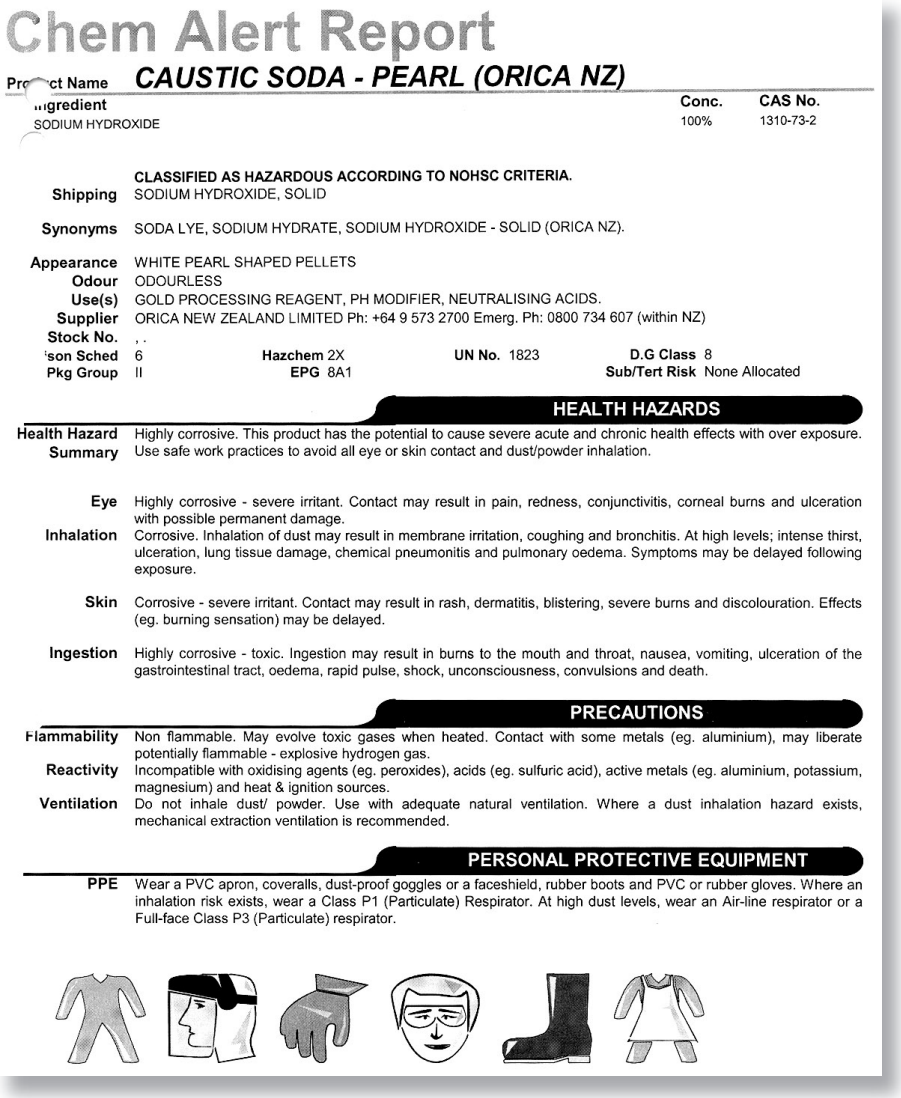
- the likely consequences of incidents
- suggestions for controlling the risk.

Product Information

Manufacturers and suppliers of products used in the workplace provide information about the product that may be used in hazard identification. This information may be available in the form of:

- material safety data sheets (MSDS)
- product labels
- manufacturer's instructions.

The value of this information is that is establishes the standard for correct use of the product. Any use of the product outside the written guidelines or instructions may be dangerous, and would normally be the subject of an investigation.



Chem Alert Report

Product Name **CAUSTIC SODA - PEARL (ORICA NZ)**

Ingredient	Conc.	CAS No.
SODIUM HYDROXIDE	100%	1310-73-2

CLASSIFIED AS HAZARDOUS ACCORDING TO NOHSC CRITERIA.

Shipping SODIUM HYDROXIDE, SOLID

Synonyms SODA LYE, SODIUM HYDRATE, SODIUM HYDROXIDE - SOLID (ORICA NZ).

Appearance WHITE PEARL SHAPED PELLETS
Odour ODOURLESS
Use(s) GOLD PROCESSING REAGENT, PH MODIFIER, NEUTRALISING ACIDS.
Supplier ORICA NEW ZEALAND LIMITED Ph: +64 9 573 2700 Emerg. Ph: 0800 734 607 (within NZ)
Stock No. , .
Poison Sched 6 **Hazchem** 2X **UN No.** 1823 **D.G Class** 8
Pkg Group II **EPG** 8A1 **Sub/Tert Risk** None Allocated

HEALTH HAZARDS

Health Hazard Summary Highly corrosive. This product has the potential to cause severe acute and chronic health effects with over exposure. Use safe work practices to avoid all eye or skin contact and dust/powder inhalation.

Eye Highly corrosive - severe irritant. Contact may result in pain, redness, conjunctivitis, corneal burns and ulceration with possible permanent damage.
Inhalation Corrosive. Inhalation of dust may result in membrane irritation, coughing and bronchitis. At high levels; intense thirst, ulceration, lung tissue damage, chemical pneumonitis and pulmonary oedema. Symptoms may be delayed following exposure.

Skin Corrosive - severe irritant. Contact may result in rash, dermatitis, blistering, severe burns and discolouration. Effects (eg. burning sensation) may be delayed.

Ingestion Highly corrosive - toxic. Ingestion may result in burns to the mouth and throat, nausea, vomiting, ulceration of the gastrointestinal tract, oedema, rapid pulse, shock, unconsciousness, convulsions and death.

PRECAUTIONS

Flammability Non flammable. May evolve toxic gases when heated. Contact with some metals (eg. aluminium), may liberate potentially flammable - explosive hydrogen gas.
Reactivity Incompatible with oxidising agents (eg. peroxides), acids (eg. sulfuric acid), active metals (eg. aluminium, potassium, magnesium) and heat & ignition sources.
Ventilation Do not inhale dust/ powder. Use with adequate natural ventilation. Where a dust inhalation hazard exists, mechanical extraction ventilation is recommended.

PERSONAL PROTECTIVE EQUIPMENT

PPE Wear a PVC apron, coveralls, dust-proof goggles or a faceshield, rubber boots and PVC or rubber gloves. Where an inhalation risk exists, wear a Class P1 (Particulate) Respirator. At high dust levels, wear an Air-line respirator or a Full-face Class P3 (Particulate) respirator.

Typical MSDS

In addition, government health and safety authorities may issue warnings about, or make regulations governing, the use of particular products. These are further sources of information about a product and its associated hazards, and will affect the manner in which it is used in the workplace.

Hazard Identification Process

When using any of the above methods of identifying hazards, you need to ask plenty of questions about the information you have gathered, so that you can be sure you have considered all aspects of the job. The following are the important questions:

- **What?**— What job is to be done and what tools and equipment will I need and be handling? Does it involve hot work, excavations, penetrations, etc?
- **When?**— When will the job be done? Is it at night, is it at a busy time for traffic, it is at a time when a break in the process is going to cause a major disruption, is it at a time when personnel numbers are down and manpower is stretched?
- **Where?**— Where will the job be conducted? Is it at height, in a confined space, in a remote location?
- **Who?**— Who is responsible for the work area; has he/she been informed? Who is doing the job and who will be assisting; are they qualified for all aspects of the job?
- **Why?**— Why is it necessary to do the job at this time and place?
- **How?**— How will the job be done? What are the steps in getting the job done and have they all been considered from a hazard identification point of view?

While you are asking yourself these questions, you need to consider the following potential sources of harm:

- pressure
- electricity
- chemicals
- rotating equipment
- vehicles
- height
- depth
- confined spaces
- vibration
- access
- moving objects
- weather conditions
- hot/cold objects
- noise
- radiation
- tools/equipment
- weight of objects
- bacteria
- hydrocarbons
- gases
- other

Along with analysis of all the potential hazards, you also need to consider the mechanisms by which you, other employees and equipment and environment can be injured or damaged.

These can include but are not limited to:

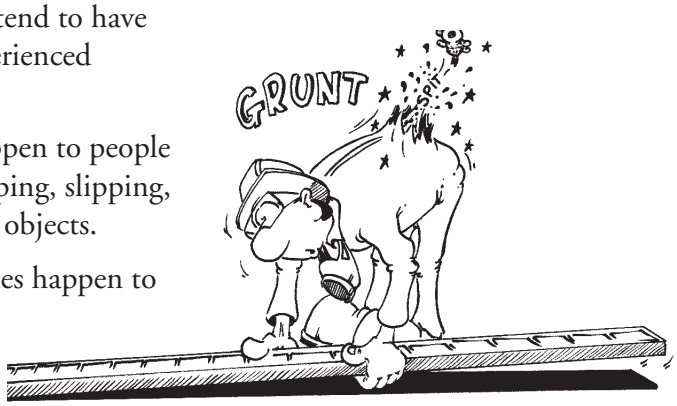
- strike against…
- struck by…
- struck by falling object
- caught in/on…
- strain/overexertion
- electric shock
- dehydration/heat stroke
- sunburn
- slips, trips and falls
- falls from height
- cuts/tears/abrasions
- pressure injuries
- burns to skin
- inhalation of…
- exposure to fumes
- exposure to gas
- exposure to dust
- exposure to radiation
- exposure to bio-agents
- toxic atmosphere
- oxygen depletion
- fire/explosion
- spillage
- release of gas/fumes

Predicting Incidents

An incident is any situation in which stored, harmful energy is released, creating consequences in terms of injury or death, and damage to property. The best way to predict incidents is to combine the benefits of both past experience and past records.

In the construction industry, past experience with accidents and incidents have shown us that the typical trends and figures are as follows:

- Young and inexperienced employees tend to have more accidents than older, more experienced employees.
- Thirty per cent (30%) of injuries happen to people moving about the job, including tripping, slipping, falling, stepping on and walking into objects.
- Twenty-nine per cent (29%) of injuries happen to people while handling materials— lifting, carrying, packing, stacking, loading, and so on.



- Eleven per cent (11%) of injuries happen to people who are struck by falling or flying objects such as falling rocks and tools and flying rock chips, gravel, etc.
- Seven per cent (7%) of injuries happen to people using hand tools such as picks, shovels, axes, crowbars, hammers, etc. Most of these accidents are caused by the condition of tools (blunt, damaged handles, jagged edges, etc.) or their misuse or abuse.

The remaining twenty-three percent (23%) of the accidents which occur on the job are caused by plant, vehicles, electricity, fires, power tools, poisons and the like.

This information is of great significance in accident prediction. It means that:

- people tend to avoid the things that they know, expect or suspect are dangerous, the dangers they can see and hear, and the dangers they have become accustomed to respecting and avoiding
- most accidents, i.e. seventy-seven percent (77%), are caused by the everyday things which people do not know, expect or suspect, the things they fail to notice and register as being unsafe.

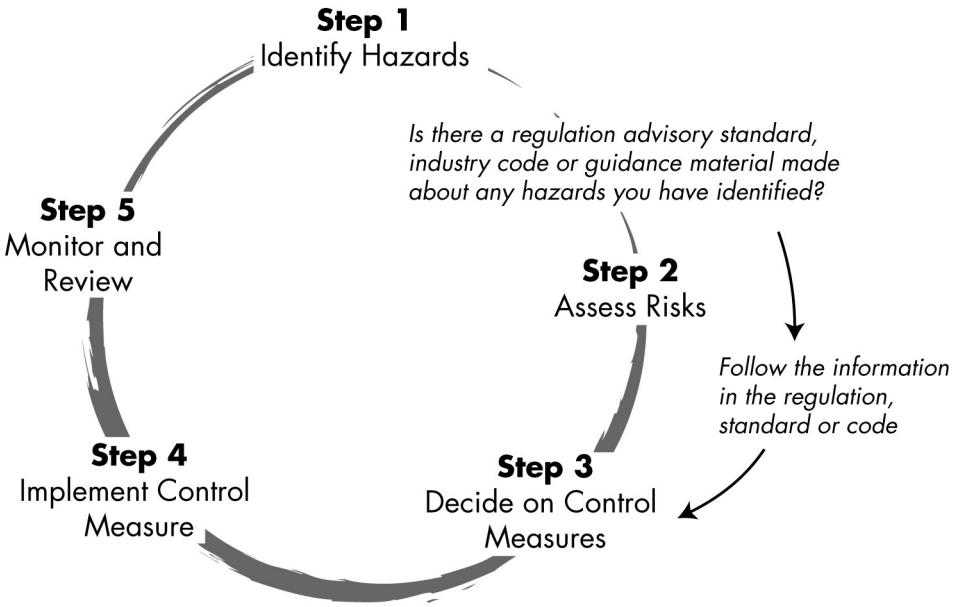
These trends give some important clues about how we might set up a safety program in the workplace. They show that we need to:

- maintain the awareness that people already have of dangers that they respect and avoid
- make people more aware of unsafe conditions that they do not recognise or suspect (i.e. the causes of 77% of on-the-job injuries).

To achieve this, we need not only consistent and persistent education and training, but reliable methods of assessing and managing risks, so that we have a solid basis for predicting and (we all sincerely hope) preventing accidents.

Risk Assessment and Management

Identifying hazards, as discussed above, is only the first step in the process of managing risks. The following diagram shows the overall 'risk control' process:



The steps involved in achieving risk control, to be discussed in more detail in following sections, are as follows:

- risk assessment
- deciding on control measures
- implementing control measures
- monitoring and review.

Risk Assessment

Once a hazard has been identified, it is subject to a risk assessment. During the assessment, we consider everyone who may, potentially, be affected by the hazard— including non-employees such as contractors, sales representatives and visiting members of the public.

Two methods are commonly used for assessing risk:

- the risk calculator
- risk prioritisation.

An important reason for undertaking a risk assessment using either of these methods is to meet the requirements of Sections 56(i) and 56(j) of the Workplace Health and Safety Regulation 1997.

These sections require the principal contractor to describe:

(i) the risks at the workplace for which the principal contractor owes a workplace health and safety obligation (as defined in the Act)

(j) the proposed control measures to prevent, or minimize the level of the risks.

The Risk Assessment Calculator

The risk assessment calculator is a chart that brings together three factors— consequence, exposure and probability— and uses them to calculate a risk score.

Consequence

When an incident occurs, the consequences may include injury to persons and damage to property. In relation to injury, the consequences of an incident may range from minor cuts and scratches requiring first-aid treatment, up to multiple fatalities. The consequences for property may range from barely noticeable (i.e. minor repair costs) up to catastrophic financial impacts costing millions of dollars.

The combined ranges of consequences for injury and property are assessed as follows.

Catastrophe	Numerous fatalities, damage over $5 million, major disruption to activities
Disaster	Multiple fatalities, damage $1 million to $5 million
Very Serious	Fatality, damage between $500 000 and $1 million
Serious	Permanent disability, damage between $5000 and $500 000
Casualty Treatment	Important, disabling injury, damage up to $5000
First Aid Treatment	Noticeable, minor cuts and bruises; bumps and minor damage

Exposure

Exposure simply means 'how often' an incident occurs, or for how long individuals or property are exposed to the hazard over the duration of the task. There are two ways of assessing exposure, as shown in the following table:

- If the period of exposure is very brief, it is simply rated as 'infrequent'.
- If it is for longer periods, the 'how long' category applies.

Exposure category	Guideline	
	How often	How long
Very rare (>1% of the time)	The hazard event has never occurred	Exposure is only momentary or rare
Rare (1% of the time)	The hazard event occurs sometimes during the task, but not every time	Exposure is only for a brief period
Infrequent (weekly)	The hazard event occurs at least once during the task each time	Exposure is only for a short period
Occasional (daily)	The hazard event occurs a few times during the task	Exposure is only for a small part of the job
Frequent (daily, several)	The hazard event occurs many times during the task	Exposure is about a tenth of the time
Continuous (100%)	The hazard event occurs numerous times during the task	Exposure is most of the time

Probability

Probability is a way of measuring the chances that an event will occur. There are two ways of assessing probability: we can make an assessment based on knowledge of past events, or we can make an informed guess. For example:

If a grader is known to break down once every nine months, the probability of breakdown in the current month is 1/9. The probability of breakdown on any given day is:

$$P_b = \frac{1}{0.75 \times 365} = 0.00365, \text{ or about 1 in 273}$$

The other approach involves making an estimate. For example: what is the probability that there will be a thunderstorm this afternoon? If there are no definite indicators, we might say (depending on conditions) 1 in 50 or 1 in 100; if today's weather forecast predicts thunderstorms, we might say 2 out of 3 or 9 out of 10.

