GENERAL GUIDE FOR WORKING IN THE VICINITY OF OVERHEAD AND UNDERGROUND ELECTRIC LINES

This General Guide provides information on how to manage risks when working in the vicinity of overhead and underground electric lines at a workplace. It is supported by specific guidance material on:

- operating cranes and mobile plant near overhead electric lines
- tree and vegetation management near overhead electric lines
- scaffolding work near overhead electric lines
- agricultural work near overhead electric lines
- working near low voltage overhead electric lines near structures, and
- transporting high loads near overhead electric lines.

You should use the guidance material that applies to your work activities.

Who should use this Guide?

This General Guide applies to all businesses or undertakings where there is a risk that a person, plant or thing at the workplace can come within an unsafe distance of an overhead or underground electric line.

This Guide does not apply to:

- Work carried out by, or on behalf of, an Electricity Supply Authority on the electrical equipment including electric line-associated equipment, controlled or operated by the authority to generate, transform, transmit or supply electricity including work on energised electric lines.
- Mobile plant or vehicles operating on a public road where the design envelope is not greater than the transit envelope and is also not greater than 4.6 metres in height.
  For example, a side loading waste collection vehicle collecting waste bins from the side of a public road under overhead electric lines.
- A crane or mobile plant when they are retracted and correctly stowed for travelling on a public road.
- Work carried out by emergency services personnel including state emergency services, fire, police, volunteer rescue associations and ambulance personnel during a declared emergency or other local emergency incident.
- Work involving low flying aircraft like crop dusting, pesticide or herbicide spraying.

This Guide should be read with the Code of Practice: *Managing electrical risks in the workplace* which provides information on managing risks associated with electrical safety and energised electrical work.

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Who has duties under the law?

Everyone in the workplace has a work health and safety duty. The main duties are set out in Table 1.

Table 1 Duty holders and their obligations

Who	Duties
A person conducting a business or undertaking	**A person conducting a business or undertaking** must ensure, so far as is reasonably practicable, that workers and other people are not exposed to health and safety risks arising from the business or undertaking. A 'person conducting a business or undertaking' is a term that includes all types of working arrangements such as organisations, partnerships, sole traders or small business owners. For example a builder, a construction business, a crane hire company, a franchisee and a self-employed person operating their own business are all persons conducting a business or undertaking. **A person conducting a business or undertaking who has management or control of a workplace** must ensure, so far as is reasonably practicable, the workplace, the means of entering and exiting the workplace and anything arising from the workplace is without risks to health and safety. **A person conducting a business or undertaking** must manage electrical risks including ensuring, so far as is reasonably practicable, that no person, plant or thing at the workplace comes within an unsafe distance of an overhead or underground electric line.
Designers, manufacturers, importers, suppliers and installers	**Designers, manufacturers, importers, suppliers and installers** of plant or structures must ensure, so far as is reasonably practicable, the plant or structure is without risks to health and safety. Designers and manufacturers of electrical equipment or installations must ensure they are designed and manufactured so electrical risks are eliminated or, if this is not reasonably practicable, minimised so far as is reasonably practicable.
Officers	**Officers,** such as company directors, have a duty to exercise due diligence to ensure the business or undertaking complies with the Work Health and Safety (WHS) Act and Regulations. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks from work in the vicinity of overhead and underground electric lines.
Workers and others	**Workers and other people at the workplace** must take reasonable care for their own health and safety, co-operate with reasonable policies, procedures and instructions and not adversely affect other people's health and safety.

What is working in the vicinity of overhead and underground electric lines?

Work in the vicinity of overhead and underground electric lines is where there is a reasonable possibility a person either directly or through a conducting medium will come within an unsafe distance to energised electric lines.

The term 'in the vicinity of' can be interchanged with other legislative or commonly used industry terms like close proximity, unsafe distance or near.

How can electrical risks be managed?

Working in the vicinity of energised electric lines can expose workers to health and safety risks including death, electric shock or other injury caused directly or indirectly by electricity.

Contact with energised overhead or underground electric lines can be fatal whether the lines are carrying a voltage as high as 400,000 volts or as low as 230 volts.

An electric shock can also occur without contact with overhead electric lines. A close approach to line conductors may allow a 'flashover' or arc to occur. The risk of flashover increases as the line voltage increases.

Working in the vicinity of energised electric lines can create risks to workers and the public where:

- a person or something the person is holding or is in contact with could come closer than the relevant approach distances, and
- the risk of damage to overhead electric lines or associated electrical equipment may create extra risks to workers.

Use the following steps to ensure, so far as is reasonably practicable, that workers and other people are not exposed to health and safety risks:

#1 Identify hazards

1. **Find out what could cause harm.** The following can help you identify potential hazards:

- Observe the workplace to identify work activities and tasks that may come within an unsafe distance of overhead or underground electric lines.
- Ask your workers, contractors and crane or plant operators about potential hazards they can see at your workplace or site.
- Review your incident and injury records including near misses.

You should always treat electric lines as energised unless the person conducting a business or undertaking or the person with management or control of the electric line or premises has:

- an access authority confirming the electric lines have been de-energised, or
- another written document from the Electricity Supply Authority that allows people to work in a no go zone.

#2 Assess risks

2. **Assess the risk if necessary.** In many cases the risks and related control measures will be well known. In other cases you may need to carry out a risk assessment to identify the likelihood of somebody being harmed by the hazard and how serious the harm could be. A risk assessment can help you determine what action you should take to control the risk and how urgently the action needs to be taken.

