VESI

FIELDWORKERS HANDBOOK

JUNE 2006

updated November 2008

ISSUE SHEET

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2. COPYRIGHT

3. INTRODUCTION

This VESI Fieldworkers Handbook – 2008 updated edition, is a compilation of work practices for the use of VESI field based personnel.

The VESI Fieldworkers Handbook incorporates a revision of the 2006 VESI Fieldworkers Handbook. The Handbook is not intended to contradict company procedures, the National Competencies or materials commonly used by RTO's.

4. STEERING COMMITTEE

The new VESI Fieldworkers Handbook – 2008 updated edition has been produced under the guidance of a Steering Committee comprised of members from the VESI:

CitiPower / Powercor	Dick Gersh (Chairperson), Barry Culph
Jemena	Adam Beel, George Smith
SP AusNet	Dave Harden, Dennis Munn
Energy Safe Victoria	Loc Vuong
Electrical Trades Union	Greg Arnett
National Electrical & Communications Association	Geoff Hamill

The Steering Committee acknowledges the work performed by Linda Wilson (22/7/1968 - 12/7/2005) in assisting with the preparation of the Fieldworker Handbook and also acknowledges the Electricity Engineers Association of New Zealand's contribution to the development of this Handbook.

5. OWNERSHIP

Ownership of the VESI Fieldworkers Handbook lies with the VESI Distribution and Transmission businesses. The Handbook is sponsored by the VESI Green Book Committee.

6. REVISIONS

The Steering Committee will meet every six months, or as required, to review the content of the Handbook to ensure that it remains up to date with industry standards and safety initiatives.

Revisions to this Handbook can be initiated via the "member" organisations. Any person wishing to suggest a change/review should initiate their request using the "Submission for Change" form at the end of this section through their local Field Practices Manager (or equivalent).

The Field Practices Manager will review suggestions and forward relevant matters to the Steering Committee.

Only the VESI Fieldworkers Handbook Steering Committee can authorise changes/revisions to this Handbook.

7. ADDITIONAL COPIES

Additional copies are to be ordered via the Field Practices Manager of the “member “organisations.

VESI Fieldworkers Handbook

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Suggestion/Recommendation

Reason

Mail or FAX to your relevant Field Practices Manager or Steering Committee member.

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GENERAL HEALTH & SAFETY SECTION 1

1. INTRODUCTION

The Victorian Occupational Health & Safety Act 2004 states that employees (including contractors) are entitled to, so far as is reasonably practicable, a safe work environment that is without risks to health. Further, all employees have a duty to take reasonable care for their own health and safety and that of others who may be affected by their work.

All employees are encouraged to raise health and safety issues with their supervisor or their health and safety representative in accordance with Company issue resolution arrangements.

The information provided in this section should be read in conjunction with relevant Company policies and procedures.

2. JOB SITE ASSESSMENTS

Prior to commencing work, a site assessment must be completed and documented for all activities to enable the identification and control of hazards. The site assessment shall be documented on your Company's relevant form (JSA, Toolbox Checklist, etc).

The 'hierarchy of control' should be used to determine the appropriate level of control for identified hazards. In order, consider each of the following:

ELIMINATE the hazard completely. This is the most preferred option.

SUBSTITUTE the hazard for a safer product or method.

Use **ENGINEERING** controls to reduce the risk (e.g. machine guards, ventilation, mechanical aids, isolate employees from the hazard, etc).

Use **ADMINISTRATIVE** controls such as signage, training, job rotation, etc.

Use personal **PROTECTIVE EQUIPMENT** such as hearing and eye protection.

If hazards cannot be effectively controlled, the work activity must not take place until additional controls are implemented.

The role of each member of the work party should be clearly understood by everyone involved.

The risk assessment shall be reviewed during the job to ensure any additional hazards are identified and controlled.

All persons newly arriving on site must sign on to the job site assessment.

3. COMMUNICATION

Employees are encouraged to question instructions to ensure a clear understanding of safe work practices and procedures, and to seek assistance whenever unsure.

Ensure that the safety aspects of each job are properly discussed in advance and that a safe working environment can be maintained throughout the various stages of the job.

4. INCIDENT CONTROL

Make incident sites safe and provide first aid (if safe to do so). When required, arrange emergency services as soon as possible. Incident sites must be made safe; however employees should take into account the possible requirements where the incident is 'notifiable'. A notifiable incident requires reporting to WorkSafe Victoria or Energy Safe Victoria and the site should not be disturbed until the relevant inspector advises otherwise.