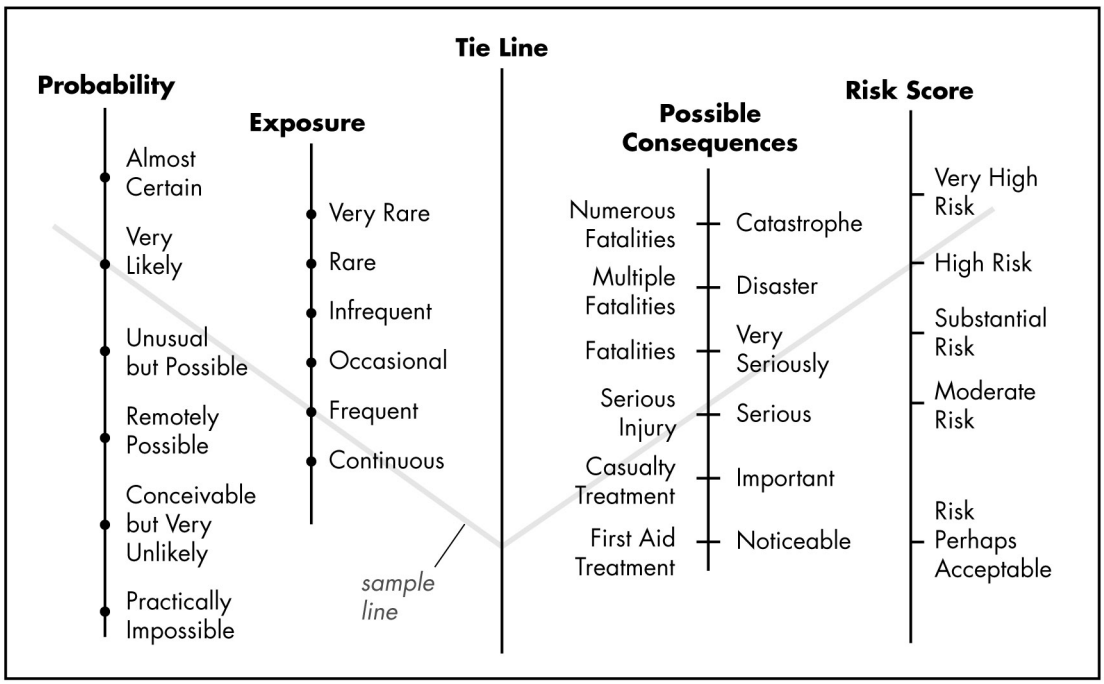
The following table is used to assess the probability of an event.

Almost certain	Almost certain, or the most likely and expected result if the selected sequence of events takes place (up to 1 in 10 chance)
Very likely	Very likely or not considered unusual (chances between approx. 1 in 10 and 1 in 100)
Unusual but possible	Would be an unusual but possible sequence of events (chances between approx. 1 in 100 and 1 in 1000)
Remotely possible	Would be a remotely possible coincidence (chances between approx. 1 in 1000 and 1 in 10 000)
Conceivable but very unlikely	Has never happened after many years' exposure, but is conceivably possible (chances between approx. 1 in 10 000 and 1 in 100 000)
Practically impossible	Has never happened anywhere, an almost impossible sequence (chances less than 1 in 100 000)

When completing a risk assessment, make sure you have taken all existing risk control measures into account. If you do not, you will tend to over-estimate probabilities.

Using the Risk Assessment Calculator

The risk assessment calculator and an example of its use are illustrated below.



To use the calculator:

- Draw a line to connect a point on the Probability scale with the appropriate point on the Exposure scale.
- Extend the line so that it intersects the Tie Line.
- From the point of intersection on the tie line, draw a line through the assessed point on the Possible Consequences scale.
- Extend the line to the Risk Score line.

The result is a risk score that ranges from 'Very High' to "Perhaps Acceptable".

Using the Risk Score

The action we might take as a result of this type of risk assessment depends on the range within which the assessed level of risk falls, as shown in the following table:

Very High to Substantial	Immediate action must be taken. Effective controls must be put in place to ensure no persons are at risk of injury or property is at risk of damage.
Substantial to Moderate	Although not as serious, the situation still requires effective controls to allow work to continue
Moderate to Acceptable	Some temporary action will be required to allow work to continue. If the work is a repetitive task, some type of permanent measure should be considered.
Acceptable	Controls may be put in place if the parties agree.

We use the rating obtained from using the risk calculator to make a judgement about whether the level of risk is acceptable or not. If the risk score is:

- greater than 'Very High', it indicates a serious situation requiring urgent action
- less than 'Perhaps Acceptable', it indicates a situation in which most people would take no action.

Note!

The risk score is a basis for making judgements. It cannot interpret unknown factors, such as complex human behaviour. Always interpret the results with caution.

Prioritising Risk

An alternative approach is to prioritise a number of risks, based on a numbered score. The method of calculating the scores is shown in the following table:

Likelihood — how likely is it to happen?	**Consequences— How severely could it affect someone?**			
	Extreme[A]	Major[B]	Moderate[C]	Minor[D]
Very Likely — could happen frequently	1	2	3	4
Likely — could happen occasionally	2	3	4	5
Unlikely — could happen, but rare	3	4	5	6
Very Unlikely — could happen, but probably never will	4	5	6	7

Details of consequences (right hand columns in table):

A. Death, permanent disablement

B. Serious bodily injury

C. Casualty treatment

D. First aid only, no lost time.

This approach combines probability and exposure into 'likelihood'. The combination of likelihood and consequences if the risk is realised determines the score.

The risk scores obtained by this method are useful for comparing risks only. The risk scores are not absolute numbers, i.e. they do not stand alone. When all the risk scores for all risks in the workplace are compared, the results are a guide to the order in which we might address the risks.

Using Risk Prioritisation

A table, as shown below, provides guidelines about the type of action we might take as a result of the assessment. The action taken depends on the range within which the assessed level of risk falls.

Score	Action
1, 2, or 3	Do something about these risks immediately
4 or 5	Do something about these risks as soon as possible
6 or 7	These risks may not need immediate action.

Deciding on Control Measures

The first step is to try to eliminate the hazard.

If this is not possible, use one or more of the following methods of preventing or minimising exposure to the risk:

- Substitute a less hazardous material, process or equipment
- Redesign equipment or work processes
- Isolate the hazard.

As a last resort, when exposure to a risk is not (or cannot be) minimised by any other means:

- Introduce administrative controls
- Use appropriate personal protective equipment.

Each of these strategies is described in more detail in the table:

Type of Control Measure	Control Strategy and Examples
Eliminate the hazard	This is the ideal solution; it is the most effective control strategy and should always be attempted before all others. Examples— • Replacing a person with a machine for repetitive manual activities. • Removal of asbestos from a workplace.
Prevent or minimise exposure to the risk	Substitution means replacing a hazard with one that presents a lower, more manageable, risk. Examples— • Replacing a flammable solvent with a water-based solvent • Replacing a toxic solvent with a detergent • Replacing glass with plastic. Redesign means changing the design of a workplace, equipment or work process. It means thinking about how the work could be done differently to make the workplace safer. Examples— • Lifting bags of cement using a forklift and pallets instead of handling them manually. • Fitting a frame to a tractor for rollover protection. • Modifying a vehicle's exhaust system to reduce noise. Isolation means separating a hazard from the person, or the person from the hazard. Examples— • Installing screens or barriers around moving machinery or welding. • Enclosing or guarding dangerous equipment. • Using remote handling techniques for hazardous substances. • Installing acoustic booths around noisy equipment.
When exposure to a risk is not or cannot be minimised by any other means	Administration and personal protective equipment (PPE) are lowest on the list of control priorities and should not be relied on as the primary method of controlling risk. They should only be used where there are no other practical control measures; as temporary measures until a more lasting solution is found; or to supplement other controls. Administrative controls involve minimising exposure to a risk through the use of procedures or instructions. Examples— • Job rotation to reduce exposure. • Limited entry to, or limited time in, hazardous areas. • Warning signs.

Type of Control Measure	Control Strategy and Examples
When exposure to a risk is not or cannot be minimised by any other means (cont'd)	People wear PPE as a final barrier between themselves and a hazard. PPE does not control the hazard at its source and relies on behavioural modification. It is often an expensive option, because of additional costs of maintenance, supervision, and the potential for a greater number of injuries. Examples— • Devices to protect hearing, such as ear muffs or plugs. • Respirators. • Protective eyewear, such as goggles • Safety helmets and wide-brim sun hats.

After completing a risk assessment, we can use the control measures shown in the table to select a measure, or range of measures, appropriate to the identified hazards.

Implementing Control Measures

Once appropriate control measures have been selected, we can put them into practice in the workplace. The activities needed to do this successfully include:

- developing work procedures
- communication
- providing training and instruction
- supervision
- maintenance.

Another important question to be addressed during the implementation phase is the balance between hazard reduction and cost.

Developing Work Procedures

Control measures will only achieve the desired effect (i.e. a safer workplace) if they are accompanied by work procedures that tell everyone how the task should be carried out.

A work procedure is a step-by-step, detailed description of how to complete a task. Work procedures are most effective if they clearly show the role of the various groups who are involved in implementing a risk-control measure. For example, if we are writing a work procedure for the use and maintenance of a machine guard placed around an electric pump:

- The manager's roles may be to ensure that the correct guard is purchased and that it is correctly installed on the right pump.
- The supervisor's roles may be to make sure that all employees use the pump only when the guard is in place.
- One employee's role may be to use the pump only when the guard is in place, as instructed; another's might be to maintain the pump and the guard.

Communication

It is useless to install a risk-control measure if you do not inform every person in the workplace who may be affected by it. You must tell people not only that a measure is now in place, but also the reasons for adopting the measure.

Providing Training and Instruction

Similarly, it is valuable to train as many people as is reasonable and possible in the use and maintenance of a risk-control measure. By doing so, we reduce the possibility that an incident involving an uninformed person will occur. Employees, supervisors and (possibly) managers may need training.

Supervision

Good supervision helps to ensure that the new control measures are in place and that people are using them as a matter of routine.

Maintenance

When any new risk-control procedure is adopted in the workplace, maintenance becomes important. Only if a measure is constantly maintained can it achieve the expected risk reduction.

Examples of maintenance would include:

- reminding people of the existence of a measure (if it is administrative, e.g. shift work)
- replacing worn materials (e.g. a broken machine guard)
- replacing dated PPE (e.g. safety helmets).

Maintenance requirements must be included in written work procedures.

Balanced Risk Control

When implementing risk control measures in the workplace, we need to check that it involves a balance between the amount of risk reduction and the cost of implementing it.

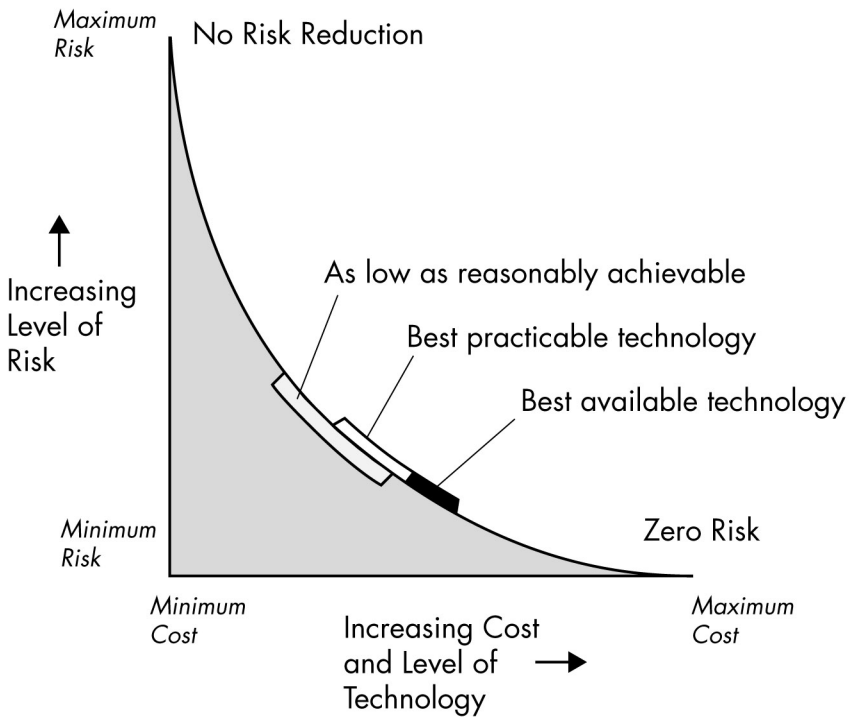
It is important to do this, because many methods or combinations of methods may be available to reduce probabilities and consequences. In general, we need to reduce a risk to a point where it is either:

- as low as is practically possible, or
- at an acceptable level.

For example, it would clearly be unreasonably expensive to erect scaffolding to do a job that could easily and almost as safely be done from a ladder or man cage.

Similarly, the level of any technology used should be sufficient to ensure the achievement of an acceptable level of risk. To go beyond this level is to waste or misuse resources. There comes a point where the cost of more technology exceeds the benefit gained by reducing the risk further.

As shown in the graph, there is a point where a balance can be achieved between risk and cost.



The aim of all risk management activities should be to achieve the lowest possible risk at reasonable cost.

Monitoring and Review

It is not enough to simply set up or install a safety measure and then leave it to chance.

The final step in the risk assessment and management process is to monitor and review the effectiveness of the adopted measures.

This involves asking relevant questions about the implementation stage, including:

- Have the chosen measures been implemented as planned?
  - Are the chosen risk-control measures in place?
  - Are people using these measures?
  - Are they using them as intended?
- Are the chosen measures working?
  - Have risk exposures been reduced adequately, or eliminated?
- Have any new problems arisen since implementation?
  - Have the chosen measures introduced any new problems?
  - Have the chosen measures worsened any existing problems?

The answers to these questions may come from a number of sources, including:

- consultation with employees, supervisors and workplace health and safety representatives
- measurement of exposures (e.g. noise levels)
- accident and incident reports.

Risk Assessment Models

The following simple and fictitious example, of changing a light bulb in the open and at height using a ladder, shows how a risk assessment process might be developed.

Sequence of Job Steps	Potential Hazards	Recommended Action
Obtain ladder and spare bulb and transport to work site	• Is the ladder in usable condition?	Clean and check ladder before commencing.
	• Is the ladder too heavy for one person to carry?	Obtain assistance if necessary.
Erect ladder	• Are any powerlines in the vicinity?	Do not proceed. Seek advice from the Electrical Department to obtain correct isolation.
	• Is the footing secure and even?	Ensure ladder footing is even and secure.
	• Is there a suitable place to lean the ladder?	If not, use another means to reach the height (eg, man-cage).
	• Is an assistant necessary to raise and 'foot' the ladder?	Obtain assistance if necessary.
	• Is it necessary to mark out a 'drop zone' and barricade the area to prevent entry by other people?	If so, obtain demarcation tape and mark out the area with appropriate signage.
	• Is any additional PPE required?	Obtain and use appropriate additional PPE
Ascend ladder	• There is a need to carry a spare bulb and tools but you must maintain 3-point ladder contact.	Use a tool-belt and/or shoulder bag as necessary.
	• Is fall protection equipment necessary?	If the height will exceed 2.4 metres, arrange for fall restraint equipment or use a man-cage.
Change light bulb	• Is there a risk of electric shock?	Ensure the light and fittings are correctly isolated.
	• Does a shroud need to be removed from the light fitting?	Consider securing the shroud to prevent it from falling once it is removed.
Descend ladder	• Need to carry dead bulb and tools but you must maintain 3-point ladder contact.	Use a tool-belt and/or shoulder bag as necessary.
Lower ladder	• Is an assistant necessary to lower the ladder?	Obtain assistance if necessary.

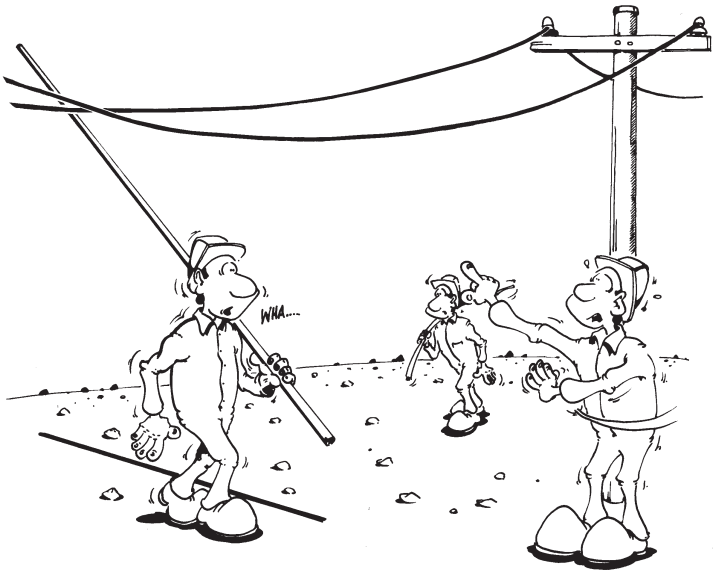
Sequence of Job Steps	Potential Hazards	Recommended Action
Store ladder	• Is an assistant necessary to transport the ladder back to the store?	Obtain assistance if necessary.
	• Is the ladder stored in a safe manner?	Follow housekeeping rules.
Dispose of old bulb	• Broken glass could be an environmental hazard	Dispose of waste in the correct manner in an approved bin.