Risk factors to consider include:

- the location, height, arrangement and visibility of overhead electric lines and supporting structures like poles, towers and stay wires
- the voltage of electric lines and exposed energised parts and whether they are insulated or bare

- possible sway or sag of the electric line caused by wind or temperature changes
- site conditions e.g. prevailing or unexpected winds and their strength and direction; the terrain and possibility of unexpected ground surface movement under plant; and vehicular traffic, pedestrians or livestock that could interfere with the work
- environmental conditions e.g. storm activity—heavy rain or lightning in the area
- the type of plant and machinery required e.g. their design envelope, inherent stability and the stability of the suspended load; their dimensions and their operating characteristics, ease of manoeuvrability and conductivity if they are earthed; the minimum clearance distances from the closest part of the plant to electric lines; and the possibility they may become energised by proximity to high voltage lines.
- the nature, size and shape of loads to be moved e.g. load stability, dimensions and surface area facing the wind; whether loads are conductive—all materials should be treated as conductive unless confirmed otherwise—or could become conductive when in contact with high voltage material; how loads are secured and if any part of the load may move and enter Zone B; and whether loads being carried above electric lines may accidently fall onto them.
- the type of work activities required and the frequency of the work tasks
- the qualifications, competency, skill and experience of the people doing the work
- setting up and packing up processes, and
- work practices and procedures.

#3 Control risks

3. Take action to control the risk. The WHS laws require a business or undertaking do all that is reasonably practicable to eliminate or minimise risks.

The ways of controlling risks are ranked from the highest level of protection and reliability to the lowest. This ranking is known as the hierarchy of control. You must work through this hierarchy to manage risks.

The first thing to consider is whether hazards can be completely removed from the workplace. For example, risks can be eliminated by preventing people, plant, equipment and materials from coming close enough to energised electric lines for direct contact or flash over to occur. This could be done by de-energising the electric line for the duration of the work, isolating and earthing the line (or equivalent for low voltage or rail) so it is not energised, re-routing the electric line away from the work area or replacing existing overhead electric lines with underground electric lines e.g. cables.

Note: De-energising or moving electric lines should be arranged with the Electricity Supply Authority as soon as possible because, depending on the circumstances, this may take some time to arrange.

If it is not reasonably practicable to completely eliminate the risk then consider one or more of the following options in the order they appear below to minimise risks, so far as is reasonably practicable:

- substitute the hazard for something safer e.g. use alternative plant which cannot enter an unsafe zone, non-conductive tools designed to reduce the possibility of direct contact with the electric line, or ultrasonic measuring devices instead of the mechanical types for measuring heights of overhead lines
- isolate the hazard from people e.g. erect a physical barrier to prevent any part of the plant or equipment or a person or anything held by a person, or attached to a person entering Zone B. A physical barrier should be made of non-conductive material like wood or plastic and be erected safely. This may require isolating the electricity supply while the barrier is installed
- use engineering controls e.g. limit movement of plant with mechanical stops, fit plant with programmable zone limiting devices, mechanically limit slew speed of a crane to slow or use electrically insulated plant and equipment.

If after implementing the above control measures a risk still remains, consider the following controls in the order below to minimise the remaining risks, so far as is reasonably practicable:

- use administrative controls e.g. warning signs to indicate the location of overhead electric lines and defined work areas and supervising work to ensure safe work procedures are followed, and
- use personal protective equipment (PPE) e.g. insulating gloves that are effectively electrically tested, rubber soled boots, safety helmets, standing on a rubber insulating mat or an equipotential conductive mat and wearing dry clothes especially in wet or humid conditions.

A combination of the controls set out above may be used if a single control is not enough to minimise the risks.

You need to consider all possible control measures and make a decision about which are reasonably practicable for your workplace. Deciding what is reasonably practicable includes the availability and suitability of control measures, with a preference for using substitution, isolation or engineering controls to minimise risks before using administrative controls or PPE. Cost may also be relevant, but you can only consider this after all other factors have been taken into account.

#4
Review control measures

4. **Check your control measures** regularly to ensure they are working as planned. Control measures need to be regularly reviewed to make sure they remain effective, taking into consideration any changes, the nature and duration of the work and that the system is working as planned.

If a Safe Work Method Statement (SWMS) (see page 6) has been prepared due to energised electrical work or high risk construction work being done, the SWMS must also be reviewed and revised where necessary.

Further information on the risk management process is in the Code of Practice: *How to manage work health and safety risks*.

Who is involved?

You must consult your workers and their health and safety representatives (if any) when deciding how to manage electrical risks in the workplace including when making changes. You should encourage reporting of safety problems.

If there is more than one business or undertaking involved at your workplace you must consult them to find out who is doing what and work together so risks are eliminated or minimised so far as is reasonably practicable.

For example, if you hire a crane company to carry out lifting operations at your workplace and there are overhead electric lines, you should talk with the crane operator and the Electricity Supply Authority about safe approach distances and control measures to prevent contact. You should work together and co-ordinate the work to ensure workers are not exposed to electrical risks, for example instructing on and ensuring compliance with no go zones.

You should also talk to the owner of the electric line—also known as the asset owner. The owner may be the Electricity Supply Authority, or in the case of work involving private overhead electric lines, the person with management or control of the electric line or premises.

Further information on consultation requirements is in the Code of Practice: *Work health and safety consultation, co-operation and co-ordination*.

Planning and preparation

Before starting work careful planning and preparation is essential to ensure work is done safely. This can include:

- understanding important stages of the planned work and how to deal with changes as the work proceeds
- understanding what plant will be used in the operations

- identifying possible hazards and risks associated with the work
- talking to the Electricity Supply Authority or asset owner about the proposed work if there is a risk of people, plant or things coming within an unsafe distance of an overhead or underground electric line
- ensuring compliance with all conditions imposed by the Electricity Supply Authority for the work
- a competent person inspecting visual indicators on electric lines like tiger tails before starting operations each day—if visual indicators have moved or been damaged the Electricity Supply Authority should be contacted so they are replaced or relocated in the correct position
- ensuring an effective communication system is in place between workers at the site
- providing training and verifying qualifications and competency of workers
- providing information and instruction to operators and other workers about control measures to eliminate or minimise electrical risks
- supervising workers to ensure safe work procedures are followed
- checking the plant and equipment including limiting devices are working properly
- checking proximity of people, cranes, mobile plant, material and tools to overhead electric lines
- checking proximity of people to cranes and mobile plant
- ensuring safe workplace entry and exit
- checking emergency plan and rescue procedures
- ensuring emergency equipment is provided and readily accessible on site including first aid kits and fire-fighting equipment suitable for electrical fire
- ensuring approach distances are relevant for the authorisation levels of the workers doing the work
- ensuring a safety observer is used to warn people and plant operators when they are likely to come closer than the approach distances and zones, and
- managing the impact of environmental factors including storms and lightning in the area.