Immediately notify your supervisor / team leader of all incidents, injuries, near misses and hazards and complete the necessary forms in accordance with Company procedures.

Where an electrical shock or network incident has occurred on network assets, the asset owner must be advised immediately. Refer to each network asset owner's rules when reporting such incidents.

5. WORK PRACTICES

Always follow organisational safe working practices and procedures and avoid injuries to yourself, your team mates and the general public.

Use approved tools, personal protective equipment and appliances, and ensure they are well maintained, within test date and replaced when necessary.

Only operate plant and equipment for which you are authorised and feel confident to use or when being supervised by an appropriately authorised person.

Ensure your training (including refresher training) is current and up to date.

Undertake all work in accordance with the Code of Practice on Electrical Safety for the Distribution Businesses in the Victorian Electricity Supply Industry (The Green Book), Company procedures and other relevant legislation.

6. FALL PROTECTION

When planning for and assessing the hazards involved with working at heights, the following hierarchy of controls shall be implemented:

a. Eliminate the hazard, i.e. perform the work at ground level.

b. Use a passive fall arrest system, i.e. EWP, guardrail.

c. Use a work positioning system, i.e. Maypole or other restraining system.

d. A fall injury prevention system, i.e. safety net, harnesses.

e. Use of ladders, (footed) and/or administrative controls, (JSA's).

Prior to the commencement of any work at height, a risk analysis is to be carried out. The risk analysis may be in the form of:

- Field Job Safety Analysis (JSA) for normal tasks involving limited work at height, e.g. carrying out tests or pole replacement and maintenance activities.
- Design planning Job Safety Analysis where there are 2 or more people or groups involved in the work and work involves more complex operations, e.g. installation of façade mounted ABC assets.

The risk analysis should as a minimum consider the following:

- The Fall Prevention Hierarchy of Control
- Means of fall prevention
- Access for mobile work platforms
- Condition of access equipment, including ladders and harnesses
- Loads likely to be encountered at height.
- Wind and weather conditions
- Vehicular and pedestrian traffic
- Use of tools and equipment

Employees shall use company equipment provided and the processes established to control the risk of a fall.

Elevated work platforms (EWP's)

Persons working from an EWP work platform shall use free fall arrest (harness & lanyard) appropriate to the work platform. The fall arrest system used shall be attached to an anchorage point designed for fall protection.

- All work must be carried out from the floor of the workbox.
- Elevated work platforms must be used on firm level ground.
- Where fitted, outriggers must be used before raising the workbox.
- Platforms must be lowered into a stowed position before the unit is moved.
- Checks must be carried out on the equipment prior to use.
- Check that there is adequate clearance from surrounding equipment prior to elevating personnel.

Operators of over 11 meters EWP's

Operators and safety observers shall be licensed by OHS Certification Australia and complete annual refreshers on EWP Escape and Rescue.

Operators of under 11 meters EWP's

An operator and safety observers shall be suitably trained and complete annual refreshers on EWP Escape and Rescue.

When working within proximity of live electrical assets the Elevating Work Platform shall be used and,

- Be visually inspected by the operator daily before use.
- Be electrically tested six monthly.
- Be inspected by a recognised elevating work platform specialist three monthly.
- Be weight tested annually.

Any faults or programmed maintenance identified that could put the user or other's at a heightened risk must be tagged and not used.

Scaffolds

Scaffolds are a common means of providing a safe work platform for working at height. There is a wide variety of scaffolding systems available.

Any scaffold from which a worker or object could fall more than 4 metres must be erected, altered and dismantled by (or under the direct supervision of) a person with a certificate of competency of the appropriate class.

Scaffolds are subject to the requirements of the Plant Regulations regarding design, installation and use.

Ladders

Access by ladders should be considered only where the persons using the ladder have been appropriately trained and the use of the ladder is supported by appropriate company procedures.

The primary use of ladders is for gaining access to areas at height, although in some situations the use of a ladder as a work platform may be the only practicable method. Work carried out from a ladder should be of a light nature requiring the use a lineworker's pole belt or a harness complete with a pole strap.

Persons required to access, egress from the initial work positions via a ladder shall use restrained fall arrest as soon as they reach the work position at or near the top of the ladder.