This is a very simple example, but it does show the process of analysis that might be used to identify hazards and controls.

Common Workplace Hazards

The following pages cover hazards that are commonly encountered in construction workplaces, including:

- hand tools
- portable electric power tools
- manual lifting and handling
- using ladders
- working at height
- working in trenches
- confined spaces
- welding and cutting
- traffic management
- mobile equipment safety
- hydraulics and pneumatics
- power lines and underground power
- tagging and isolation.



The aim of the coverage given under each heading is to provide a brief introduction to the hazard, and to highlight the main control measures in each case.

Additional information about each of the hazards and the appropriate control measures may be obtained from:

- manufacturers' manuals, for tools and equipment
- site inductions
- company safe work procedures

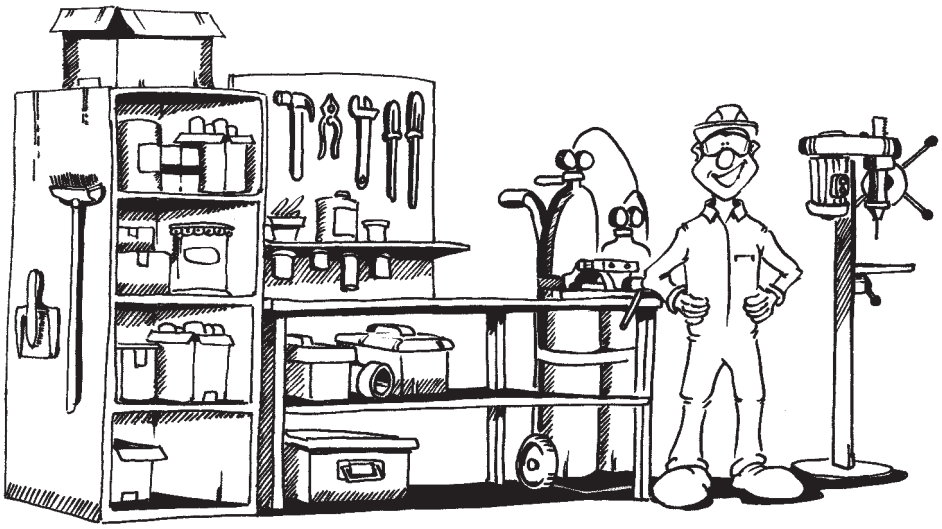
- relevant Australian Standards
- legislative instruments applicable to the civil construction industry in Queensland (see list in Section 1 of this topic).

Hand Tools

A wide variety of hand tools may be used in construction work, ranging from common workshop tools to larger cutting tools, such as sledge hammers, axes and brush hooks. The following discussion of hand tools includes unpowered devices only.

Always follow the basic rules for safe use of hand tools:

- Inspect all hand tools for damage before issue from the store, before use, and on return to store. Report any defects immediately. Tag out and return any unserviceable tools.
- Use hand tools only for their intended purpose. For example, do not use a pair of pliers to tighten a nut or bolt, or a screwdriver as a lever or chisel.
- Hand tools must be properly maintained. For example, keep chisels sharp and slide the protective cover over the blade after use. Do not use an axe or brush hook if the cutting edge is chipped— fix it first. Smooth out splintered sections of wooden handles before use, or replace the complete handle if the area available for grip has been compromised.
- Take care when sharpening edged tools. Always ensure that the tool is firmly secured in a vice. When sharpening, use the correct type of file (e.g. mill bastard for a brush hook) and keep the sharp edge pointed away from you. File the cutting edge carefully, at the correct angle.
- Take extra care when using edged tools. Do not use axes and brush hooks while on slippery ground, and make sure you have a firm footing before swinging.
- Return tools to their correct storage location, to protect them from deterioration, misuse and theft. Do not throw tools into toolboxes.

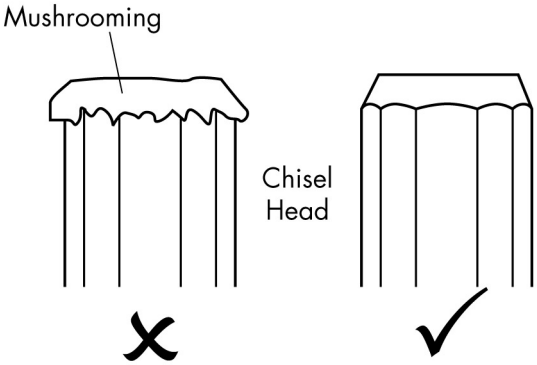


Hammering and Chiselling

If you strike hardened steel, eg. hitting a cold chisel with a hammer, small chips and sparks may fly from the work. If travelling at high velocity, small pieces of steel may penetrate the skin.

When hammering:

- do not work near flammable materials
- wear eye protection
- grind any mushroom edges on tools first
- remove all personnel from the area.



Portable Electric Power Tools

Note!
Training in the use of portable electric power tools is competency-based and should be only carried out by a registered training organisation.

Portable electric power tools such as drills, saws, angle grinders and impact wrenches are 'good servants but bad masters'. Training in the use of power tools should be carried out as part of competency based training. Always observe the following precautions related to their use and storage.

Safe Use of Power Tools

- Check the condition of the tool before use. Report any defects immediately. Tag out and return any unserviceable tools.
- Make sure that all guards and shields are in place and functional.
- Make sure you have a good footing and grip before starting the tool. Use two hands, and be ready to release the power switch or trigger immediately.
- Know the whereabouts of those who are nearby and warn them of your intentions. Never swing around with an operational power tool.
- Never point the moving parts of a power tool towards yourself or anyone else.
- Keep electrical power cords away from oil, hot surfaces, chemicals and water.
- Never leave a tool in an overhead or unstable position where a pull on the cord would cause it to fall.
- Be careful to select the correct grade and type of grinding wheel when sharpening a tool. Do not use a cracked wheel. Make sure it is not over-tightened on its spindle.

Correct Storage

- Store power tools, attachments and extension leads in a secure location, out of the weather.
- Do not hang electrical power cords or air hoses over nails, bolts or sharp edges.
- Ensure that flexible cables attached to power tools, and all extension leads, are properly tagged after they have been tested. The tag indicates the date of the last inspection— this must be performed regularly by a qualified electrician.

Manual Lifting and Handling

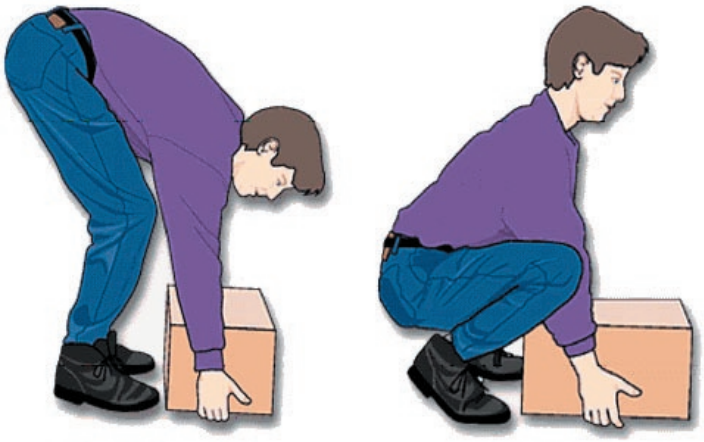
The back consists of vertebrae held in place by discs of cartilage. It is very easy to strain or damage the cartilages, especially those between the lower vertebrae. In all workplaces where manual lifting and handling is carried out on a regular basis, it is desirable that all staff be instructed in safe lifting and handling techniques. Research has shown that the risk of back injury increases significantly when objects being lifted are above the range from 16 to 20 kg when standing, or above 4.5 kg when seated.

Modifying the workplace and using mechanical lifting aids are the best ways to deal with manual handling problems. However, the fact that back injuries are so prevalent in Australian industry suggests that the individual worker is the person who can do most to protect his or her back from injury.

When manual handling of any heavy or bulky materials is necessary, avoid any actions that increase the possibility of back injury. These include:

- Bending over to lift, without bending the knees
- Lifting items that are too heavy or bulky.

The correct position to adopt when lifting ANY item from the floor is illustrated.



The Wrong Way **The Right way**

The essential points are:

- Try the load first. If the object is too big or too heavy to handle, get help.
- Bend the knees, not the back.
- Move in as close as possible to the object being lifted.
- Place feet firmly on the floor, with one slightly back from the other.
- Ensure a firm grip on the object to be lifted, using palms and fingers.
- Apply the lifting power with the legs, not the arms.
- Keep the back straight while lifting.
- Lift slowly and carefully.
- Keep the object close to the body while lifting.
- Do not twist the back or attempt to turn while lifting.

Setting down the load is just as important as picking it up. Use the leg muscles, not arms, to take the weight while lowering the load to the floor or ground. Bend the knees (to a semi-squat, comfortable position), and don't let go of the load until it is secure.

Slips, Trips and Falls

When carrying any load, always be aware of the possibility of slipping, tripping or falling. The danger is increased when carrying a bulky item that restricts the view.

Note!
If you do not have a clear view of the way ahead, get someone to help you.

Another important point to remember is to avoid lifting objects in positions where over-reaching or standing on unstable surfaces would be necessary.

Using Ladders

Inspection before use and correct positioning of the feet are essential safety steps when using ladders.

Inspection Before Use

Before you using a ladder, check:

- for broken or missing rungs
- for broken or split side rails
- for cracking
- the condition of the non-slip foot attachments.

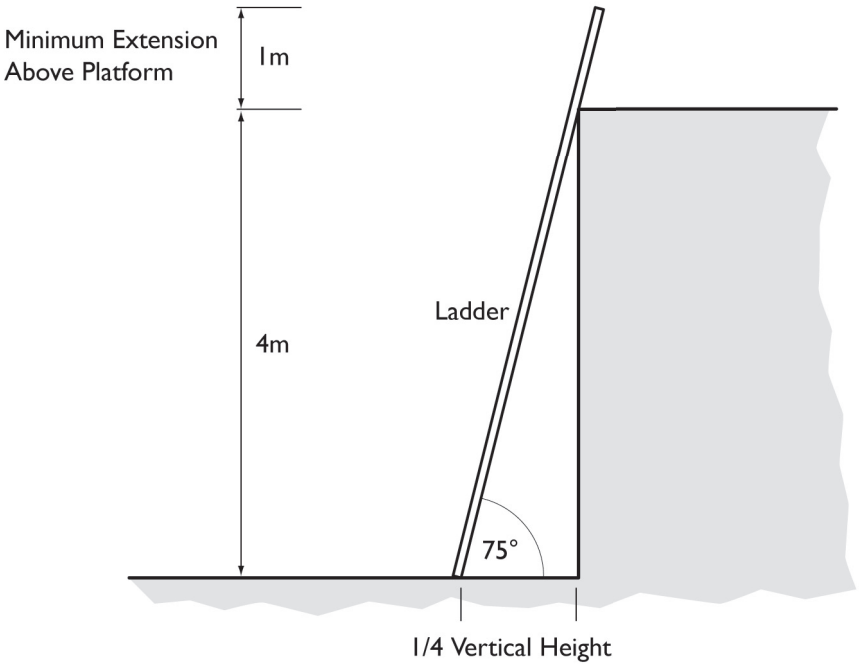
Remember!
Never use a defective ladder.

Correct Positioning of Ladder Feet

When placing a ladder against a wall or structure, make sure that the distance between the base of the ladder and the wall or structure is ¼ of the vertical height. For example, if the point where the upper end of the ladder rests is 4m above ground, the feet should be 1m from the wall.

As shown, this makes the slope of the ladder about 75°.

Always site a ladder on a level and uncluttered base.



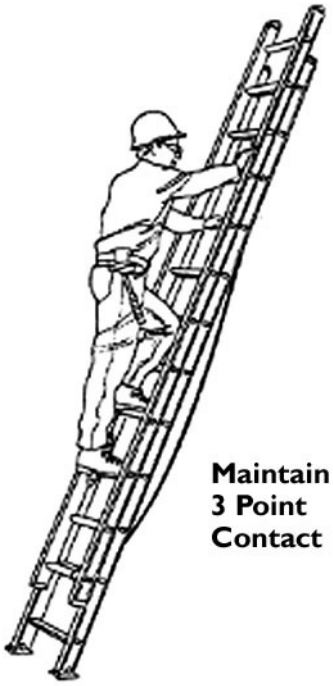
Safe Use of Ladders

Part 18, Division 5, of the Workplace Health and Safety Regulation 1997 gives specific legislative requirements for ladders. Ladders used in workplaces must be:

Rated at 120 kg safe working load (SWL)

Marked 'industrial'.

Note!
Before using any imported ladder in the workplace, check that it complies with the requirements of AS/NZS 1892: Portable Ladders.



The following general safety points apply when using ladders:

- Must be rated at 120kg minimum SWL.
- Never use a metal ladder where the work involves electricity.
- The ladder must be strong enough for its intended use and long enough to protrude at least 1 m above the stepping-off point.
- Always face the ladder when climbing up and down. Maintain three-point contact. Place your hands on the rungs, not the sides.
- Do not erect a ladder in a passageway unless you have closed off the access.
- Do not carry any article in the hands while ascending or descending a ladder.
- Make sure ladder rungs are free of all slippery substances.
- Extension ladders must be overlapped by at least three rungs.

For further information refer to Workplace Health and Safety Regulation 1997, part 18, division 5.

Step Ladders

- Ensure that the ladder is of the correct length for the job.
- Do not lean out past the confines of the ladder.
- Make sure the ladder spreaders are tight.
- Place the step ladder on a level, firm surface— ensure that the ladder will not wobble, slip or sink.
- Do not stand on the final two rungs— it is easy to overbalance and fall.
- Replace any defective ladder immediately. Do not attempt to use it, no matter how small the job.
- Beaware of ladders that do not comply with Australian standards.

Working at Height

The main considerations when personnel are working above ground are:

- providing fall protection, such as a harness attached to a life line, a fall-arrest device, or a railing of adequate height and strength
- providing protection against falling objects, such as tools or equipment, by barricading off areas below the works zone.

The dangers associated with work in and around trenches are covered under a separate heading in this section. However, it is important to remind people that working near a trench presents a similar set of hazards to those arising from work at heights.

Legislative Requirements— Working at Height

The conditions under which fall-protection devices must be used, and the requirements for their use, are defined in Part 18 of the Workplace Health and Safety Regulation 1997. The Dictionary to the Regulations gives relevant definitions of 'free fall' and "limited free fall".

Detailed requirements for providing protection against objects that could fall or otherwise hit members of the public are defined in Part 19 of the regulation.

Risk Assessment

The following table lists items that may need to be considered during the risk assessment for a task involving working at heights. How applicable each item is will depend on the nature of the task and its location.

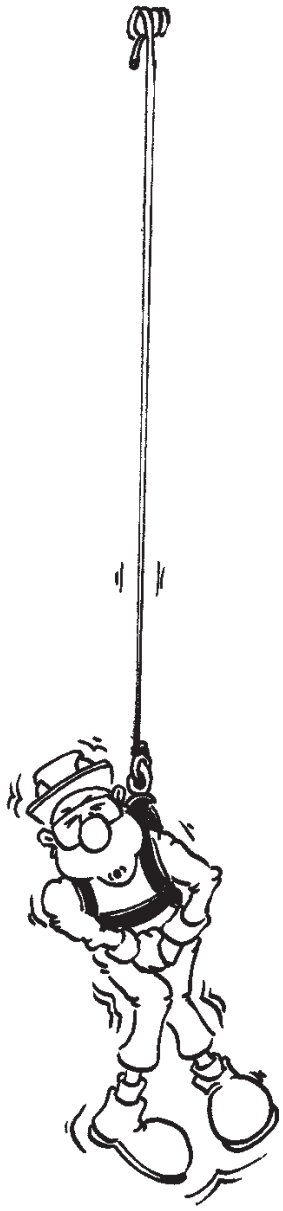
Item	Detail
Is the task to be considered as working at height?	• Is the work at a height of 2.4 metres or above, with no permanent or temporary barrier? • If the work is at a height of less than 2.4 metres, is there is a risk of falling onto a dangerous surface (e.g. concrete, exposed re-bar, rotating equipment)?
What is an acceptably safe method to reach this job?	• Consider the use of: - ladders - mechanical man-lift and cage (cherry-picker) - scaffold, etc
What fall arrest equipment is appropriate for the task?	• Consider the use of: - fall arrest equipment - static line - temporary barrier, etc

Item	Detail
Is there a potential drop zone?	• Assess the risk of tools or equipment falling onto the area below. • If there is any risk, erect appropriate drop zone barricades and signage.
Is the job going to take place in a traffic area?	• Assess the risk and erect suitable traffic diversions or barricades.