When preparing for the work you should ensure no new hazards are created.

Safe work method statements

Construction work carried out on or near energised electrical installations or services is defined as high risk construction work.

A SWMS is required for energised electrical work and high risk construction work. You must prepare a SWMS before work starts and ensure high risk construction work is carried out as specified in the SWMS for the work.

More information on SWMS is in the Code of Practice: *Construction work*.

APPROACH DISTANCES FOR OVERHEAD ELECTRIC LINES

Approach distances are one way of separating people from hazards. An approach distance is the minimum space from an energised overhead electric line that should be maintained by a person or an object held by or in contact with that person. The approach distances in specified zones should consider different levels of technical knowledge and items of plant.

People without the relevant technical knowledge and experience of electricity transmission and distribution networks and associated electrical equipment will not be able to identify the operating voltage of electric lines and recognise the dangers. These people are referred to as ‘unauthorised persons’.

Approach distances are greater for unauthorised persons than for authorised persons who have

been trained and assessed as having the necessary technical knowledge and skills.

When considering approach distances for unauthorised and authorised persons you should include the distance required to avoid electrical flashover and allow for the inadvertent movement of a person, crane or mobile plant and the sag and sway of conductors to ensure the person or plant does not enter an unsafe zone.

Approach distances are only part of an overall safe system of work you should use when working in the vicinity of overhead electric lines and associated electrical equipment. Where it is not reasonably practicable to ensure a safe distance a risk assessment must be carried out for the proposed work and control measures put in place that are consistent with the risk assessment and the requirements of the Electricity Supply Authority.

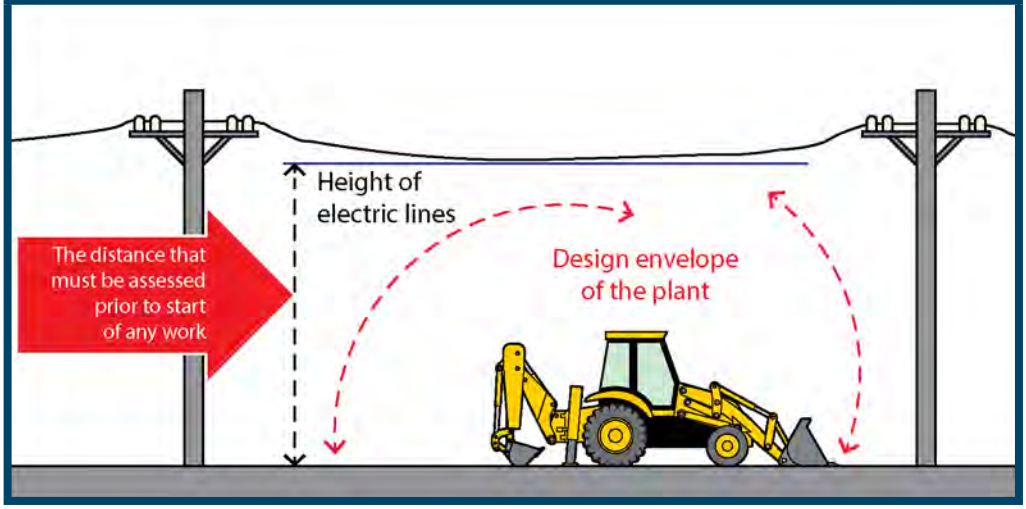
Assessing the approach distance

Before starting work it is essential the height and voltage of the overhead electric lines and if applicable the horizontal safety clearance be assessed at the site. Figure 1 shows the distances that must be assessed for each site.

As distances increase estimating them without equipment can be difficult. It may be necessary to allow greater clearance distances or use more accurate ways to estimate distances. An ultrasonic cable height indicator provides a safe and accurate way of estimating distances near overhead electric lines.

If the height or voltage of the overhead electric lines cannot be accurately estimated ask your Electricity Supply Authority for advice.

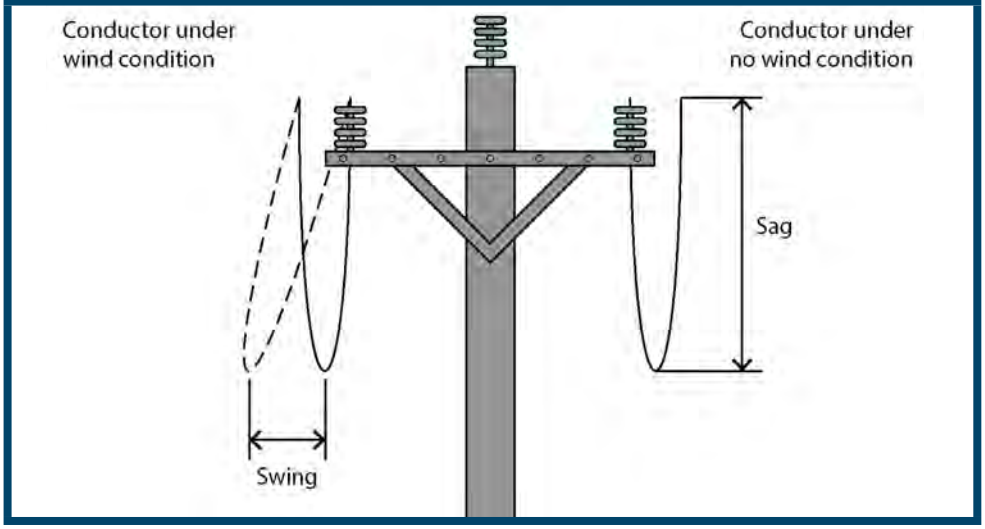
FIGURE 1 Distance that must be assessed for each site



Overhead electric lines are made of metal and expand or contract when heated or cooled. This can be caused by changes in ambient air temperatures and electrical load current passing through conductors.