Where obstructions or other factors prevent continuously attached climbing using the line worker's body belt (i.e. climbing over crossarms), then limited free fall arrest or free fall arrest shall be used until such time as restrained fall arrest can be resumed. (i.e. the worker shall be continuously attached with a lanyard or a pole strap at all times.)

Where a ladder cannot be secured or tied, (i.e. at the POA) and the employee is working from the ladder 2 metres or more above ground level, (measured from ground to feet), the ladder shall be footed until the work is completed.

If transferring to a ladder from an EWP or a structure, the ladder shall be appropriately secured prior to transfer.

When working with ladders, employees should:

- Select the ladder on the basis of the type of work to be performed and should be:
    - Constructed of a non conductive material.
    - Fitted with a non conductive bucket.
    - Fitted with a 12mm head rope.
    - Fitted with non slip feet.
    - Marked with an identification number.
- Portable ladders are to have a clearly identified load rating of not less than 120kg.
- Inspect ladders annually and before each use. If defects are found, the ladder shall immediately be removed from service, labelled as defective and reported to the responsible person.
- Be placed as close to the work position as practical to avoid over reaching as this could affect the stability of the ladder.
- Three points of contact should be maintained with the ladder during ascent and descent.
- The ladder shall be footed or mechanically stabilised until secured.
- Securely place, hold or tie a ladder whenever possible to prevent slipping or falling. Ladder chocks may be used.
- Set the base of the ladder a safe distance from the vertical – approximately 25% of the working length of the ladder (i.e. a 4:1 ratio).
- Always face the ladder when ascending or descending, using both hands.
- Undertake work from no higher than the second top rung and not stand on stiles.
- When working from a ladder for extended periods, rest periods or job rotations should be considered.

- Where a ladder is used to gain access to a roof, work platform or landing, the top of the ladder shall extend above the level roof by a distance of at least 1m. The ladder shall be footed by an assistant during ascent and descent unless secured.
- Where a ladder is used near doorways, the door shall be blocked open, locked closed or a person may be used to guard the base of the ladder. Warning signs should also be displayed.
- Ladders should not be left unattended while erected in a public area.
- No person shall ascend closer than the second last step, (not including the top) from the top of a step ladder.
- Step ladders shall only be used when in the fully open position.
- Step ladders & trestle ladders should not be used for access to or egress from solid construction.
- Ladders shall be handled with care and not be subject to dropping, jarring or misuse.
- Two or more people may be required to safely carry and erect ladders.
- When a ladder is being carried, raised or lowered care must be taken to avoid injuring any person standing nearby, including both the operator and assistant.
- When ladders are stored or transported the ladder should be supported to avoid sagging and securely tied.

Carrying ladders

Ensure that the head and extension ropes are tied.

Have two people to carry ladders over 4.8, (Extended Length):

- One person at each end to share the load and avoid projecting ends,
- When walking keep in step,
- Walk forward only.

NOTE: See Section 10, Tools & Equipment for further information regarding ladder inspection.

Work on roofs

When working from or over awnings, roofs or verandahs, a JSA shall be undertaken to identify the hazards and the controls to be established at each job site taking into consideration both the requirements of the task (e.g. short term or long term), and the hierarchy of controls for fall prevention.

Examples of controls to be considered:

- Do task or part of task from ground
- Post safety observer
- Maintain controlled body movements
- Check structure for soundness (visual check looking at rust, rot etc)
- Ensure roof surface is safe
- Ensure footing is level
- Remove tripping hazards
- Keep task duration to a minimum
- Use of verandah boards
- Visual warnings, (e.g. witches hats)

Where the task is long term, i.e. LVABC facade mounting, a JSA is to be undertaken taking into consideration the Fall Prevention hierarchy of controls to achieve the best fall protection for the task ,e.g. barriers.

7. RESCUE TECHNIQUES

Pole top rescue

The following principles of PTR shall be adhered to:

- That the rescuer protects him/herself.
- That the contact is broken quickly.
- That resuscitation commences quickly.
- That the victim is not exposed to further injury.
- If the victim's belt is not secured, attach rescue rope first.

These principles also apply in the case of contact with high voltage, except that the victim must not be approached too closely until contact is broken by use of a live line stick, or an operating stick.