Fall Protection

If there is even a small chance of falling, it is better to wear a harness attached to a life line, or a fall-arrester device. When wearing a safety harness, ensure that:

- it is in good condition
- you have adjusted it for correct and comfortable fit
- the life line is not frayed or chafed
- the anchor point is capable of withstanding 15kN (1500kg) in a fall situation
- the life line is as short as possible without preventing you from performing the task unhindered
- an observer or assistant is present at all times
- fall points have been roped or barricaded before work commences
- you are constantly aware of the safety limits of the platform or structure from which you are working.



Part 18, Division 4, Section 188, of the Workplace Health and Safety Regulation 1997 gives specific legislative requirements for fall-arrest harness systems. Where one person is attached and there is a possibility of free fall, an anchor point must be capable of withstanding a force of 15 kN or 150 kg.

Substantial safety rails, securely bolted, should be erected in all cases where it is considered necessary to provide fall protection and workers will be exposed to the risk for lengthy periods. For further information refer to Workplace Health and Safety Regulation 1997, part 18.

Suspension Trauma

Background

When a person is walking, the movement of the limbs naturally tends to push the blood from the legs back through the veins to the heart; from there, it is pumped to the lungs and re-oxygenated. However, if a person must stand still for an extended period, gravity causes blood to pool in the legs. The accumulated blood has a lower oxygen content than blood in circulation, as it is not moving back through the veins to the heart and lungs.

If this condition continues, the amount of blood in circulation in the body decreases, and the heart rate speeds up in an attempt to maintain a supply of oxygenated blood to the brain. However, if the amount of blood removed from circulation is large, e.g. after an extended period of standing still, the heart rate will slow and blood pressure will drop. The reduction in the quantity of blood flowing to the brain causes fainting. The person then falls over (e.g. as commonly seen with soldiers on a parade-ground). This action restores blood to circulation, as legs, heart and brain are again on the same level. Provided the fall has caused no injury, the person will soon regain consciousness and in most cases recovers rapidly.

Applicability to Workers Using Fall-Arrest Systems

If a person working at height falls, and the fall is stopped by a safety harness, the person will be left suspended in a vertical position. The suspended person is then exposed to the risk that blood will accumulate in the legs. The following symptoms and signs may develop:

- faintness
- breathlessness
- sweating
- loss of pallor
- hot flushes
- increased heart rate
- nausea
- dizziness
- unusually low heart rate
- unusually high blood pressure
- 'greying' or loss of vision.

If a person is left suspended for an extended period, the risk of unconsciousness and death increases. Depending on the conditions (see below), death may occur in as little as 30 minutes. While not common, such fatalities are referred to as suspension trauma.

The degree of risk depends primarily on the length of time for which the person is suspended. However, there are other factors that may make the problem worse, including:

- head injuries or unconsciousness
- inability to move the legs
- pain
- injury sustained during the fall
- fatigue
- dehydration
- hypothermia (i.e. cold)
- shock
- cardiovascular or respiratory disease
- loss of blood.

Training Requirements

Workers who are using fall-arrest devices should be trained to:

- check that the devices are properly fitted and worn
- recognise the risk of suspension trauma
- understand the factors that may increase the risk
- recognise the signs and symptoms of a suspended worker who is at increasing risk
- carry out rescue procedures.

Rescue Procedures

If a person must be left suspended in a fall-protection harness, he or she should be:

- rescued within 10 to 12 minutes, before the safety harness begins to restrict blood flow.
- advised to pump the legs frequently to activate the muscles, if possible
- continuously monitored, especially for breathing and consciousness
- handled with care once released (e.g. sudden return to a horizontal position may cause a dramatic increase in load on the heart)
- taken for medical examination (the risk of kidney failure is enhanced if the person has been suspended for a long period).

Suspension trauma safety straps that can be fitted to any fall-protection harness are available from safety suppliers. Provided they have been fitted and are worn as recommended, they allow the suspended worker to stand up in the harness, reducing blood pooling in the legs.

Falling Objects

As mentioned in the table above, barricades should be erected around a potential drop zone before work at height commences. The important point is to assess the potential extent of the drop zone, taking into account the possible deflection of dropped objects by structures, pipe work or other equipment in the area.

A tape barrier around the drop zone with 'Caution' signs on each side, stating that work is in progress, will provide adequate warning to passers-by.

Workers must also take care not to drop tools or equipment while performing work. This is includes small items, such as nuts and bolts.

If work stops, secure the area and remove all tools and equipment, and remove the drop zone barriers.

There may be a need to reassess the extent of the drop zone if the work extends beyond its original dimensions. If necessary, change the limits of the barricaded area to suit.

When the job is complete, make sure that all tools and equipment have been removed from above, before removing the barricades and signs.

Note!
Check whether a 'Working at height' permit is required before the work commences.

Working in Trenches

Legislative Requirements

The principal contractor's obligations when work is carried out in an excavation or trench are defined in Part 17— Excavations of the Workplace Health and Safety Regulation 1997. This part of the regulation also gives definitions of an excavation and a trench as follows:

excavation means a hole in the earth, or a face of earth, formed after rock, sand, soil or other material is removed.

trench means an excavation where the maximum depth is more than the minimum width.

Before commencing excavation work, an employer is required to:

- identify hazards associated with a person:
  - being trapped by the collapse of the excavation
  - being struck by an object falling into the excavation
  - falling into the excavation
  - inhaling, or otherwise being exposed to, carbon monoxide or another impurity of the air in the excavation.
- assess the risk that may result because of the hazards
- implement control measures to prevent, or minimise the level of, exposure to the risk.

Trench Hazards

Any work performed in or around trenches can be very dangerous. In some situations, personnel have been seriously injured on falling into a trench, or have suffocated when the trench collapsed onto them.

The following hazards may be encountered while working in or around trenches:

- Objects falling or being accidentally dropped or kicked into the trench
- Personnel slipping or falling into the trench
- Failure to use ladders to access a trench, and jumping or climbing down into a trench
- Build up of toxic or flammable atmospheres (e.g. from machinery working nearby, or following a gas leak)
- Engulfment, resulting from a lack of shoring or poor shoring practices, piles of excavated material stored beside the trench, or machinery moving near the trench
- Personnel being crushed between heavy objects and the walls or floor of the trench.

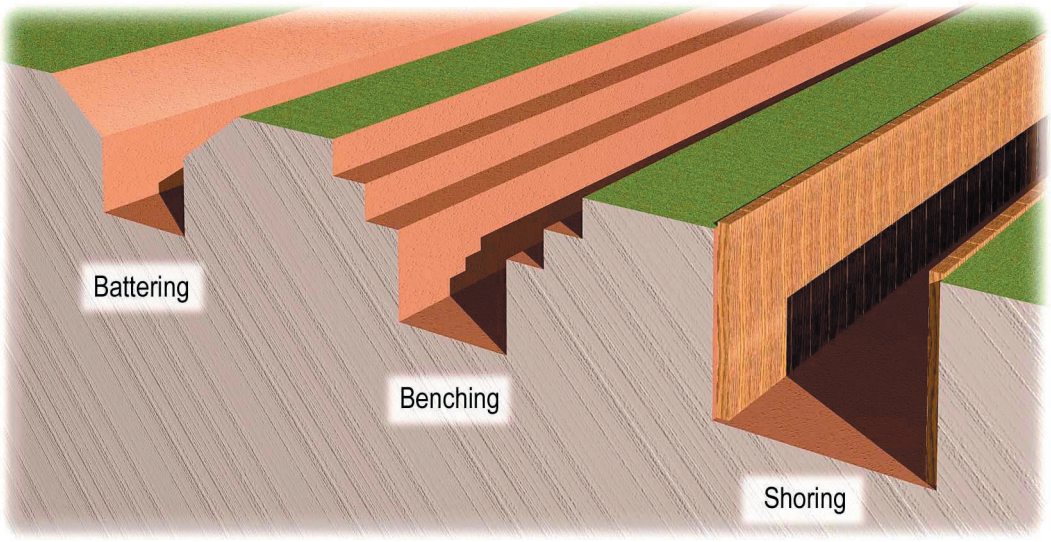
Identified Hazards

All identified hazards must be recorded on the project safety plan.

Implementing Control Measures

The following control measures may be needed to meet the requirements of the Regulation:

- Setting up barricades at least 900 mm high to restrict access to the trench by members of the public (these are mandatory if the trench is at least 1m deep)
- Where the trench is at least 1.5 m deep and a person must enter the trench to perform work—
  - benching, battering or shoring the walls of the trench
  - having a geotechnical engineer inspect and give written approval for the trench.



Battering, Benching and Shoring

- Where the trench sides are benched, each bench must be no higher than it is wide.
- Where the trench sides are battered, the angle of each batter must not be more than 45° from the horizontal.
- No side of a benched or battered trench may be higher than 1.5m, unless a geotechnical engineer has inspected it and given written approval.
- If access to and from the trench is by ladder, there must be at least one ladder giving access to and from the trench every 9m along its length.

Where proprietary shoring devices such as hydraulically operated soldier sets or shields are used, they must be installed as per manufacturer's instructions and in accordance with Section 17. Such installations may be carried out by specialist contractors.

Prevention of Trench Collapse

All persons working around a trench must be extremely cautious. Work activities or the movement of materials or equipment must not result in the collapse of the trench. At any time while any personnel are working in a trench, the following precautions must be implemented to prevent the trench from collapsing:

- Do not store any materials near the edges of the trench, especially spoil from an excavation, pipes or building materials.
- Do not allow heavy equipment to operate next to the trench. Maintain a safe distance.
- Do not excavate near buildings or structures unless the correct shoring is in place.
- Avoid vibrations from operating plant or equipment.

Trench Conditions

When working in or around a trench, workers must constantly take into account local conditions that threaten safety or reduce the stability of the trench walls. These may include, but are not limited to:

- Depth of the trench
- Soil type and expected soil pressures
- Ground water seepage, and saturated or submerged soils
- Location of utilities, services or structures that will need temporary support
- Previous trenches
- The type of excavator in use, and its impact on the surrounding environment
- Working space requirements
- Sizes of pipes to be installed in the trench
- Weight of specified bedding materials.

Confined Spaces

Australian Standard AS/NZS 2865–2001

All confined space entries must be conducted in accordance with the standards set out in Australian Standard AS/NZS 2865–2001: *Safe Working in a Confined Space*. For clarification on any matter related to procedure s for confined space entry, you should refer to AS/NZS 2865–2001.

AS/NZS 2865–2001 provides a clear definition of a confined space. You should also refer to any specialised definitions of 'confined space' adopted by your organisation.

Legislative Requirements

Requirements for risk assessment, entry to and use of confined spaces are defined in Part 15 of the Workplace Health and Safety Regulation 1997. The dictionary (Schedule 9 to the regulation) gives the legal definition of a confined space as follows:

A 'confined space' means an enclosed or partially enclosed space that:

(a) is at atmospheric pressure when anyone is in the space; and

(b) is not intended or designed primarily as a workplace; and

(c) could have restricted entry to, or exit from, the place; and

(d) is, or is likely to be entered by a person to work; and

(e) at any time, contains, or is likely to contain, any of the following—

(i) an atmosphere that has potentially harmful levels of a contaminant;

(ii) an atmosphere that does not have a safe oxygen level;

(iii) anything that could cause engulfment.

Examples of confined spaces include:

- storage tanks, tank cars, process vessels, pressure vessels, boilers, silos and other tank-like compartments;
- pits and degreasers;
- pipes, sewers, sewer pump stations including wet and dry wells, shafts and ducts; and
- shipboard spaces entered through small hatchways or access points, cargo tanks, cellular double bottom tanks, duct keels, ballast or oil tanks and void spaces.

Dangers of Unsafe Entry

Entry into confined spaces is a potentially hazardous procedure, especially if proper procedures are not followed.

Records of industrial incidents, both in Australia and overseas, indicate that of all deaths attributed to confined space entry, 60% are would-be rescuers. In most cases, these are people who enter a confined on the spur of the moment, with the intention of performing a rescue. Rarely do they stop to think that the person whom they are attempting to rescue may not have entered the confined space in accordance with standard procedures.

Danger!

Never enter the confined space if a person in that space has collapsed. Initiate the emergency response procedures and act in accordance with those procedures.

Need for Correct Procedures

Case Study No. 5 describes two instances where people used incorrect procedures for entry to confined spaces. In both cases, the consequences were fatal. There is no room for error. Unprotected entry into an oxygen-deficient space or one that contains toxic gases will quickly lead to loss of consciousness and death.

Confined Space Fixed Signage

In order to reduce any doubt about which areas are actually classed as confined spaces, signage is installed at the entry or entries to all identified accessible confined spaces. The photograph shows a typical example of such a sign. Any entrance provided with such a sign is an entrance to a confined space. Access to any such space must be controlled through the correct confined space entry procedures. The appropriate permit to work may be raised and issued only by a person authorised to issue confined space entry permits.

Typical Confined Space Sign

Confined Space Atmospheres

For any confined space entry, it is important to ensure that the atmosphere is safe for entry and remains so while personnel are within the confined space.

To ensure the conditions are safe, the confined space must be tested for oxygen, flammable contaminants and other contaminants as per the hazards identified in the risk assessment. Before unprotected entry may take place, it must first be proved that toxic gases or asphyxiants are absent and that oxygen is present at the correct levels.

Gases

The following material describes some of the gases that may be encountered in confined spaces and the affects they can have on human beings.

Oxygen (O_2)

Oxygen at normal levels in the atmosphere is critical to sustain life. Oxygen is present in normal air at sea level at approximately 20.9%. Oxygen levels of 16% or below in an atmosphere are life-threatening. At levels above 21%, the atmosphere is becoming oxygen-enriched and, among other hazards, there will be a greater risk of combustion of many materials.

Any person entering a confined space with less than a minimum of 20% oxygen, or an oxygen level above 20.9%, is in an unsafe situation.

Hydrogen Sulphide (H_2S)

H_2S is a colourless gas which is a compound of hydrogen and sulphur. It has an unpleasant odour resembling rotten eggs. At low concentrations it will cause eye and respiratory organ irritation. At higher concentrations, it will cause unconsciousness and death.

An important point about H_2S is that it quickly 'fatigues' the sense of smell. In other words, after initially identifying the presence of H_2S by its odour, you will quickly lose the ability to smell it as concentrations build up.

Carbon Monoxide (CO)

CO is a colourless, odourless and tasteless gas which is a compound of carbon and oxygen. When absorbed into the bloodstream, it poisons the human body by preventing the blood from taking up and transporting oxygen. At low concentrations it will cause headaches and nausea. At higher concentrations, it will cause unconsciousness leading to death.

Ammonia (NH_3)

Ammonia is a colourless gas which has a distinct, strong odour. Ammonia is commonly experienced around stables and farmyards where urine is present and has decomposed, and may be present in high concentrations in sewers. The odour is noticeable before the gas reaches toxic levels. Exposure to elevated levels of ammonia causes eye and mucus-membrane irritation. As with many other gases, ammonia displaces oxygen in confined spaces and can act as a suffocant.

Nitrogen Oxides (NOx)

The generic group of NOx gases includes:

- nitric oxide (NO)
- nitrogen dioxide (NO_2)
- nitrogen peroxide (N_2O_4).

NOx gases are extremely poisonous and in the early stages of contamination can cause violent coughing and a feeling of illness. They are sometimes visible as a reddish-brown haze. At lower levels, they will cause respiratory passage irritation; at higher levels, they can cause bronchopneumonia and life-threatening respiratory illness.

Exposure Standards

National standards for exposure to these gases are set out in Adopted National Exposure Standards for Contaminants in the Occupational Environment [NOHSC: 1003 (1995)], published by the National Occupational Health and Safety Commission, as amended.

Gas	TWA	STEL
Hydrogen Sulphide (H_2S)	10 ppm	15 ppm
Carbon Monoxide (CO)	30 ppm	Special conditions
Ammonia (NH_3)	25 ppm	35 ppm
Nitric oxide (NO)	25 ppm	Not specified
Nitrogen dioxide (NO_2)	3 ppm	5 ppm

An exposure standard set by the NOHSC means an airborne concentration of a substance in the worker's breathing zone, exposure to which, according to current knowledge, should not cause adverse health effects nor cause undue discomfort to nearly all workers. The exposure standard may be of three types:

- time-weighted average
- peak limitation
- short-term exposure limit.