An expansion will result in gravity causing the electric lines to sag downwards. Wind can make the electric lines swing from side to side. For these reasons approach distances should be vertically or horizontally increased by the amount of conductor sag or swing at the point of work (see Figure 2).

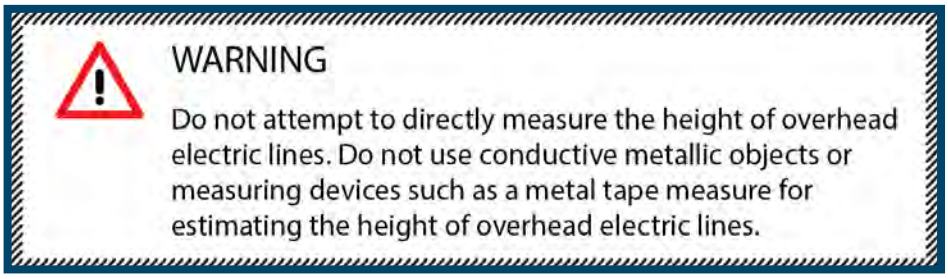
FIGURE 2 Conductor 'sag or swing'



Where more than one voltage is present the approach distance for each voltage should be maintained. For example where overhead electric lines have two or more circuits operating at different voltages and both are supported on the same pole.

Allow increased clearances where the risk assessment identifies the load or lifting gear like crane hooks, chains and slings may move or swing towards the overhead electric lines or associated electrical equipment when cranes or mobile plant are used.

A warning sign like the one shown below can alert workers and others to possible hazards when estimating approach distances. This may be useful for temporary work sites that are sectioned off from the public and have specific entry points.



How close can I go to overhead electric lines?

Once an assessment of the site and the overhead electric lines has been done a decision on the approach distance for the proposed work can be made.

Approach distances can apply to all:

- parts of a crane or mobile plant including vehicles
- loads being moved including slings, chains and other lifting gear
- people working at heights e.g. from an elevating work platform, scaffold or other structure, and
- hand tools, hand control lines, equipment or other material held by a person.

The approach distance for each work zone (see Figures 3 and 4) will vary depending on the voltage of the overhead electric line and the level of authorisation of each person carrying out the work. As the risk increases a greater approach distance is required. There are three work zones:

- Zone C is a no go zone closest to and surrounding the electric line where authority from the Electricity Supply Authority is required.
- Zone B surrounds the electric line and is further away than Zone C. It is for authorised persons.
- Zone A is furthest away from the electric line and is for unauthorised persons.

FIGURE 3 Work zones in the vicinity of overhead electric line poles

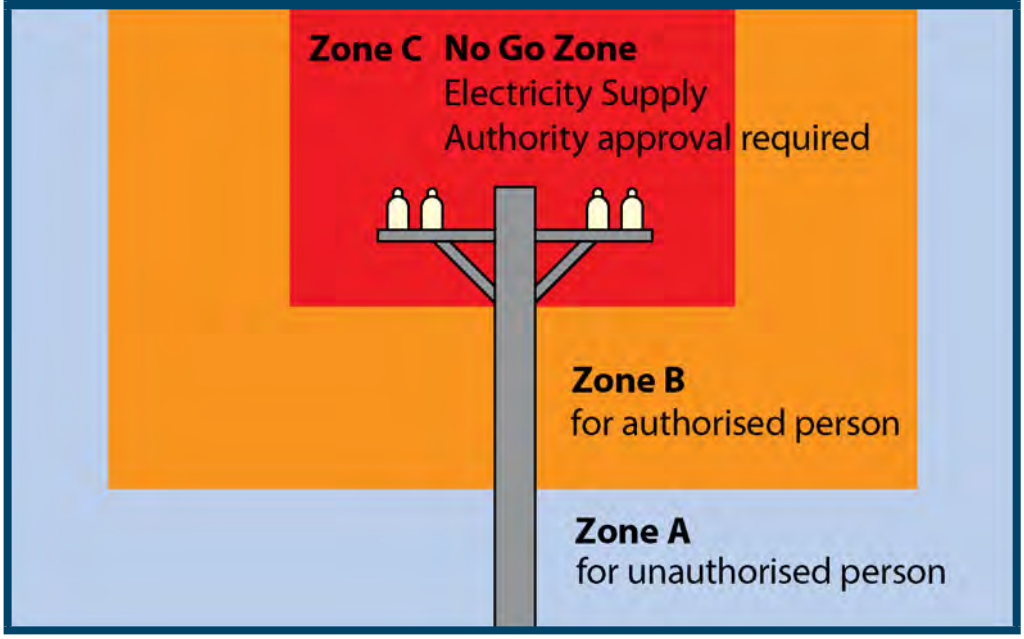
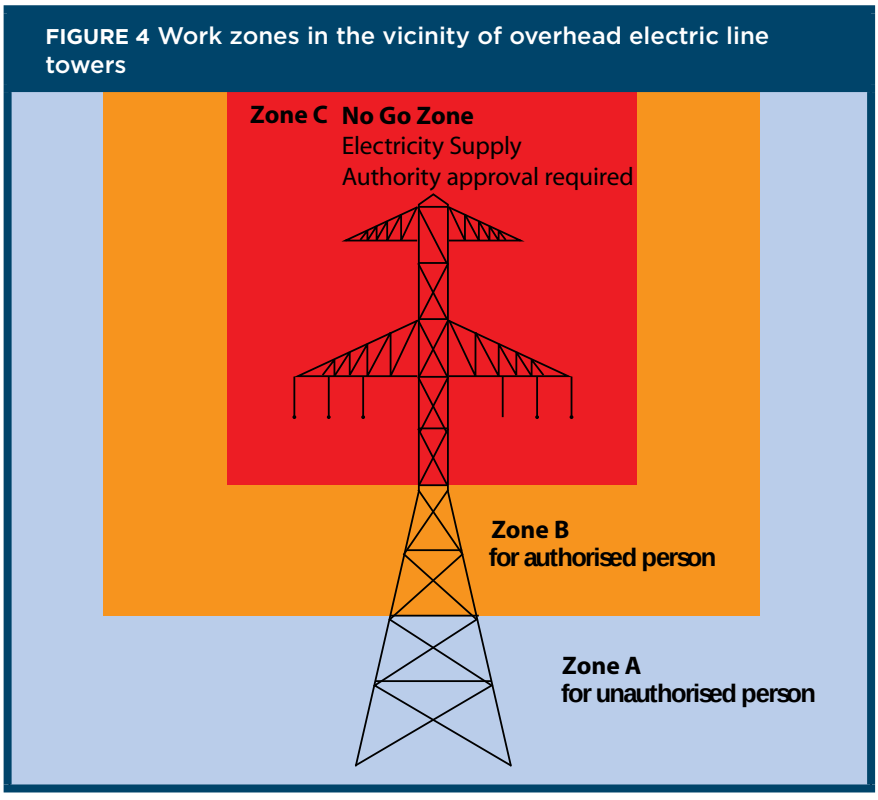