PTR Procedure

1	Ascend Ladder	Wear LV gloves and rescue belt. Ensure rescue rope available. Secure rescue belt around ladder. Stop below the victim.
2	Adjust Your Body Belt	Tighten rescue belt to support yourself and the victim so that you may quickly complete the rescue using both hands.
3	Push the Victim Forward (this will often break the contact)	Hold the victim against the ladder or structure with your shoulder to ensure he does not overbalance.
4	Break the Contact	Use one hand only.
5	Rig for Rescue	The rescue rope should be attached to the structure at a location to minimise free fall of the victim prior to detaching the victim's belt. Attach rescue rope to harness or belt (if wearing body belt push belt to below underarm). Take up slack of rope.
6	Clear Pole Strap from Structure	Cut or remove pole strap. **Caution:** Ensure cutting action does not accidently sever any other ropes or pole straps.
7	Shift to the Lowering Position	Pass the rescue rope (between the ladder and the victim) to the opposite side of the ladder. Descend until your rescue belt is below the victim's feet.
8	Lower the Victim	Hold the weight on the rope with one hand and with the other, lever his feet from the ladder and the victim's ankles, grasp the ladder stile and lever his feet from the rung. Lower the victim using the rescue rope.
9	Descend Ladder	Descend the ladder.
10	Commence Resuscitation Immediately	Ring emergency number. Report the accident.

1. If the victim is conscious he or she may be permitted to climb down the ladder provided the rescue rope is rigged for rescue and held while he descends.
2. The rescue kit shall consist of – Bag, LV gloves, Rescue rope, and Rescue belt with knife and cable cutters.
3. Rescue kits should be checked 6 monthly that the kit is in a sound and undamaged condition.
4. Where sealed kits are used, they shall be sealed at all times.

EWP escape

- The rope shall be long enough to reach the ground from full height.
- Check CDD has correct number of loops and is at the upper end of the escape rope:
  1. All white rope – 2 loops
  2. Coloured rope or rope with a coloured strand – 3 loops
- Two-person EWP baskets must be fitted with 2 units.

EWP Escape Procedure

1	Check Below	Check that when the CDD is released, there will be a clear descent course to the ground, i.e. where possible, the CDD rope should be clear of the tray of the vehicle when dropped.
2	Lower CDD	Remove lynch pin to release escape rope and outer fibreglass cover. (Press end of fixed pin from which lynch pin has been removed if internal leaf spring does not cause instant release).
3	Check CDD	Check condition of: 1. Rope 2. Bollard 3. Hook latch
4	Attach CDD	Fasten CDD to harness. Keep rope between bollard and attachment point as short as possible.
5	Release harness	Once escape rope is securely attached, release harness from its EWP anchor.
6	Climb outside the EWP basket.	Maintain a hand-hold of the EWP basket until the body weight is taken up by the escape rope.
7	Grasp tail of escape rope	To control descent speed. Ease off hand grip on EWP and begin descent.
8	Control descent	By raising the tail of the escape rope and applying light tension using one hand. NOTE: The person on the ground can control the descent by applying light pressure to the tail of the rope and assist by hauling the loose rope tail to one side.
9	Refit the CDD	Refit the CDD escape rope after use. Ensure the metal hand piece is returned within 300mm of the anchor point and carefully coil the rope within the fibreglass container.

Tower rescue

The following principles of Tower Rescue shall be adhered to:

- That the rescuer protects him/herself
- That the electrical contact if present is safely broken
- That the casualty is secured from fall before commencing and at all times during rescue
- That the casualty is not exposed to further injury

see chart next page......