The terms are defined as follows:

- TWA or 'Exposure Standard— Time Weighted Average' means the average airborne concentration of a particular substance when calculated over a normal eight-hour working day, for a five-day working week.
- 'Exposure Standard— Peak' means a maximum or peak airborne concentration of a particular substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.
- STEL or 'Exposure Standard— Short Term Exposure Limit' means a 15-minute TWA exposure which should not be exceeded at any time during a working day, even if the eight-hour TWA average is within the TWA exposure standard.

Exposures at STEL should not be longer than 15 minutes, and should not be repeated more than four times a day. There should be at least a 60-minute gap between successive exposures at the STEL.

An additional term that is used to describe gases is LEL. The definition of LEL is as follows:

- LEL = Lower Explosive Limit is the minimum concentration at which a gas will explode. Referring to a percentage of the LEL is a common method of quantifying the amount of a certain gas in an atmosphere.

Warning!
Prior to a confined space entry, the concentration of flammable gases within the space must be less than 0% of the Lower Explosive Limit (LEL).

It is therefore vitally important to:

- carefully check the atmosphere before any entry is made into a confined space
- monitor the atmosphere within a confined space as the work progresses.

Gas Test Equipment

A specialised gas tester or monitor is needed for each type of gas that may be present in a workplace.

The items of basic gas testing equipment illustrated below may be used for particular situations:

- LEL and oxygen level detector
- Personal NOx tester
- Personal ammonia monitor.

LEL & Oxygen Level Detector

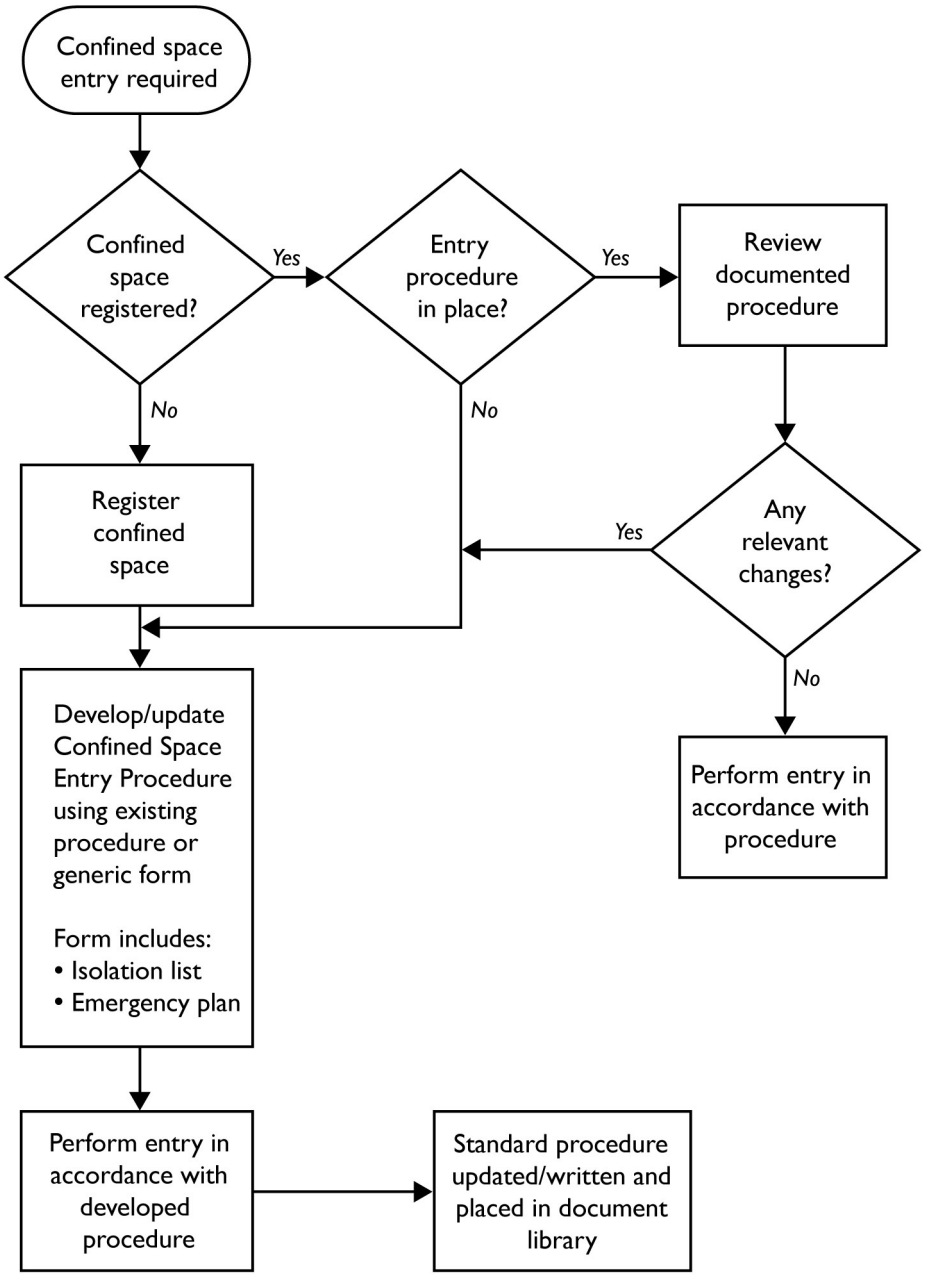
Typical Personal NOx Gas Detector

Typical Personal Ammonia Detector

All gas testers and monitors must be calibrated every six months to ensure that they are operating correctly. The current calibration status of most testers will be indicated on a label attached to the tester. Do not use a tester or gas monitor if the calibration label is out of date. Only use equipment if it is in current calibration and arrange for the out-of-calibration item to be recalibrated. Generally, all gas-testing equipment needs to be re-calibrated every six months.

General Confined Space Entry Procedure

The following chart shows the applicable work-flow when a confined space entry is required.



Before a person may enter a confined space, certain safety precautions must be taken. The extent of those precautions will depend on an assessment of the risks within the confined space.

The following precautions must be taken and documentation must be raised prior to a confined space entry:

- All possible gas and/or liquid entries into a confined space must be positively isolated by slip plating, blanking or pipe spool removal. If these forms of positive isolation are not possible, double-block and bleed valving arrangements may be used as a last resort.
- Gas tests for oxygen and hazardous gases must be conducted.
- Moving parts (stirrers, fans, etc) must be positively isolated.
- Adequate ventilation must be ensured either by natural or mechanical means.
- A trained standby person must be stationed at confined space entry points at all times and all persons entering/exiting must sign the confined space entry/exit log. This must be maintained by the standby person and attached to the special permit.
- A confined space access permit must be raised.
- The confined space entry procedure must be reviewed.
- A confined space entry sheet must be raised.
- Check weather forecasts for the possibility of rain or storms.
- Check for local storm water run off.

Another important consideration is the possibility that the confined space may be flooded by rainwater runoff. It is therefore important to check the weather forecast before confined space entry, to check the possibility of rain or storms. While rainwater may not enter the confined space directly, there is the possibility that rainfall some distance away may produce run-off that fills the confined space.

Interim Do Not Enter Signage

When a confined space access man-way door or hatch has been opened, a Do Not Enter—Confined Space sign must be placed in front of the open door or hatch. This must be done to prevent personnel from entering the confined space before purging, ventilating and gas testing have been completed.

Once the confined space has been tested and is ready for entry, the sign may be removed, to indicate that it is safe for personnel to enter in accordance with the conditions noted on the relevant permit to work.

If there is more than one open access door/hatch, a do not enter sign must be placed in front of each entry-way.

Do Not Enter — Confined Space Sign

Confined Space Standby Person

The nominated stand-by person must have completed suitable confined-space entry training.

As a minimum, the confined-space standby person must:

- Remain in a position adjacent to the point of entry.
- Maintain a continuous readiness to communicate with personnel in the confined space.
- Hold lifelines (or signal lines) attached to each person as required.
- Warn persons inside the confined space of any hazards outside the confined space.
- Be in possession of a hand-held, two-way radio and know how to communicate with the control room.
- Use the confined-space entry sheet and maintain an up-to-date record of the time each person enters and leaves the confined space.
- Ensure each person entering the confined space is listed on the confined space entry special permit. Any person not listed is not permitted to enter.
- Be qualified to render senior first aid.
- Be familiar with rescue procedures and assist with any rescue.
- Hold a current first-aid certificate and have recently undergone CPR training.

Step-by-Step Confined Space Entry Process

The following steps (1–13) describe a basic process that may be followed prior to entry into a confined space. Because the steps are generalised, some of them may not be applicable to particular situations or organisations, or additional steps and procedures may apply.

1. Review the confined space entry procedure, with consideration of the particular task to be performed.
2. Prepare the confined space for entry (e.g. by de-pressuring, draining, purging or flushing).
3. Where required, isolate the plant to enable installation of the confined space entry isolations (slip plates, spool removal, opening man-ways, etc.). Tags on the isolations must make reference to the permit to work number.
4. Prepare and issue a permit to work.
5. Prepare a confined-space entry access permit and tag the isolations with isolation tags referencing the confined space entry access permit number.
6. Test the confined space to ensure the adequacy of oxygen levels and to check for presence of hazardous gases.

Confined Space Safety Signage

7. Once the confined space is deemed safe to enter, the authorised person authorises access into the confined space by signing the confined space entry access permit. The appropriate signs are then placed at the entry points.
8. At this stage, the confined space may be entered by persons after they have signed the confined space entry/exit log. The entry log must be controlled by the standby person.

Confined Space Permit Pouch

9. Permit to work (PTW) clearance certificates, allowing persons to perform work inside the confined space, may be now issued against the confined space entry access permit. The permit to work clearance number/s must be noted on the confined-space entry access permit.
10. Once the work inside the confined space is complete, the permits to work are signed off as complete.
11. Once satisfied that the work is complete and the confined space is vacated and there is no equipment or materials remaining in the confined space, an authorised person may close the confined space entry access permit and sign it off.
12. The confined space entry isolations (slip plates, spools, etc.) are then be reinstated under the PTW clearance which was used to facilitate installation of the confined space entry isolations.
13. The equipment can then be de-isolated and re-commissioned as required.

Note!
No oxygen, acetylene, or LPG gas cylinders or bottles may be taken into a confined space.

Welding and Cutting

Welding and gas cutting are specialised operations requiring special skills. Do not attempt either operation unless you have been appropriately trained, and have been authorised to weld or cut at the particular works site.

PPE for Welding and Cutting Operations

For gas cutting, the minimum safety clothing consists of:

- long-sleeved, cotton shirt with collar, and
- long cotton trousers, or
- overalls instead of the shirt and trousers.

In addition to this clothing, the following PPE must be worn during all electric welding work:

- long leather gloves
- welding goggles or mask
- high-sided leather boots
- leather apron (if required).

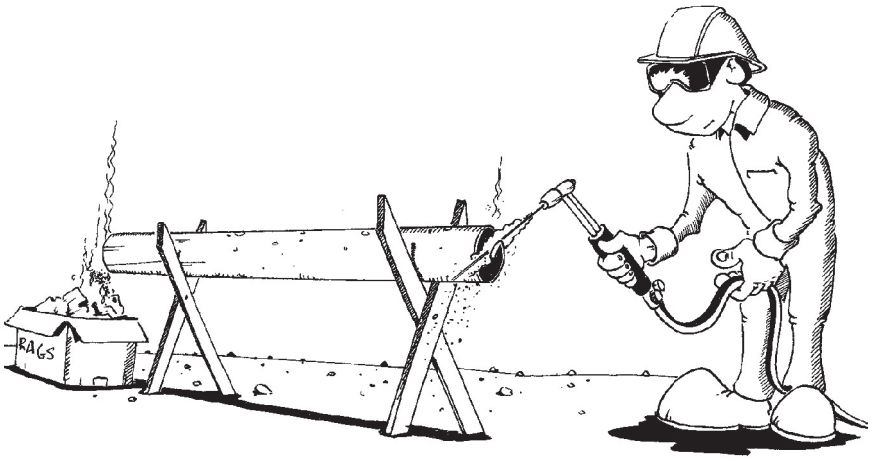
Only the welder and assistant are allowed within the area where welding is performed. The welding area is delineated by screens (to protect passers-by from heat, sparks and welding flash) and safety signs.

Note!
A person assisting with gas-cutting or welding must wear the same PPE as the person doing the job.

General Safety Considerations

The following safety warnings apply to both gas cutting and electric welding:

- Make sure all flammable materials have been removed from the area before commencing welding or gas-cutting operations.



- Keep fire-fighting equipment on hand throughout the operation.
- Inspect all equipment thoroughly before use.
- Make sure that all fittings, couplings and connections are tight.
- Avoid breathing the fumes from welding or cutting work. Use an exhaust system, blower, or respirator where possible, or position the job so that natural ventilation will remove the fumes.
- Never cut into, or weld on to, tanks, drums or other containers without obtaining a 'hot work' permit; always abide by its conditions.
- Be aware of the locations of nearby persons at all times.

Fumes from Welding and Cutting

The fumes and gases from welding and cutting may contain hazardous substances. The welding or cutting arc may create oxides of nitrogen, carbon monoxide and other gaseous contaminants. In addition, the intense arc from some types of welding may produce ozone.

The type of contaminant produced by the operation depends on the:

- type of consumable used (electrodes or filler metals, heating or shielding gases and fluxes) — check the MSDS for details.
- material being welded, and the presence of any chemical coating on the metal (e.g. galvanising, lead-based paint).
- operating conditions (e.g. temperature and electric current).
- obtain MSDSs for welding rod or wire.

Safety Considerations for Electric Arc Welding

Note!
Welding is the subject of an advisory standard issued under the Queensland Workplace Health and Safety Act 1995.

All personnel involved in electric welding must observe the following safety provisions, which have been divided into don'ts and do's:

Welding Don'ts

- Never chip a weld without eye protection. Hot pieces of slag may fly off when a weld is chipped while cooling. These pieces can travel long distances, as can welding sparks.
- Do not overload main fuses or welding circuits.
- Never conduct electric welding from a metal ladder.
- Do not look at the welding arc without the correct eye protection lenses. Rays from welding can cause painful burns ('sand in the eyes'), with possible long-term damage to eye tissue.

Welding Do's

- Clamp the earth electrodes as close as practicable to the job. (Do not connect them to metal close to the welder).
- Check that welding leads and the handpiece are well-maintained, and that electric equipment associated with the welder has current safety approval.
- Put the stub ends of welding rods into a proper container— do not leave them on the floor.
- Always set up welding screens to isolate the work area when welding is carried out near other personnel.

Safety Considerations for Gas Cutting

Following are the don'ts and do's for gas cutting:

Gas Cutting Don'ts

- Never allow oil or grease anywhere near cylinders or equipment carrying oxygen. Oil and grease are perfectly safe in air, but will burst into flame or explode if they come into contact with pressurised oxygen. Therefore, lubricants should never be used on regulators or hose connections.
- Do not exceed 100 kPa on the torch side of the gauge when using acetylene.

Gas Cutting Do's

- Always keep acetylene and oxygen cylinders upright— both in use and in storage.
- Before connecting the regulators to the cylinders, carefully crack open the cylinder valve to blow out any particles of foreign matter. Once the regulator is connected, stand to one side of the cylinder and open the cylinder valve.
- Make sure that the oxy-acetylene sets have been fitted with flashback arrestors before using. They must be tested in accordance with AS 4603–1999: Flashback arrestors — safety devices for use with fuel gases and oxygen or compressed air.
- Ignite the gas torch with flints only— never use an open flame.
- Open the valves on the fuel gas cylinders one-quarter of a turn only. This will allow rapid shut-down the flame in an emergency.
- Use the correct tip for the type of gas being used— type 41 for oxy-acetylene and type 44 for LPG.
- Keep cylinders and hoses well away from sparks and hot slag.
- Close all cylinder valves to prevent leakage when gas is not required.
- Roll up all hoses when the job is finished and return excess materials to the storage point.
- Remove the regulators when transporting gas cylinders.
- Keep the floor of the welding/gas cutting area clean.
- Double-check that gas bottles have been turned off after use.

Traffic Management During Construction

Managing traffic during the construction period is important from both the safety and the public relations viewpoints. The traffic management plan is the key document.

Traffic Management Plan

Requirements for traffic management during the construction period are set out in the terms and conditions of the contract. The contractor prepares the traffic management plan so that all staff involved in construction are aware of their duties and responsibilities. The plan must be submitted to the local traffic authority.

Typical headings of a traffic management plan are as follows:

- objectives
- project information
- duties and responsibilities
- project-specific requirements
- emergency contacts
- annexures.

Objectives

Under this heading, the contractor states the reasons for compiling the traffic management plan. For example, a statement of objective might read:

> "To plan and monitor the safe and orderly passage of vehicular and pedestrian traffic through and around the site at all times, and to comply with all aspects of the contract documents".