FIGURE 4 Work zones in the vicinity of overhead electric line towers



Zone A: Unauthorised persons

Unauthorised workers can only work in Zone A. Unauthorised persons are workers who have not received training in overhead line electrical hazards and do not have sufficient training or experience to enable them to avoid the dangers from overhead electric lines and associated electrical equipment.

Zone A applies to:

- unauthorised persons performing work in the vicinity of overhead electric lines including plant, hand tools, equipment or other material held by them, and
- cranes and their loads and mobile plant operated by an unauthorised person in the vicinity of overhead electric lines.

Use a risk assessment to decide whether a safety observer is necessary. The safety observer should monitor work close to Zone B to ensure no workers, plant or equipment enters Zone B.

Zone B: Authorised persons

Authorised persons are workers who have successfully completed a recognised training course in overhead line electrical hazards so are permitted to work in Zone B.

Zone B applies to:

- authorised persons, with a safety observer, performing work in the vicinity of overhead electric lines including plant, hand tools, equipment or other material held by them, and
- cranes and their loads and mobile plant operated by an authorised person, with a safety observer, in the vicinity of overhead electric lines.

Zone B approach distances are based on the results of a written risk assessment.

You must develop a safe system of work for Zone B. It should be based on a risk assessment and consultation with the Electricity Supply Authority about the proposed works. It should also comply with each work condition imposed by the Electricity Supply Authority.

Zone C: No Go Zone – requires Electricity Supply Authority approval

Zone C is the no go zone around overhead electric lines and associated electrical equipment where no part of a person, material, crane, vehicle or mobile plant may enter while the electric lines and associated electrical equipment are energised, without written approval from the Electricity Supply Authority. This includes:

- all parts of a person, hand tools, equipment or other materials held by them, and
- cranes, vehicles or mobile operating plant including the load, controlling ropes and other accessories associated with the plant.

The safest option is to have the electricity turned off and tested or have the lines moved. This will rule out the need for a no go zone. If the electrical part is high voltage, it must be earthed. If the electricity cannot be turned off, the electric line remains energised and dangerous.

No go zones apply whenever work is done or plant like a tip truck, crane, elevating work platform or a concrete pumping truck is operating around energised overhead electric lines and associated electrical equipment and the risk cannot be eliminated.

The area of a no go zone may vary, but it will always exist. A no go zone extends in all directions around the energised overhead electric lines and associated electrical equipment—not just sideways. No go zones should be established before work starts.

No one should enter a no go zone without the written approval of the Electricity Supply Authority. The approval may include special control measures restricting access to the no go zone, for example where or how the plant can move, equipment to be used and who may enter the no go zone. The written approval should be available at the site when the work is being done.

In planning the work and to decide the correct no go zone for the circumstances, you should contact the Electricity Supply Authority or asset owner to verify:

- the voltage of the electric line, and
- if it is insulated or bare.

A written safe system of work should also be developed for work done in a no go zone where a SWMS is not required. It should consider the safety of workers while doing the work and be readily accessible by workers including contractors. A safe system of work may include safe work practices and procedures, safe sequencing of work tasks, safe use of equipment, permit systems and relevant signs.

You should also consider who or what will be working in the vicinity of the energised overhead electric lines, for example the:

- type of work to be done
- type of plant to be operated, and
- amount of plant and the number of people with permission from the electrical supply authority to enter the no go zone.

Equipped with the right electrical training or experience, an authorised person can work within a reduced no go zone based on a risk assessment. On site the authorised person could be the plant operator, supervisor, electrician or worker.

All of these factors govern the safe approach distance.

Note: Different approach distances apply for scaffolding work and working near low voltage overhead electric lines near structures (see relevant information sheets).

Approach distances for vehicles

Table 2 sets out approach distances for vehicles and mobile plant stowed for transit, or with a design envelope up to and including 4.6 metres in height, that are driven by or operated by people under overhead electric lines. The design envelope varies across jurisdictions and is generally between 4.3 to 4.6 metres in height. Further information on the requirements for transporting high loads is in the *Guide for transporting high loads near overhead electric lines*.