Tower rescue *cont.*

1	Alert Control Room	If practicable, alert the control room to coordinate the attendance of emergency services.
2	Ascend Tower	Ascend the tower with rescue kit. Secure your pole belt to the tower. Assess the situation.
3	Electrical Contact	If the casualty is in contact with a live object, remain clear of the casualty and break contact using a live line stick rated for the voltage.
4	Clearance Check	Check clearances to live conductors near the casualty. Check that the rescue path is clear for both the rescuer and the casualty.
5	Secure the casualty	Check the casualty's harness and ensure that he is attached to the tower by pole belt.
6	Rig for Rescue	The rescue rope must be located above the casualty to provide a safe descent path ONE Rescuer: The rescue rope is attached to the structure via a sling and karabiner. TWO Rescuers: The rescue rope is passed through the auto-stop descender which is attached to the structure via sling and karabiner. The rescue rope is attached via karabiner to the casualty's chest loops, rear dorsal 'D' ring or shoulder extension strap.
7	Transfer to Rescue Position	ONE Rescuer: The rescuer is attached to the rescue rope via auto-stop descender and karabiner connection to the chest loops of his harness. The casualty is then connected to the rescuer's chest loops via the karabiner and short sling, to the casualty's chest loops, rear dorsal 'D' ring or shoulder extension strap. The rescuer then takes the weight to the rescue rope. TWO Rescuers: The rescuer aloft transfers the weight of the casualty to the rescue rope. A tag rope is also attached and lowered to the second rescuer on the ground.
8	Manoeuvring Clear	If necessary, rig the casualty recover pulley system to manoeuvre the casualty clear of obstructions and assist in transfer to the rescue gear. (The casualty must remain attached either to the structure or rescue gear during this operation).
9	Clear the Pole Strap	The rescuer unclips or cuts the casualty's pole strap to get clear of the structure. **Caution:** Ensure cutting action does not accidently sever any other ropes or pole straps.
10	Controlled Descent	ONE Rescuer: The rescuer descends with the casualty attached via chest loops, controlling descent with auto-stop descender and maintaining the casualty clear by pushing out from members. TWO Rescuers: The rescuer aloft controls descent via the auto-stop descender, while the second rescuer maintains the casualty clear of the tower members via the tag rope.

GENERAL HEALTH & SAFETY

LV panel rescue

1	Assess the situation	• Speed is essential. • Rescuer safety. • Hazards: electrical, fire or height. • Size of victim. • Is it low voltage or high voltage?
2	Isolate supply if practical	WARNING – Mains and apparatus are to be treated as alive even if the isolating switch has been operated.
3	Put both gloves on	Remember to protect yourself.
4	Release the victim	Use a safety crook or other suitable device to release the victim from the electrical apparatus. Be prepared to use suitable force to push or pull the victim from the live electrical mains and apparatus.
5	Remove the victim to a safe area	A safe area is clear of all live mains and apparatus. You may have to drag the person clear of the danger area using the one person drag method.
		For the one-person drag method of removing a person to a safe area, the rescuer crouches behind the person and places their arms under the person's armpits across the chest and locks one of their hands over the persons opposite wrist. He then lifts the person and then proceeds to drag them to a clear safe area for treatment or observation.
6	Carry out basic life support and First Aid as required	Speed is critical. First Aid must be applied as soon as it is safe to do so.
7	Call 000 for an ambulance as soon as possible	

8. SAFETY OBSERVER

A Safety Observer shall be used as required by The Green Book and/or organisational procedures.

Where it is considered that a person, equipment or mobile plant may infringe safe approach distances or inadvertently contact live electrical apparatus, a safety observer shall be posted.

The Safety Observer's sole duty shall be to warn people should the approach to live electrical apparatus become hazardous.

9. TRAINING & AUTHORISATIONS

All employees are to undertake only those activities for which they are trained and authorised.

Advise your supervisor/team leader of any limitations you or others may have which will affect the safe completion of duties.

"All employees issued with a VESI Passport are responsible to ensure it is updated as training modules are completed. All employees shall carry their Passport with them while working for an electrical distribution business".

10. FITNESS FOR WORK

All employees shall be fit for work with their ability to work safely not adversely affected by alcohol, drugs, fatigue, occupational (or personal) stress or other factors (e.g. age, injury, medical condition).

Any employee adversely affected by alcohol, drugs, fatigue, stress or other factors (as above) shall not commence work.

Employees are required to comply with Company alcohol and drug policy.

All work is to be undertaken in accordance with the relevant Company fatigue policy.

Supervisors and employees should monitor each other for the effects of any of the above mentioned conditions and discuss concerns immediately.

11. FIRE PREVENTION

All employees shall:

- On total fire ban days if it is absolutely necessary to carry out work using spark producing tools or naked flames, ensure the appropriate permits (MFB, CFA or DNRE) are in place and proper precautions are taken.
- Be responsible for recognising fire hazards, eliminating the fire hazards where possible, and reporting those which are beyond your control to your supervisor / team leader.
- Dispose of wastepaper, oily rags and other combustible materials in appropriate containers.
- NOT use open flames or spark producing tools in any area where combustible gas vapours or dust may exist unless proper precautions are taken.
- NOT use open flames or spark producing tools in areas that are grassed or contain other combustible materials unless proper precautions are taken.
- Be aware of what actions are to be taken in case of fire, including who to notify, where and how to sound available alarms and what fire fighting equipment to use.
- Remove fire extinguishers that have been discharged, even partially, from service. The discharged extinguisher shall be replaced as soon as possible.
- NOT obstruct access to fire extinguishers and other fire protective equipment and ensure exit routes are kept clear of all obstacles.
- Exercise care when operating vehicles and plant in areas that are grassed or contain other combustible materials.
- Where appropriate, ensure that vehicles carry the equipment outlined in Table 1 during declared high fire danger periods.