Project Information

This section contains general information, such as:

- location of the project
- brief description of the works
- speed limits applicable during construction
- reduced speed limits applicable to specified sections
- special requirements (e.g. bridge construction).

Duties and Responsibilities

The responsibilities of key personnel in charge of traffic management may include:

- preparation of programs and plans
- giving notice of proposed traffic changes

- approval and removal of temporary regulatory signs
- audit of signs
- monitoring and recording of traffic movements
- inspections of road conditions
- ensuring compliance with contract requirements.

The duties and responsibilities (in regard to traffic management) of the project manager and the site supervisor are usually set out in the plan.

All traffic signage must be checked daily, as per Appendix A of the Manual of Uniform Traffic Control Devices.

Project-Specific Requirements

There may be traffic-management requirements specific to the project. If so, they are listed in the plan and may include:

- limitations on excavation (e.g. single lane only, or depth of excavation near carriageway)
- detouring
- use of traffic controllers
- lane widths
- maximum delay periods (e.g. for automatic traffic signals or for temporary closures on busy roads)
- All signage must be checked daily as per Manual of Uniform Traffic Control Devices, Appendix A - 2003.

Emergency Contacts

The names and contact numbers of key company personnel are given in the plan.

Annexures

Annexures to the plan may cover such subjects as procedures for temporary closures during working hours, and principal's specifications for traffic lane configurations.

Emergency Access

Throughout the construction period, there must be sufficient road width available for access to any part of the site by emergency vehicles including police cars, ambulance vans and fire trucks. In urban areas, it may be advisable to provide a dedicated parking space or spaces, for example near the site office.

This access may be necessary in the event of either:

- an accident involving the travelling public
- an accident involving a road worker.

Ensuring the Safety of the Travelling Public During Construction

There is obvious potential for accident, injury and damage to property when motorists and construction machinery are sharing the same stretch of road at the same time.

For this reason, all traffic control devices and their placement on the road during the construction period are governed by standard specifications. The Manual of Uniform Traffic Control Devices is the national standard, though it may include state-based modifications. The manual contains specifications for the design of, and the methods, standards and procedures applicable to, every sign, signal, marking, light or other device installed on a road.

The manual is updated at intervals to reflect new situations, products and legislative provisions.

Part 3 of the manual, available separately, specifies the traffic control devices used to warn, instruct and guide road users in the safe negotiation of work sites on roads. This includes the distance separating the warning device from the points where actual construction work begins and ends.

Specific Safety Devices

Traffic controllers, automatic stop/go signals and mobile floodlights may be used as part of the site traffic management, particularly on roads where high traffic volumes are expected.

Traffic controllers employed on the job must be able to prove that they have completed recognised training in traffic management and be able to produce certification upon request. They must be able to produce certification on request.

Mobile equipment involving electricity supply and electronics, such as automatic stop/go signals and mobile floodlights, have a high replacement cost and are easily damaged. Because of this, they must constantly be checked for:

- correct operation
- security and damage.

Ensuring the Safety of the Road Construction Worker During Construction

While road construction creates the potential for injury to the travelling public and damage to vehicles, there is also the possibility of injury to construction workers as a result of dangerous driving and angry motorists. Prevention or reduction of the scale of this problem is achieved partly by specification, and partly by adopting good public relations practice.

Part 3 of the Manual of Uniform Traffic Control Devices includes guidelines for maintenance of a safe workplace for workers on site.

Barriers and/or signs are to be erected and safety cones and stop/go bats are to be used as set out in the Provision for Traffic specification in the contract.

Road user aggression or 'road rage' is a term used to describe aggressive behaviour by motorists. It has been used to describe a wide range of behaviours, including:

- sounding the horn
- using a vehicle to block another's path
- more violent acts, such as physical assault.

If there are any incidents of road user aggression on the job, report them immediately to your supervisor. This is essential in some circumstances, e.g. where you can identify that the same person has repeatedly been aggressive, or the incident involves threats.

Community Liaison Plan

Issues related to the safety of both the traveling public and road workers are included in the Community Liaison Plan for the project.

Typical headings and content included in a community liaison plan are discussed in Topic 7 in this series.

The plan addresses the need to provide information about the works to all affected parties, before work commences. The main objective of providing doing this is to ensure safe passage for emergency vehicles and the public through the works.

Mobile Equipment Safety

Legislative Requirements— Plant

Section 65W of the Workplace Health and Safety Regulation 1997 requires a principal contractor to ensure safe housekeeping practices are implemented in the workplace. Section 65V includes ensuring enough area in which to safely store materials or plant as a safe housekeeping practice.

Section 65Z defines 'common plant' at a construction workplace as plant provided by the principal contractor for use by an employer, self-employed person or worker at the workplace. Section 65ZA defines the principal contractor's obligations to ensure that common plant is safe for the purpose for which it is provided, and to keep the common plant effectively maintained. In addition to the regulation, the Advisory Standard for Plant 2000 gives practical advice on ways to manage exposure to risks related to the use of plant, including its safe design, manufacture and installation. It outlines the obligations of persons involved with plant and provides information on risks and their control.

Hazards

Hazards associated with mobile plant and machinery include, but are not limited to:

- Operator blind spots. These are locations where a person or other mobile plant may be hidden from the operator's view. The operator must be aware of the machine's blind spots and exercise extreme caution at all times.
- Overhead passes. The plant operator must make sure that the arc of swing of a machine's body or attachments never passes over the top of other plant or pedestrians.
- Suspended loads. For example, workers walking underneath a load suspended from a crane.
- Machinery operating outside safe working load specifications. This may result in equipment failure and loads falling; for example, if a crane lifts a load that is heavier than the safe working limit.
- Unsuitable ground support. If the ground on which a machine is operating is unable to support the weight, it may become unstable or fall over.
- Flying debris. Materials dislodged as a result of mobile plant or machinery operation may strike other personnel; for example, concrete loosened by a jackhammer.
- Excessive noise. For example, the release of air from a compressor.
- Missing or loose safety guards. Guards should always be fitted to rotating or moving equipment, to prevent limbs or clothing from being caught. They may be fitted or removed by authorized persons only, and must be inspected at regular intervals to ensure that they are serviceable and afford adequate protection.

Hazard Control

General suggestions for safety with mobile equipment can be found in Appendix 5, Safety Tips for Mobile Plant Operations, of the Guide to Safety in the Civil Construction Industry. The guide can be downloaded from

http://www.whs.qld.gov.au/subject/construction.htm

and is located under Guides/Safety in the Civil Construction Industry.

Construction workers near mobile plant or heavy machinery have no direct control over the actions of the machinery operator, and equipment failures cannot be predicted. The correct methods of controlling the hazards involved are:

- maintaining vigilance while working around plant and machinery
- constant awareness of the movements of the equipment
- maintaining a safe distance
- wearing high-visibility clothing.

Wear High Visibility Clothing

In addition, workers must be aware of the actions of pedestrians moving around the work site.

Plant operators are to:

- Walk around their machines to ensure that the working area is clear of men and obstructions before moving off.
- Take special care when reversing, especially in confined locations.
- Use a spotter or traffic controller.
- Ground all buckets, cutting edges, etc and secure the machine before leaving it for job breaks, or at the end of the day's work.

Other Plant and Equipment Considerations

Wet Weather

After rain, wet and slippery conditions reduce tyre traction for all vehicles. The following safety precautions apply:

- avoid sudden or harsh steering movements
- avoid sudden or severe braking
- avoid rapid acceleration
- use the transmission to control speed on down slopes
- engage 4WD on light vehicles

- increase the following distance between vehicles
- use headlights where visibility is reduced
- reduce speed
- ensure the vehicle's washer/wipers are in good conditions
- hose the windscreen to remove mud build-up.

Refuelling

When refuelling vehicles and heavy plant, ensure that:

- the engine and mobile phones have been turned off
- fuel spills are cleaned up immediately
- fuel nozzles are replaced properly in holders
- there is no smoking or naked flame within 6 m of fuelling operations or fuel storage areas.

Towing

Trailers must be equipped with safety chains crossed under the draw bar, so that they will support and cradle it in the event that the towing hitch becomes disconnected.

Important don'ts and do's when towing other vehicles or mobile equipment include:

- Do not use chains for towing.
- Do not tow equipment heavier than the tow vehicle.
- Use approved slings or rigid towbars.
- Remember that the equipment being towed may not have normal braking or steering capabilities.

Authority to Operate

No-one, other than the operator or authorised persons (e.g. a driver instructor) is to ride on plant.

No employee will be permitted to operate designated plant or machinery or explosive-powered tools or function as a dogman, hoist driver, rigger or scaffolder, unless he or she is the holder of a current Certificate of Competence. A trainee operator must work under the direct supervision of an authorised, competent person.

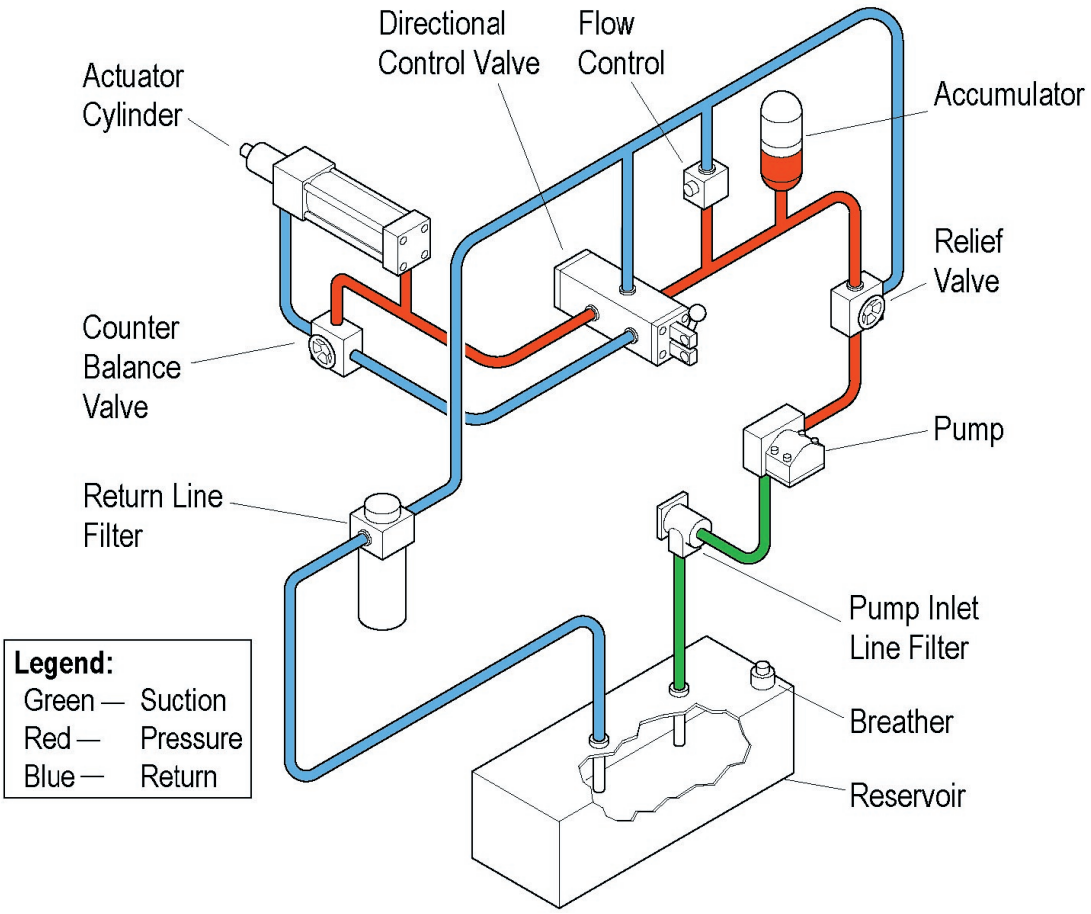
Hydraulics and Pneumatics

A pressure system can use either hydraulic (oil/fluid) or pneumatic (air) pressure to operate equipment items. The following sections outline the important safety considerations of which personnel must be aware when overseeing the operation or maintenance of these pressure systems.

Hydraulic Systems

Hydraulic systems are designed to generate immense power and mechanical forces. Personal injury and even death can result unless care is taken during their operation and maintenance. As a supervisor, you must be aware of the basic operating principles of a hydraulic system and its associated hazards. More importantly, you must use this knowledge to ensure that hydraulic systems are safely operated and maintained at all times in order to prevent personal injury, equipment damage and lost production time.

The following diagram and table identifies the main components of a typical hydraulic system and the hazards that are associated with each component.



Basic Hydraulic Circuit

Component	Function	Potential Hazards
Reservoir	• Allows for the changing oil volume created as the oil heats/cools, as an actuator extends or retracts, or when oil is added to the system. • Allows the oil to cool. • Allows contaminants and air to settle out of the oil.	Reservoir oil is often pressurized — even when the system is shut down. Oil temperatures can reach in excess of 50°C during operation.
Pump	The pump draws oil from the reservoir through an inlet line filter and supplies it under pressure to directional control valves.	Be aware of rotating shafts and unguarded couplings during system operation.
Relief Valve	The relief valve acts as a pressure limiting device or safety valve to prevent excessive pressure build-up in the system.	Incorrect adjustment of this valve can result in excessive system pressure. Do not adjust or tamper with this valve unless you are qualified to do so.
Directional Control Valves	A directional control valve changes the oil's direction of flow to enable an actuator to change the direction of its movement.	Ensure that all lever control mechanisms are operating correctly and that connecting linkages are not excessively worn. Excessive play in the linkages can result in incorrect actuator control.
Accumulator	An accumulator is used to store oil under pressure. Generally, the stored oil is only used in the event of an equipment failure when hydraulically actuated components must be moved to a safe or parked position. **Danger!** **An accumulator can still operate a hydraulic system even when the system is shutdown and isolated. Do not disconnect any component in a hydraulic system fitted with an accumulator unless the system has been depressurized, or the accumulator has been isolated from the circuit.**	Oil stored under high pressures can discharge at an uncontrolled rate. Ensure that hydraulic systems fitted with accumulators are fully depressurized before any maintenance work is conducted. Accumulators are charged with pressurized nitrogen. Discharging nitrogen gas in an enclosed space can result in an oxygen deficient atmosphere. Ensure that the accumulator is discharged in an appropriately ventilated area.
Flow Control Valve	A flow control valve controls the flow of oil to an actuator. Oil is diverted away from the flow going to the actuator, to provide the desired actuator speed.	The incorrect adjustment of this valve can result in overheating and unanticipated or dangerous equipment operations.

Component	Function	Potential Hazards
Actuators	Actuators convert hydraulic pressure into a mechanical force. The application of this force can be linear in direction (hydraulic cylinder), or rotational (hydraulic motor).	Air that is trapped in the hydraulic system at start-up can cause actuators to move without warning and without any control input.
Counter-balance Valve	A counterbalance valve is a load holding device that allows smooth cylinder movement and prevents the collapse of a loaded cylinder in the event of a hose or fitting failure.	Incorrect adjustment of this valve, or a fault in the valve, can cause the load to fall or slowly creep down. Do not allow anyone to stand under a load that is supported by a loaded actuator, unless approved load supports are installed.
Pump Inlet Line and Return Line Oil Filters	The filters on these lines remove dirt and contaminants from the hydraulic oil to help prevent system component failure.	Ensure that all connections are tight and no oil leaks exist that may cause slip hazards.

Hydraulic Safety

To ensure the safety of all personnel involved with the operation and maintenance of hydraulic systems the following safety precautions must be observed at all times:

- Carry out positive isolation procedures before commencing maintenance work.
- Relieve all system pressure by cycling the controls through their full range of movement before commencing maintenance work.
- Avoid breathing oil mist or vapors.
- Avoid prolonged skin contact with hydraulic oil — do not wear oil-soaked clothing or shoes for long periods of time.
- Do not use hands to detect oil leaks — use a piece of cardboard.

Warning!
Hydraulic fluid under pressure can penetrate the skin causing gangrene and other serious skin complications.

- Do not exceed the manufacturer's recommended hose and fitting pressures.
- Do not disconnect hydraulic fittings without isolating the system and relieving all pressure.
- Do not disconnect any hydraulic fitting on a system fitted with an accumulator with out isolating it from the circuit or discharging it completely.
- Exercise caution when removing the breather or filler cap on an oil reservoir. Units can be pressurized to prevent the ingress of contaminants and can discharge hot oil unless they are correctly relieved.
- Do not weld onto hydraulic fittings, metal lines or components.
- Do not apply pressure to a 'kinked' or folded hose.

Pneumatic Systems

Pneumatic systems operate through the use of compressed air. An air compressor is a power-driven machine for compressing air from some initial intake pressure (usually atmospheric pressure) to a higher pressure. The compressed air is stored in a pressure vessel for use as required.