Table 2 Approach distances for vehicles

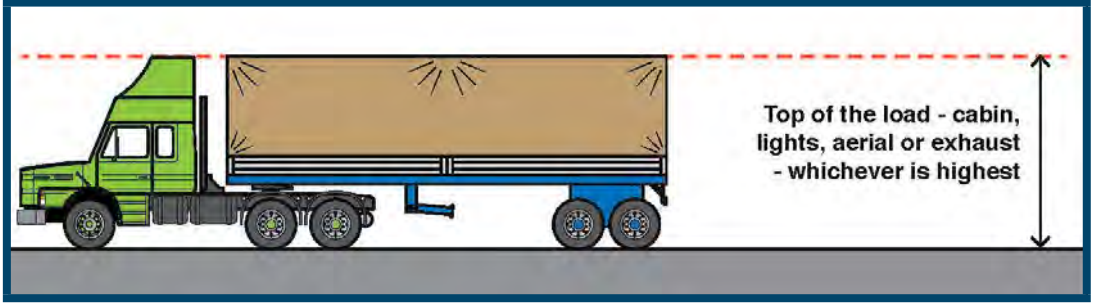
Nominal phase to phase a.c. voltage (volts)	Approach distance (metres)
Low voltage conductors up to 1000	0.6
Above LV, up to and including 33,000	0.9
Above 33,000 up to and including 132,000	2.1
Above 132,000 up to and including 220,000	2.9
330,000	3.4
500,000	4.4
Nominal pole to earth d.c. voltage (volts)	**Approach distance (metres)**
Up to and including +/- 1500 Volts	0.9

When assessing the approach distance for a vehicle being driven under overhead electric lines the following factors should be considered:

- The approach distances for vehicles specified in Table 2 are based on their design or transit envelope and do not allow any part of the vehicle to come closer than the specified approach distance. This includes the load, exhaust pipe and attachments like rotating and flashing lights or radio aerials (see Figure 5).

- Where a work activity involves a person working from, standing on or walking across the top of a vehicle the relevant approach distance specified in either Zone C or Zone B should be maintained. For example, this may include the driver of a livestock transporter who has to access the top of the vehicle to check livestock.
- Where as a result of the work being done, the distance between the overhead electric line and the ground may decrease. For example, when constructing a road or levee bank beneath overhead electric lines or where the ground level is raised during the work, the distance between the vehicle should be continually re-assessed to ensure the relevant approach distances are being maintained.
- Extra assessment factors relevant for operating the vehicle.

FIGURE 5 Transit envelope – the maximum overall height of the vehicle



Note: Approach distances and work zones in each state and territory vary for people, plant and vehicles depending on the voltage of the overhead electric line, whether the electric lines are insulated or bare, and in some states with or without consultation with the person in control of the energised overhead electric line and associated electrical equipment.

For further information contact your state or territory Electricity Supply Authority or Electricity Regulator.

Training and competence

You must ensure information, training and instruction provided to workers is suitable for the type of work being done by the worker, the associated risks and the control measures used. It should also be easily understood by the worker.

You should verify that any written certification shows the worker is trained and has the necessary technical skills, knowledge and competence to be authorised to work in Zone B.

People who work closer than the approach distances specified in Zone C and safety observers who observe the work in Zone B or closer than the specified distances in Zone C should have successfully completed a relevant training course provided by a registered training organisation. This training is in addition to the requirements for plant operators to be competent and in the case of high risk plant, hold a high risk work licence.

The organisation providing the training and competency assessment should provide statements of attainment or written certification of successful completion of assessment with a unique identifying number.

Safety observers must be competent to implement control measures in an emergency and to rescue and resuscitate the worker who is carrying out the work, if necessary. A safety observer must have been assessed in the previous 12 months as competent to rescue and resuscitate a person.

Training requirements and qualifications may vary across jurisdictions. For further information on the requirements in your state or territory contact your WHS Regulator, Electricity Supply Authority or your Electricity Regulator.

Maintaining competency

Authorised persons and safety observers should be re-assessed annually to ensure their on-going competency to work in the vicinity of overhead electric lines.

Re-assessment or re-training should cover—as a minimum—the knowledge and skills necessary to ensure relevant safe work practices, resuscitation procedures and emergency rescue procedures in the event of an incident.

People who have failed to maintain competency by applying skills and knowledge learnt to their work on-the-job should complete refresher training and competency assessment.

Safety observers

The safety observer is a person specifically assigned the role of observing the work activities in the vicinity of energised overhead electric lines and associated electrical equipment. This person should have successfully completed specific training so they are competent to observe the work and are able to implement control measures in an emergency. They should alert workers, crane or plant operators when approach distances may be about to be breached or if other unsafe conditions arise.

A safety observer should:

- be used whenever the work activity is likely to be done in Zone B or when the work is done closer than the distances outlined in Zone C
- be positioned at a safe location to effectively observe both overhead electric lines and plant operations
- be able to immediately and effectively communicate with the crane or mobile plant operator or other people if required
- ensure all people stay outside the specified approach distance unless they are:
  - performing a rescue in accordance with approved procedures, or
  - carrying out a specific task described in the SWMS e.g. a crane dogger holding a non-conductive tag line attached to a load suspended from a mobile crane
- not do other work while acting as a safety observer e.g. passing tools, equipment or materials to workers
- not observe more than one work activity at a time, and
- monitor the work activity being done and have the authority to stop the work at any time.

Further information and examples of what can go wrong when approach distances are not maintained are in Case studies – Incidents and scenarios.

UNDERGROUND ELECTRIC CABLES

Working in the vicinity of underground electric lines or cables may involve potential contact with exposed energised parts. For example:

- a plumber cutting a conductive water pipe that is part of the site's electrical installation's earthing system
- a fencing contractor digging holes or driving posts where an electrical cable could be buried
- digging holes with metal hand tools e.g. spades, shovels, picks, forks and hammers
- driving implements into the ground e.g. star pickets where underground services may be located
- a plumber digging a trench to locate underground pipes
- excavating trenches with earth moving machinery using a metal toothed bucket, and
- using mobile cranes or heavy vehicles that become bogged.

An injury resulting from damage to energised underground electricity cables is usually caused by electric shock or the explosive effects of arcing current and by the fire or flames which follow when the sheath of a cable is crushed or contact is made between the individual phases of a cable. The presence of gas or a mixture of gases in a trench could be ignited by an electrical charge or an electrical arc resulting in a fire or explosion, the severity of which depends on the gaseous mixture.

Gas can be present in the ground due to gas pipe damage or leakage, sewerage pits, chemical reactions or leaching and the accumulation of airborne gases in low lying areas. Gas can be introduced by the type of work being done including oxy-acetylene cutting or chemical grouting.