TABLE 1

Vehicles that may travel off public roads	Equipment
Sedans/Station Wagons	Knapsack 9 litre to comply with AS 1687 or dry chemical fire extinguisher that complies with AS/NZS1841. 1:1997 and AS/NZS 1841.5: 1997
EWP's, Crane Borers, LCT's and Vehicles carrying/ towing Portable Generators (Additional)	Knapsack 16 litre (plastic) or Knapsack 14 litre (brass) (both must comply with AS 1687) Shovel and rake hoe

- When operating plant & equipment in off road situations, operators must ensure that the following steps are taken:
  - never leaving the vehicle unattended with the motor operating
  - remove build up of grass from the vehicle
  - the vehicle is carrying tools (shovels, rakes) to clear an area

Table 2 lists which fire extinguishers are appropriate for particular uses.

TABLE 2

Type	Colour	Uses
Water	Red / Red	Wood, paper & plastics
Wet Chemical	Red / Lemon	Wood, paper & plastics Cooking oils & fats
Foam	Red / Blue	Wood, paper & plastics Flammable & combustible liquids Cooking oils & fats (limited)
Powder AB(E)	Red / White	Wood, paper & plastics Flammable & combustible liquids Flammable gases Energised electrical equipment
Powder B(E)	Red / White	Flammable & combustible liquids Flammable gases Energised electrical equipment Cooking oils & fats
Carbon Dioxide*	Red / Black	Wood, paper & plastics (limited) Flammable & combustible liquids (limited) Energised electrical equipment
Vaporising Liquid	Red / Yellow	Wood, paper & plastics Flammable & combustible liquids (limited) Flammable gases (limited) Energised electrical equipment

** Generally not suitable for outside use. Suitable only for small fires.*

12. NOISE

Appropriate personal protective equipment is to be worn when:

- operating or working adjacent to noisy equipment, or
- when indicated by relevant signage or directed by a supervisor, or
- when working in noisy environments where there is potential for noise exposure standards to be exceeded

Hearing protection is to be fitted and maintained as per the manufacturers instruction

13. DISPOSAL OF SHARPS

Sharps are only to be picked up using the appropriate personal protective equipment (gloves and tongs) and shall be disposed of in specific sharps disposal containers.

14. THERMAL ENVIRONMENT

All employees shall work in accordance with Company policies regarding thermal environments.

Consideration shall be given to environmental conditions such as extreme heat or cold.

Supervisors and employees shall monitor each other to ensure the effects of thermal stress are not apparent.

Duties should be rotated as appropriate to prevent thermal stress.

Sunscreen shall be worn by all employees and frequent intake of fluids (preferably water) shall be encouraged.

15. PERSONAL PROTECTIVE EQUIPMENT

All employees shall wear and use approved personal protective equipment (PPE) as required by Company procedures or The Green Book.

All employees are to ensure PPE is appropriately selected, used and maintained to avoid or minimise unacceptable risk by ensuring:

- Suitability for purpose
- Correct fit
- Appropriate maintenance and inspection

Defective PPE shall be withdrawn from service and repaired or replaced.

16. SMOKING

Smoking is prohibited in all buildings (including zone substations, canteens, warehouses and stores) in designated walkways and building surrounds (including near points of entry and exit) and all vehicles.

Smoking is prohibited in outdoor locations where hazardous conditions exist, such as:

- Where combustible vapours or fumes may be present.
- Where records and supplies would be exposed to a hazard from fire, smoke or ash.
- Where dangerous goods have smoking precautions prescribed in their Material Safety Data Sheet.
- In confined spaces.

17. CONFINED SPACES

All confined spaces shall be entered only in accordance with Company procedures and relevant legislation.

If an employee is unsure as to whether a space is a defined confined space or not, they should assume that it is a confined space and follow relevant procedures. Management shall be notified so that a determination can be made.