Most compressed air is not clean. Contaminants such as dirt, rust and scale as well as traces of water and oil may be present in the compressed air when it is discharged. Unless care is taken when operating and maintaining these systems, air under pressure can be discharged directly towards the body. In these instances, the speed at which the air discharges can cause any contaminants to enter the body directly through the skin, through open wounds, or through the nose mouth or eyes.

Supervisors should ensure that all operators and maintainers observe the following safety points:

- Always make sure that the air supply has been turned off before disconnecting ANY hose from a pneumatic system.
- Do not work on a pneumatic system unless it has been isolated and completely depressurized.
- Never aim compressed air towards your body or at other personnel.
- Do not use compressed air to blow down your clothing.
- Isolate and depressurize air lines before removing them from their connections or when changing over tools.

Note!
A tight connection can be an indication that residual pressure remains in the hose.

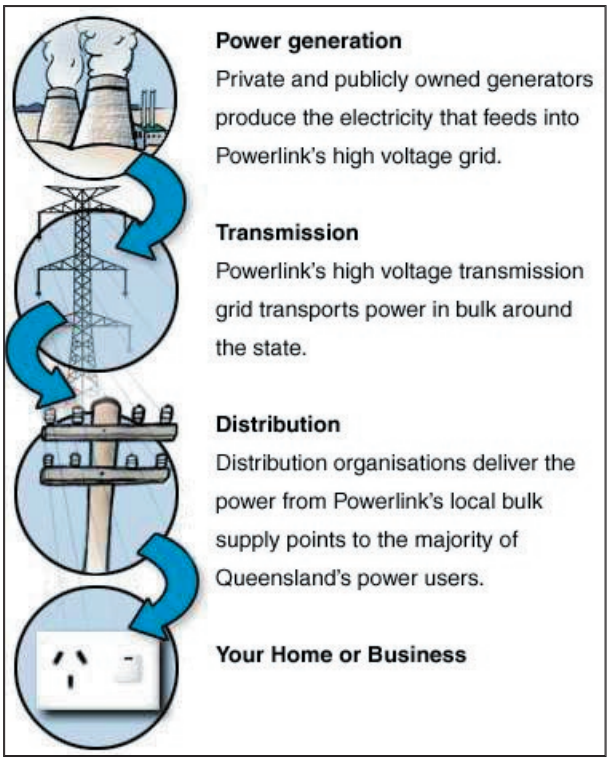
- Always fit safety clips when connecting air lines to an air supply or when connecting tools to an air line.
- Before using an air hose, you should purge the line by directing the free end towards the floor and then opening the isolation valve. Air lines may have dirt, water, oil or particles present from previous use.
- Not all hoses are suitable for compressed air. Ensure that the hose is of the correct type before connecting it to a compressed air system.
- Bull hoses on high volume compressors are to be restrained by chains or wire ropes.
- Turn air supply off before detaching hose.

Power Lines and Underground Power

The following discussion covers the dangers that may arise during construction, as a result of overhead and underground powerlines.

Electricity Networks

Electricity is generated at high voltage (e.g. 275 000 V) in power stations, and is transported through the high-voltage transmission network. In Queensland, this network is owned and operated by Powerlink Queensland. As the electricity gets closer to the point of use, its voltage is reduced (usually 110 000 to 132 000 V) at high-voltage substations.



The high-voltage network ends at a local electricity distribution network, as the electricity is channelled through a bulk-supply substation in the region where it will be used.

From there, various substations and transformers reduce the voltage in a series of steps as the electricity moves closer to connection points in homes and businesses.

Energex owns and operates the retail electricity distribution network in south-east Queensland, while Ergon Energy performs the same role in the remainder of the state.

The Powerlink high-voltage network is almost exclusively above ground. While the retail networks are still located mainly above, an increasing proportion is being installed below ground (e.g. in new residential estates).

Either type of power reticulation may present dangers during construction of the works.

Overhead Power Lines

In the past ten years, there have been 30 deaths and numerous accidents resulting from contact with overhead powerlines. Many of these could have been prevented if people had simply taken due care while working in the vicinity of the lines.

Work requiring caution includes:

- painting or working from ladders, trestles or scaffolding (especially metal)
- working on the roofs of buildings
- carrying or lifting tall objects

- pruning or cutting trees
- operating mobile equipment, especially cranes.

General Precautions

All personnel on a construction site must be aware of the layout of the electricity distribution network within the area. This includes both high-voltage and retail distribution lines.

Powerlink, Energex or Ergon Energy can advise the clearance levels underneath the powerlines. (When calculating clearances, always take the sag of the lines into account).

This is especially important for mobile equipment and heavy plant that will be used on site. The maximum height of the plant must be checked against the clearance available under overhead and stay wires before the plant actually arrives at the site. If necessary, arrangements must be made with the relevant power authority to have lines de-energised for periods when tall equipment will be operating under the power lines.

Note!
Power shut-down periods are usually specified as a hold point in the contract. Dates of shut-down must be arranged some months in advance.

The following steps are taken to protect plant operators:

- placement of markers on the ground near power lines
- attachment of reminder stickers on the outside and in the cabs of mobile equipment.

Remember: "Look up and live".

Wearing Shoes

Shoes are essential in all situations where there is the possibility of contact with overhead powerlines. In one-third of all electric shocks, the power has flowed to earth through the victim's feet.

Danger!
Never use a metal ladder while barefoot.

Rubber or plastic-soled shoes or boots will give far more protection than thongs or no shoes. However, footwear must be in good condition. This means the shoes are dry, are not torn or split, and are completely covering the feet.

Contact with Overhead Wires

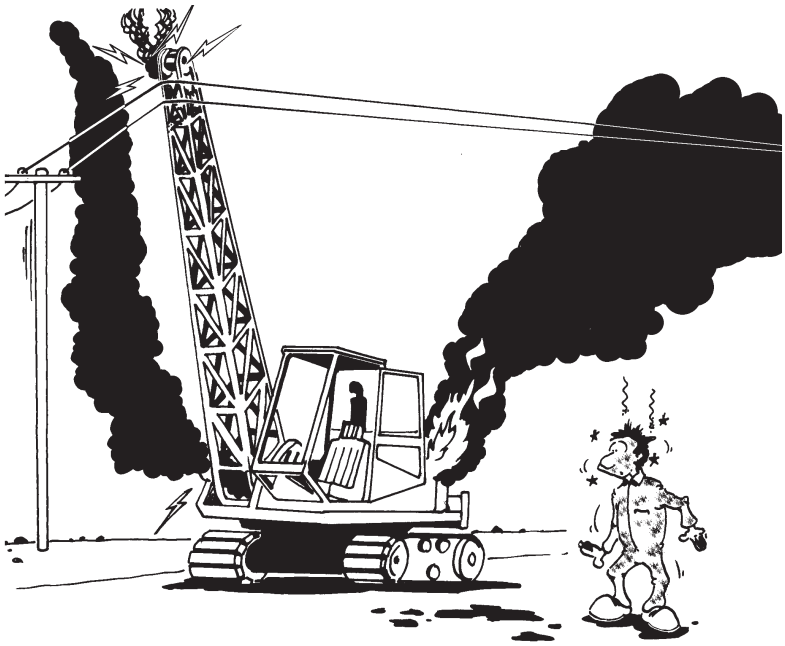
In the event that machinery comes into contact with overhead powerlines, the operator should:

- not step down from the machinery (if possible)
- warn other personnel to stay well clear of the machine
- stay still, and call for someone to contact the emergency services and electricity supplier
- if necessary jump off, keeping both feet together and trying to land as far away from the machine as is safe
- when on the ground, hop clear of the machine while still keeping both feet together

Refer to AS 2550.1–2002 *Cranes, hoists and winches— Safe use— General requirements* for safe operating distances.

If parts of the operator's body are still touching 'live' metal on the machine as a foot touches the ground, the contact may create a path for electricity to run through the body. Jumping off is the only safe method of leaving the machine if it is necessary to do so.

Once a machine has come into contact with overhead wires, no-one should walk anywhere near it, as dangerous voltages may form between the feet.



Underground Power

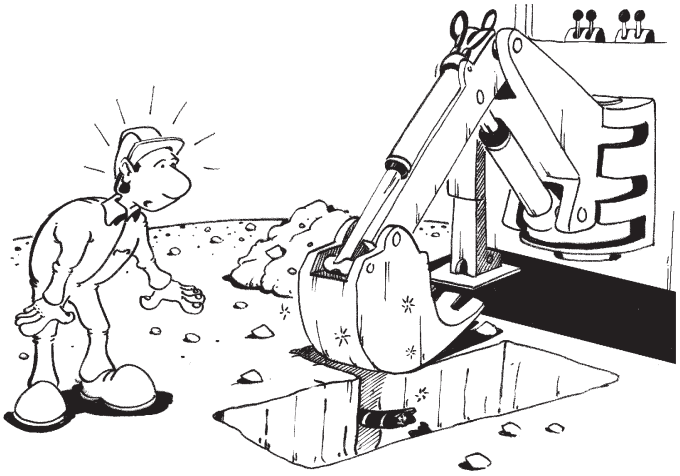
The principal contractor's obligations in relation to underground service lines are defined in Part 17 of the Workplace Health and Safety Regulation 1997.

Three essential procedures must be followed on jobs where underground power cables are known to be, or may be, present:

- Dial before you dig
- Plan–prepare–pothole–protect–proceed
- Resolve conflicts.

Dial Before You Dig

Dial Before You Dig, or DBYD, is an organisation that has been set up and is owned by various utility service providers, including electricity suppliers, Telstra and others.



It is essential to contact DBYD before attempting any earthworks in any area where buried plant may be present. This includes water, sewerage, gas, power and telecommunications equipment. Contact with DBYD would normally be part of the planning process for roadworks construction.

The information held by DBYD is sufficient only to identify that a utility owner's plant is present at a specific worksite. DBYD does not hold specific information about location and depth of services.

Therefore, in response to each customer request, DBYD contacts the relevant utility owners, who then provide plans, maps, excavation advice, contact requirements and emergency telephone numbers. DBYD may need to contact as many as ten utility owners for particular information in response to a customer's requests.

DIAL 1100
BEFORE YOU DIG

The customer receives a Caller Notification. This shows the utilities that exist in the area, and shows:

- The services that DBYD have searched for
- The services that exist at the worksite
- Direct phone numbers for assistance, if required.

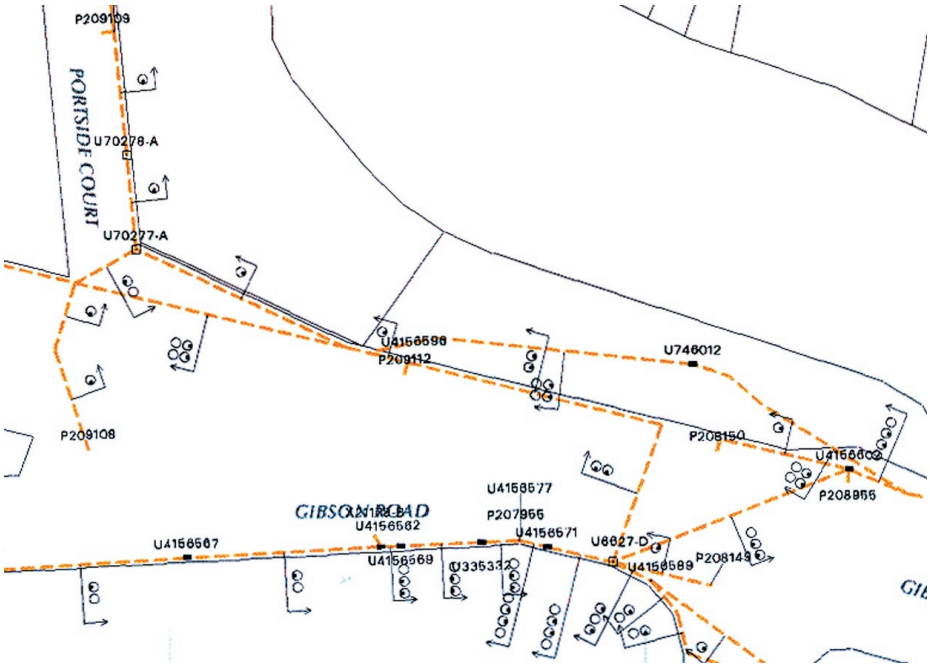
Note!
The caller notification and utility maps must be kept on site at all times while work is in progress.

Each caller notification includes a sequence number, which identifies the date of the request.

Information Supplied by DBYD

The following drawing shows the type of map that DBYD supplies in response to customer requests.

The example shown is the underground power distribution map for Portside Court, Noosaville, Noosa Shire.



Conditions Attached to DBYD Information

Information provided by utility owners is valid only for a specified, limited period. For example, Energex information is valid for 30 days.

The legend on the DBYD plan will show the difference between the aerial and underground components, and this difference must be clearly understood.

Electricity companies attach conditions to the plans, and these must be complied with. Usually, they are outlined in the 'duty of care' statement supplied with the plans. For example, hand excavation (potholing) must be carried out if the excavation is within 2.5m of the nominal position.

Note!

Always read carefully the conditions and disclaimers attached to plans.

Plan–Prepare–Pothole–Protect–Proceed

Any person undertaking work that may damage buried services must exercise his or her legal duty of care.

Utility company plans obtained from DBYD generally include a section on 'Duty of Care'. The key points are that the utility companies:

- Accept no responsibility for any damage caused by other parties to their networks.
- Reserve the right to recover compensation for loss or damage so caused.
- Do not warrant or hold out that plans are accurate at any time after installation, as both the depth and alignment of the services may change with time.

In order to exercise your legal duty of care you will, as relevant to the particular situation, need to carry out the five steps:

- Plan
- Prepare
- Pothole
- Protect
- Proceed.

The meaning of each of these elements of the duty of care is explained in more detail below.

Plan

This means obtaining all relevant information from DBYD in the first instance. If you do not do this, the utility owner may take legal action to halt the works and recover the costs of any damage. Make sure you have all the plans, and the caller notification from DBYD, on site at all times.

Examine the plans carefully, and assess the possible impacts of all proposed actions on networks present in the area. Be sure to consider small actions that may cause damage.

Remember that if the scope of works changes, e.g. to include areas outside the range of the plans, you must obtain new plans from DBYD.

Prepare

This means preparing the site before carrying out any excavation work. It includes:

- Defining the scope of works to include all places where the ground is broken, such as driving in stakes for barricades around the works site.
- Locating buried services using locating equipment.

- Making the area safe for the general public, e.g. by signs and barricades.

You must ensure that all relevant authorities have been notified of the works proposal.

As site inspection is carried out gain a preliminary appreciation of the location of underground power lines, before actual excavation.

Important!
Before commencing work, whether emergency or scheduled, at any site, you must walk the area and search for utility markers.

It is not sufficient to simply 'eyeball between the posts' to obtain an estimate of the location of a service. The service line may follow a curved path, or have an elbow, between the posts.

There are some important points to remember with utility companies' marker posts:

- Each company has its own particular marker design to help ensure positive identification.
- The telephone contact numbers shown on marker posts may be out of date. Before starting work, check that you have current numbers for each utility.
- Distances from a utility line, as shown on a marker post, are sometimes incorrect.
- Distances from a utility line may be shown in imperial units. Before proceeding, convert them to metric and check the conversion arithmetic.

(The general conversion factors for distance are:

1 foot = 0.305 metre; 1 yard = 0.914 m; 1 chain = 20.1 m).

Note!
There is only one sure way to confirm the location of a buried service—by actual digging.

Pothole

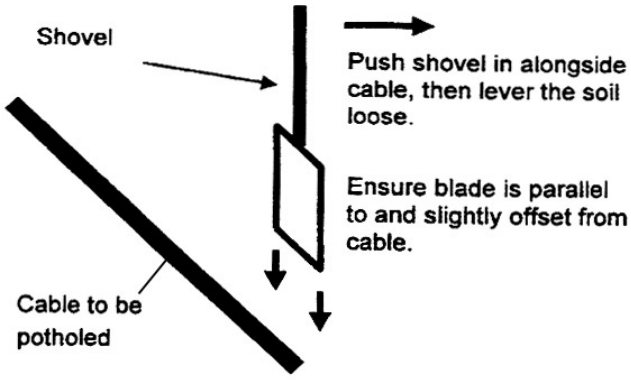
Potholing means digging with hand tools. All plans received from utility owners will include a condition requiring you to use only careful hand digging within a specified distance of the utility.

Before putting shovel to ground, remember that:

- Plans are intended to provide an indication of plant presence only.
- Marks or posts provided by the utility owner are approximate only.
- Locating equipment provides more detailed information, but can still be inaccurate under some circumstances.