Before starting work and whether at a construction site or not, you must find out from relevant sources what underground electrical cables could create a risk if contacted or damaged. Use this information to plan the work and keep a written record of this information on site.

If excavating in a public place you must identify all electrical cables present. For example:

- Contact *Dial Before You Dig*, a free enquiry service for information on underground assets anywhere in Australia. This organisation will tell you if electrical cables owned by one or more of its contributory members are located in the vicinity of your site. Definite cable locations can be determined by special arrangement with the organisations. *Dial Before You Dig* can be contacted by:
  - phoning 1100; or
  - submitting an online enquiry on the Dial-before-u-Dig website (www.1100.com.au)
- Contact relevant authorities about all cables they may have placed in the vicinity of the excavation. Authorities may include:
  - electricity supply authorities
  - communication companies
  - local government authorities, and
  - water authorities.

In some cases, customers of electricity supply authorities have authority to place electricity cables in public places. If excavating on private property, contact the owner or occupier of the premises about buried cables before starting work.

When you have identified the electrical hazards at your workplace or site you must assess the risks. A risk assessment should consider:

- tools damaging cables or equipment e.g. when digging, driving equipment or excavating where buried electrical cables may be present, and
- electric cables or equipment being concealed in a work location.

A written risk assessment should be available on site for the duration of the work.

If it is not known whether cables, conduits, equipment or situations form an electrical safety risk, you should assume the risk exists or you should have a qualified person investigate and provide a report.

If you cannot determine exactly where an underground cable is, you should use pot-holing to carefully identify the cable location and avoid accidental contact with the cable. Pot-holing involves digging with hand tools to a pre-determined depth to verify if assets exist in the immediate location. You may use insulated hand digging tools suitable for the voltage concerned or use vacuum pumping in the pot-holing process to locate the underground cable.

Where the risk is known, for example where an electrical conduit contains an energised low voltage circuit and there is a risk the conduit could be cut or scraped with a power tool, suitable control measures must be used.

The best way of eliminating these hazards is to prevent people, plant, equipment and materials from coming close enough to energised underground electric cables for direct contact or flash over to occur.

This may include having the electricity supply to the site isolated. Sometimes when many cables are co-located identifying the isolation point for a particular cable is not easy. A qualified person should be engaged to do the isolation work or it may be necessary to have the Electricity Supply Authority disconnect the supply. De-energising electric lines should be arranged as soon as possible.

If it is not possible to eliminate the risk then the remaining risk can be minimised by:

- using insulated hand digging tools
- using non-powered hand tools
- hiring a person with relevant electrical qualifications to do the job
- installing a physical barrier to prevent accidental contact between a hand-held tool and underground electric cables
- ensuring authorisation is obtained to carry out the work e.g. a permit to work
- training workers to identify the hazards and perform the work safely, and
- using PPE like effectively electrically tested insulating gloves, fire retardant clothing and eye protection.

Identifying cables

Electric lines and cables are made in many different ways. Not all cables are covered with thermoplastic sheath, although these are common and often well known. Electrical cables have different shapes and appearances and can be circular, oval, flat or ribbed in cross section. These cables can also be any colour.

Some electric cables consist of a copper sheath with copper conductors within the sheath and a mineral insulation separating the conductors and sheath. These cables look and feel identical to copper water pipe or gas pipe. Cables of this kind could also be made of other metals like stainless steel and aluminium.

Electrical conduits are made of different materials and construction varies, for example:

- Polyvinyl chloride (PVC) rigid conduit from 16 mm or 5/8 inch outside diameter (OD) to 150 mm or 6 inch OD is generally light grey; if the conduit is heavy duty and acceptable for underground use, it may be orange. PVC conduit for protection against high temperatures is black
- PVC flexible conduit or flexible hose
- PVC corrugated conduit
- screwed metal conduit generally made from galvanized steel
- split metal conduit, while obsolete it is still widely used and generally painted black
- cable trunking, rectangular or square in cross section and in a wide range of sizes, made of steel or plastic, and
- cable tray, generally galvanized steel in a wide range of sizes and styles.

More information on excavation is in the Code of Practice: *Excavation work*.

EMERGENCY PLAN AND RESCUE PROCEDURES

Planning work in the vicinity of overhead or underground electric lines should include possible emergency situations and the rescue and evacuation of workers.

You must ensure an emergency plan is prepared and maintained so it is effective for each workplace or site. This is especially critical for work sites at remote locations.

More information is in the Fact Sheet: *Emergency plans*.

Emergency plan

A risk assessment should be done covering potential emergency situations resulting from mobile plant or attached equipment contacting energised electric lines including:

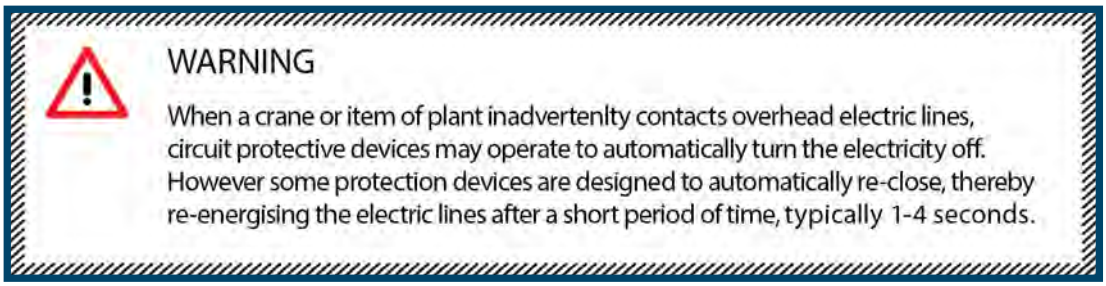
- contact with energised electric lines when the electricity trips
- contact with the energised electric lines when the electricity does not trip
- a fire starting on the mobile plant or attached equipment
- a grass or bushfire starting
- a tyre catching fire or tyre pyrolysis leading to a tyre explosion, or
- a combination of any of the above

An emergency plan should be developed from the results of the risk assessment, consulting with workers, the Electricity Supply Authority or the person with management or control of the electric line or premises and emergency service providers.