Note!
Exposure of all cables, conduits and pipes at the required intervals may be a condition attached to the plan. This is essential, to ensure that you determine the exact location of the service.

The only way to confirm that you have found a particular cable or buried service is to trace it all the way to the next pit, and physically verify it.



When digging, use the following techniques:

- Use a shovel or spade with the blade aligned along the expected direction of the service line
- Dig at a slight offset to the expected position of the service.
- While digging, remember that the depth of cover may vary. The original depth may have changed over all or part of the service line, due to:
  - Installation technique
  - Type of service
  - Date of installation
  - On-site or off-site erosion
  - Changed ground level due to road works, development or landscaping.

Note!
Do not use a crowbar or spike for hand digging near buried services.

Protect

Once a service has been exposed, you may need to support it over the distance of exposure. This may mean using star pickets driven into the ground parallel to, but offset from, the trench in which the service is located, with rope supports to suspend the service lines from the stakes.

Make sure that everyone on site is aware of the need to protect the exposed service lines. Safety barriers and para-webbing provide greater awareness of any areas that are at risk.

Retain copies of the plans on site while works are in progress.

The importance of good, clear markings cannot be over-emphasised. These enable the machine operator to easily see the direction and location of the service line. The site supervisor must monitor the activities of machine operators at all times when they are operating near buried services.

Proceed

Proceed to excavate with machinery only after you have:

- a copy of the plans and caller notification on site
- located the buried services using locating equipment and potholing, and
- protected the services.

Remember that machine excavation can only be used in conjunction with careful hand excavation, and that it must be carried out parallel to the expected direction of the cable.

Do not use a machine with teeth when excavating buried services.

Always maintain specified minimum clearances between machinery and buried services, as specified in the plans

Note!
If any damage is caused to a buried service at any time, the utility owner must be contacted immediately.

Resolving Conflicts

Once a service line has been exposed and its position is confirmed, it should be relatively easy to identify areas where there is the potential for conflict between the intended works and the existing service location.

In such cases, the person responsible for the construction must contact the utility owner for assistance before any further works are carried out.

Steps can be taken to minimise the impacts of conflict, and to prevent additional cost and disruption to the network.

Positive outcomes are generally achieved when the utility owner is contacted early. The project manager is in the best position to identify any likely problems.

Tagging and Isolation

Safety Tag System

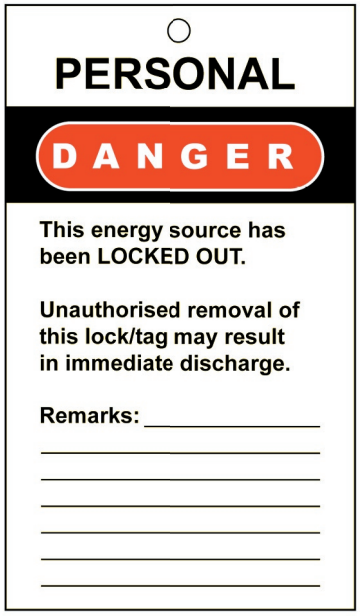
The safety tag system is in place for the protection of both personnel and equipment. In order to provide a safe system of work, safety tags and locks are attached to isolation points when equipment is isolated for maintenance and other work. The purpose of safety tags is to clearly warn personnel that equipment must not be started because there may be someone working on it.

Warning!
Equipment must never be started while safety tags are in place.

Tags used on construction sites may vary, depending the company's adopted design. The following discussion shows a system of tagging that is considered typical. It includes:

- Danger Do Not Operate Tag (or 'DNO')
- Personal danger tag
- Caution/Information Tag
- Out of service tag.

Personal Danger Tags



The purpose of the personal danger tag is to protect the person named on the tag. It is a warning to all personnel that the tagged plant or equipment must not be operated until the tag has been removed by the person named on the tag.

The personal danger tag of an authorised, nominated person must be placed on all isolation points where 'lockout' is required. Personal danger tags must be placed on electrical and mechanical isolation points where there is a possibility of contact by the tag owner with rotating equipment. Personal danger tags may only be used in conjunction with the relevant permit to work.

The typical colour scheme for a personal danger tag is yellow with red and black text, and the words 'Personal Danger Do Not Operate' in black text.

Warning!
Unauthorised removal of a personal danger tag is a matter of gross misconduct that will result in severe disciplinary action and, potentially, termination of employment.

Personal Danger Tag Use

These steps must be followed for placement and use of personal danger tags by the permitted person.

1. Write name, date and clearance number and sign the personal danger tag/s.
2. Attach personal danger tag/s to the relevant isolation point/s.
3. Attach personal lock/s to the relevant isolation point/s.
4. When the permit to work is handed back, the permitted person must remove the personal danger tag/s and personal lock/s whether or not the work is complete.

Personnel must not leave site and must not sign off a work permit as complete, until all their personal danger tags have been removed from isolated equipment.

In cases where a personal danger tag has been left in place and the tag owner has left the site, the following procedure must be used:

1. Every attempt shall be made to contact the person who, if contacted, must return to site to remove his/her tag.
2. If the person cannot be found, every attempt shall be made to contact his/her supervisor who, if contacted, will again attempt to contact the tag owner.
3. If neither the tag owner nor his/her supervisor can be contacted, an authorised person at management level must be contacted.
4. The circumstances will be investigated by the manager (or his/her delegate). If investigation reveals it is safe to do so, the personal danger tag will be removed and the equipment cleared for operation.
5. An incident report must be raised to record the sequence of events associated with removal of the personal danger tag and the precautions applied.

Note!
Tags shown in this and following discussion are samples for the purpose of illustration only. Actual design varies from workplace to workplace.

Out of Service Tag

The purpose of the out of service tag is to communicate to other personnel that the tagged item of plant or equipment is not operational. The reasons for the tag may be related to either operation or maintenance.

The out of service tag is open for use by all personnel.

The out of service tag may not be removed until the equipment is made operational or the tag is replaced by a permit to work isolation and a DNO tag.

Typical colour scheme for an out of service tag is yellow with black text and the words Out of Service.

Caution/Information Tag

The purpose of the information tag is to communicate to personnel any issues that are out of the ordinary about the equipment or plant that is tagged. These issues may be operational,

process or maintenance related. The information tag is open for use by all personnel.

Typical colour scheme for an information tag is white with black text and the words Caution/Information in black text.

Process Locks

Process Lock

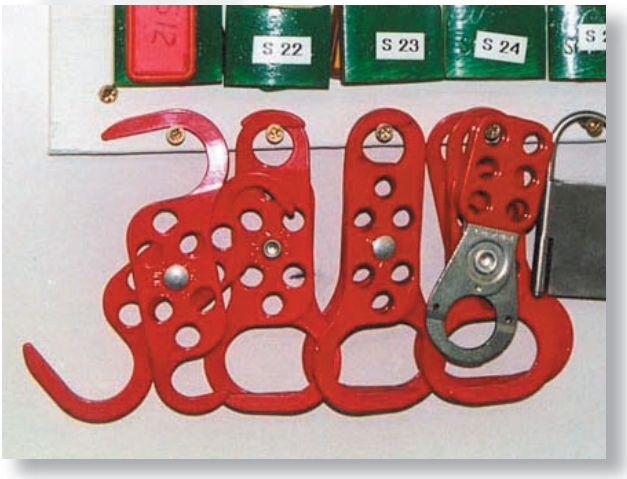
Process locks are a keyed-alike padlock security system that may only be used by either a responsible operations person or a person authorised to issue permits to work. These locks are typically red in colour.

Process locks are used primarily for electrical isolation of plant and equipment in conjunction with permits to work and DNO tags.

In some cases, it would be impossible to use a padlock by itself to lock a valve or other isolation point. To facilitate the use of padlocks on these types of isolation points, special valve clamps or chains may be used.

Scissor Locks

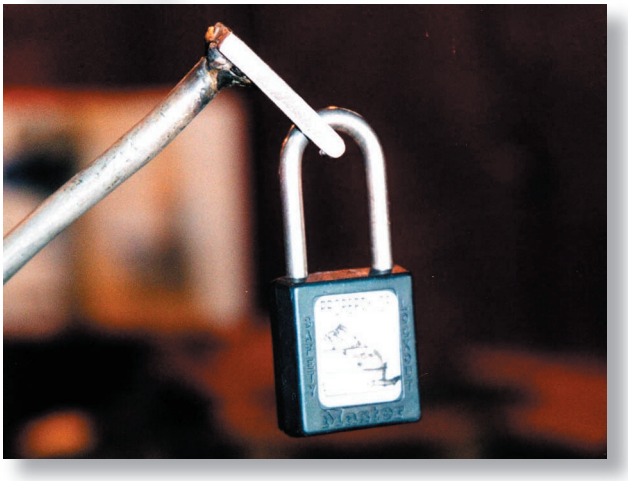
Typical Scissor Lock



Scissor locks are for use where more than one lock must be placed on an isolation point, e.g. for electrical isolations.

Personal Locks

Personal Locks



Personal locks are individual, unique locks used in conjunction with personal danger tags to ensure that plant and equipment is not operated while it is being worked on.

Personal locks may not be red in colour. This is to ensure that they are easily distinguishable from process locks.

Personal locks may only be removed by the person who placed the lock.

In cases where a personal lock has been left in place and the lock owner has left the site, the following procedure must be used:

1. Every attempt shall be made to contact the person who, if contacted, must return to site to remove his/her personal lock.
2. If the person cannot be found, every attempt shall be made to contact his/her supervisor who, if contacted, will again attempt to contact the lock owner.
3. If neither the lock owner nor his/her supervisor can be contacted, an authorised person at management level must be contacted.
4. The circumstances will be investigated by the manager (or his/her delegate). If investigation reveals it is safe to do so, the personal lock will be removed and the equipment cleared for operation.
5. An incident report must be raised to record the sequence of events associated with removal of the personal lock and the precautions applied.

Tagging and Lockout Procedure

Each company has its own tag and lockout procedure. The procedure involves a system of trained and authorised staff, each of whom has a definite role as part of the system. All personnel must be aware of the procedures and apply them correctly to all work where their use is specified.

Before a permit to work is issued, DNO tags and, if applicable, process locks must be attached to all the relevant isolation points. The permitted person must place his/her personal danger tag and a personal lock on any isolation point where a process lock is used.

In addition to confined space entry, certain other types of work that may be performed on construction sites, such as hot work, work at height, excavations, and penetrations are also potentially hazardous. Accordingly, special training is required for the personnel who are approved and authorised to raise and issue permits to work which involve these hazards. These personnel have been approved and authorised to operate in this capacity by the relevant manager.

Section 4 – Assessment Activities

For information on how these assessment activities may be used as part of the learning process, see the section on 'Assessment' in the 'Topic Descriptor' section at the front of this topic.

Theory Questions

The following questions allow you to assess your progress in understanding the material presented in Section 4. The questions may be of any of the following types:

- multiple choice (identify correct answer or answers)
- multiple choice (identify incorrect answer or answers)
- fill in the gaps in a sentence or statement
- identify a sentence or statement as TRUE or FALSE
- write a few sentences or a short paragraph.

Answers to the question are shown in the separate 'Answer' section.

Question 1

How is a hazard converted into a risk?

_____

_____

_____

Question 2

What is an incident?

_____

_____

_____

Question 3

Name three commonly used methods of identifying hazards in the workplace

_____

_____

_____

Question 4

Give two reasons why past safety records cannot be used to predict all types of accidents that may occur in the future.

_____

_____

_____

_____

Question 5

Name three sources of information about product hazards.

_____

_____

_____

Question 6

Pressure, confined spaces, radiation and electricity are four examples of sources of harmful energy. Name four more.

_____

_____

_____

_____

_____

Question 7

Why is personal protective equipment known as the 'last line of defence' against occupational injury?

_____

_____

_____

_____

_____

Question 8

Place the following control measures in order from most effective to least effective.

( ) Personal Protective Equipment

( ) Separation

( ) Design

( ) Redesign

( ) Elimination

( ) Substitution

( ) Administration

Question 9

Which of the following can best be described as 'the line of defence between the worker and the hazard'?

- Elimination of the hazard ☐
- Redesign ☐
- Personal protective equipment ☐
- Isolation ☐
- Substitution ☐
- Administrative controls. ☐

Question 10

Name four general sources of information about hazards that may be encountered in the workplace.

_____

_____

_____

_____

Question 11

What are the guidelines for the safe storage of hand-held electric power tools?

_____

_____

Question 12

When you are carrying any load, the possibility of slipping, tripping or falling exists. In what situations is the risk of injury increased?

_____

_____

_____

_____

Question 13

Before setting up a ladder in a passageway, you must first _____.

Question 14

You are required to work at a height of 2.7 m above ground, with no permanent or temporary barrier available. What are some available alternative methods of reaching the work location safely?

_____

_____

_____

_____

Question 15

When wearing a safety harness, you should ensure that the harness is in _____ and

that it will _____ .

Question 16

Name four factors that may increase the risk of suspension trauma when a worker has fallen and is left suspended in a safety harness.

Question 17

In addition to the area directly beneath, what other is taken into account when assessing the potential extent of the drop zone below a person working at height?

Question 18

At what level of oxygen content is a workplace atmosphere regarded as oxygen-deficient? As oxygen enriched?

Question 19

One of the dangers of H_2S is that it quickly 'fatigues' the sense of smell. What does this mean?

Question 20

What are the main dangers associated with carbon monoxide?

_____

_____

_____

Question 21

What do the following acronyms stand for?

TWA _____

STEL _____

LEL _____

Question 22

Once a trench has been correctly battered, benched or shored, and people are required to work in the trench, what measures may be used to prevent the trench from collapsing?

_____

_____

_____

_____

Question 23

List four roles of the confined-space standby person.

_____

_____

_____

_____

Question 24

What is the minimum PPE applicable to electric arc-welding operations?

Question 25

Why should oil or grease never be permitted anywhere near cylinders or equipment carrying oxygen?

Question 26

What publication contains the Australian national standards for traffic control devices and their placement on the road during the construction period?

Question 27

If you are subjected to an incident of road user aggression on the job, what is your immediate reaction?

Question 28

Identify the correct statement or statements from the following list.

An operator blind spot is a location where a person or other mobile plant may be hidden from the operator's view. ☐

The plant operator may allow the arc of swing of a machine's body or attachments to pass over the top of other plant or pedestrians, provided they have been warned first. ☐

Workers should never walk underneath a load suspended from a crane. ☐

Safety guards fitted to rotating or moving equipment may be fitted or removed by any worker on site, provided such action is for the purpose of regular inspection. ☐

Question 29

Briefly describe the guidelines for safe refuelling of vehicles and heavy plant.

_____

_____

_____

_____

Question 30

Why is it dangerous to disconnect any component from a hydraulic system fitted with an accumulator?

_____

_____

Question 31

What danger arises if air from a pneumatic system is discharged towards a person's body?

_____

_____

Question 32

In the event that machinery (e.g. crane, excavator, backhoe) comes in contact with overhead powerlines, what actions should the operator take to protect his/her own safety and that of others?

_____

_____

_____

_____

_____

Question 33

Identify the correct statement or statements in relation to information provided by utility companies through DBYD. Utility companies:

Accept some responsibility for damage caused by other parties to their networks if the company was not able to clearly indicate the location of the buried service. ☐

Provide plans that are intended to give an indication only of the likely presence of buried plant. ☐

Reserve the right to recover compensation for any loss or damage caused by other parties to their networks. ☐

Warrant that their plans are reasonable accurate in most circumstances. ☐

Question 34

Any person undertaking work that may damage buried services (such as water, gas and sewerage pipes or electrical and telephone cables etc.) must exercise his/her legal duty of care. Five steps have been identified in carrying out this responsibility, arrange the five steps in the order that you would carry them out.

( ) Protect

( ) Prepare

( ) Plan

( ) Proceed

( ) Pothole

Question 35

Give three reasons why the original depth of cover over a buried service line may change with time.

_____

_____

_____

Question 36

You may remove a personal danger tag if you are sure that the person named on the tag has left the worksite. Is this statement true?

_____

_____

_____

Question 37

What requirements must you meet before you can raise and issue permits for hazardous work, such as hot work, work at height, excavations, and penetrations, on a construction site?

_____

_____

_____

Practical Exercises

Practical Exercise 1

Obtain and consult the material safety data sheets for chemicals commonly used in your workplace. What information does the sheet provide about the chemical?

Practical Exercise 2

Using the Risk Calculator on Page 11 of this section, calculate the Risk Score for a scenario where:

- Possibility is 'Unusual but possible'
- Exposure is 'Frequent'
- Possible Consequence is 'Serious Injury'.

What action should be taken as a result of this assessment?

Practical Exercise 3

Under supervision, carry out maintenance of a number of edged tools, such as chisels, axes or brush hooks. What problems did you encounter with the cutting edge? With the handle? What are the main safety hazards involved in tool maintenance?