Emergency rescue procedures

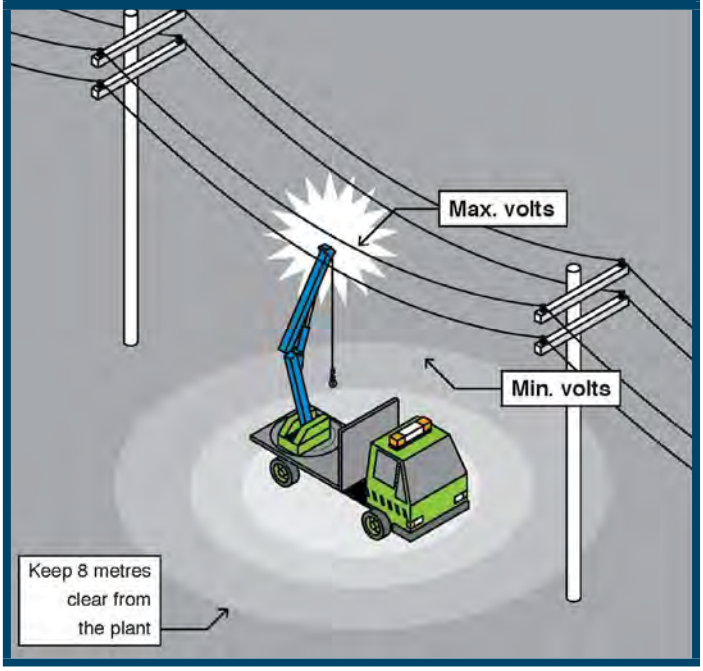
Where contact is made with an energised overhead electric line or a flash-over occurs between an energised overhead electric line and a crane or mobile plant take the following actions:

- **Try to break the crane or mobile plant's contact with the energised overhead electric line** by moving the jib or driving the mobile plant clear only if safe to do so.
- **If it is not possible to break the contact with the energised overhead electric line, the operator of the crane or mobile plant should remain inside the cabin of the crane or on the plant item.** Contact the Electricity Supply Authority immediately to isolate electricity to the energised overhead electric line. The operator should remain in place until the electricity has been isolated and the 'all clear' given by the Electricity Supply Authority.



- **If it is essential to leave the cabin or the operator's position because of fire or other life threatening reason, then jump clear of the equipment.** Do not touch the equipment and the ground at the same time. When moving away from the equipment, the operator should hop or shuffle away from the mobile plant with both feet together until at least 8 metres from the nearest part of the crane or operating plant. Under no circumstances run or walk from the crane or mobile plant as voltage gradients passing through the ground may cause electricity to pass through the body resulting in an electric shock.
- **Warn all other people and members of the public to keep 8 metres clear from the crane or mobile plant** (see Figure 6). Do not touch or allow other people to touch any part of the crane or mobile plant. Do not allow people to approach or re-enter the vehicle until the Electricity Supply Authority has determined the site safe. Remember electricity flows through the ground, so an electric shock could be received from walking close to the scene. If the crane or mobile plant operator is immobilised, ensure the electricity supply has been isolated and the site made safe before giving help.
- **Unauthorised, unequipped people should not attempt to rescue a person receiving an electric shock.** Secondary deaths often occur because others get electrocuted trying to help earlier victims. If the crane or mobile plant operator is immobilised, ensure the electricity supply has been isolated and the workplace has been made safe before giving help.

FIGURE 6 Affected area surrounding mobile plant when in contact with an energised overhead electric line



Inspecting plant after contact with electric lines

When a crane or mobile plant has been in contact with an energised overhead electric line, it should be checked by a competent person for damage to the components of the crane or mobile plant. All recommended actions are to be completed before the crane or mobile plant is returned to service.

Tyres on cranes and mobile plant that have been in contact with overhead electric lines where electrical flash-over and current flow occurs through the rubber tyres should be considered as a potential hazard. These rubber tyres may catch fire or have the potential to explode. A lesser known danger is when combustion takes place within the tyre and there are no apparent external signs. When excessive heat is developed in or applied to a tyre as in the case from contact with overhead electric lines, it can initiate a process known as pyrolysis, which is the decomposition of a substance by heat. This can generate a build-up of flammable gases and pressure within the tyre, which may rupture or explode.

Vast amounts of energy can be released by a tyre explosion often leading to significant equipment damage, serious injuries or fatalities. Pyrolysis related explosions are very unpredictable and have been known to occur immediately or up to 24 hours after initiation. An explosion can occur where no fire is visible. The danger area can be up to 300 metres from the tyre.

A crane or mobile plant with rubber tyres involved in an incident where contact is made with overhead electric lines which results in discharges or flash-over of electrical current through the tyres should be considered as a potential hazard. If anyone suspects there is a danger of a tyre explosion, as in the case of a mobile crane contacting overhead electric lines, the procedure should include:

- parking the crane in an isolation zone, with a minimum 300 metre radius
- removing everyone from the area and not allowing entry to the isolation zone for 24 hours, and
- alerting firefighting services.

APPENDIX A
OTHER RELEVANT INFORMATION

The following list of published technical standards provides guidance only and compliance with them does not guarantee compliance with the WHS Act and Regulations in all instances. This list is not exhaustive.

Australian and New Zealand Standards

- AS/NZS 1768:2007: *Lightning protection*
- AS 2550.5-2002: *Cranes, hoist and winches - Safe Use Part 5: Mobile cranes*
- AS 4024.1-2006: *Safety of machinery*
- AS/NZS 4576:1995: *Guidelines for scaffolding*
- AS 61508-2011: *Functional safety of electrical/electronic/programmable electronic safety-related systems*

International Standards

- ISO 13849-1:2006: *Safety of machinery – Safety related parts of control systems – Part 1: General principles for design*

National Electricity Network Safety Guidelines

- ENA NENS 04-2006: *National guidelines for safe approach distances to electrical and mechanical apparatus – Energy Networks Association*.