18. EMPLOYEE SECURITY

All employees are to immediately remove themselves from any situation where their security is threatened.

Any incident compromising employee security is to be immediately reported to management and/or the police and employees shall await further instruction. Incidents include action by a customer or member of the public such as:

- verbal or physical harassment
- verbal, written or physical threats
- damage to property
- any actions that cause others to feel unsafe in the workplace

19. SUPERVISION OF LINEWORKER APPRENTICES

Introduction

The complete Supervision Guidelines for Lineworker Apprentices in the Victorian Electricity Supply Industry (Distribution) can be located on the ESV web site (www.esv.vic.gov.au).

Supervisors should use these Guidelines when planning work or allocating work functions and activities in the workplace for apprentices.

Apprentices should not assume responsibility for tasks unassisted unless they have received relevant training. However, this does not restrict an apprentice from observing or assisting qualified personnel undertaking tasks, for which the apprentice is not qualified, e.g.,

a. A first year apprentice should not undertake LV cable jointing, yet can assist a qualified jointer for example by cutting lengths of cable, or applying a heat shrink under direct supervision.

b. A second year apprentice should not perform metering and testing work, but can assist a qualified tradesman for example by hanging and wiring a meter under direct supervision.

c. A first year apprentice should not install overhead or underground services, but can assist a qualified tradesman for example by hanging the house end under direct supervision in preparation for testing.

Table 3 provides guidance on the activities apprentices can and cannot undertake. It has been aligned to the training package as delivered for the VESI (Distribution) Powerline 3 qualification, ie. it shows apprentices as being able to perform live metering and servicing during the second year, which is when they complete that relevant module.

Supervision types

During the term of their apprenticeship the apprentice shall be under either Direct, General or Broad Supervision as defined below at all times. A supervising employee must be competent in the task being undertaken.

Direct (Constant) Supervision

This means the tradesperson is to work with the apprentice at all times, constantly guiding and reviewing the work practices and standards of the apprentice's tasks/work. The tradesperson shall be in direct visual & audible contact with the apprentice whilst the task/s is being performed.

NOTE: All "Live Work" requires Direct Supervision on a one to one basis.

General Intermittent Supervision

This means the apprentice does not require direct (constant) supervision, but requires frequent face to face contact during the task/s to provide progressive instructions and to check on the work being performed.

Broad Supervision

This means the apprentice does not require the continuous direct or general supervision of the on site supervising tradesperson. However the supervising tradesperson shall maintain regular face to face contact with the apprentice to inspect and assess the work being carried out by the apprentice.

As part of Broad Supervision the supervising tradesperson shall provide the apprentice with instruction and direction for the tasks to be performed.

Supervision Practice

The goal is for supervision to progressively diminish from direct to broad in the third or fourth year of the apprenticeship (depending on the task) with the exception of performing "Live Work".

TABLE 3 WORK TYPES

NOTE: No tasks can be undertaken unassisted until the apprentice has been trained by an RTO or appropriate trainer/assessor and passed the relevant course.

TABLE 3 WORK TYPES

	Type of Work	First Six Months	Second Six Months	Year Two	Year Three	Year Four
General	Yard Work	General	Broad	Broad	Broad	Broad
	Ground Work at Job Site	Direct	General	General	Broad	Broad
	Pole Dressing	Direct	General	General	Broad	Broad
	Traffic Control	No	General	General	Broad	Broad
	Install Stays	Direct	Direct	General	General	Broad
Working Aloft	LADDER Work Aloft (Under EAP or Not Commissioned).	Direct	Direct	General	General	Broad
	EWP Work Aloft [1] (Under EAP or Not Commissioned).	Direct (Not Operating EWP)	Direct	Direct	Direct / General	Broad
Earthing	Install Substation / Switch Earths	Direct	Direct	Direct	Direct / General	Broad
	SWER Earth maintenance	Direct	Direct	Direct	Direct / General	Broad
Public Lighting	New Public Lighting Installations. (De-energised)	Direct	Direct	General	General	Broad
	Public Lighting Maintenance & Repair (Live)	No	No	No	No / Direct	Direct

[1] Must be at least 18 years of age and hold the relevant WorkSafe licence to perform high risk work, (boom-type elevating work platform operation).

GENERAL HEALTH & SAFETY

SEC:1

Type of Work		First six Months	Second six Months	Year Two		Year Three		Year Four
Metering & Servicing	Install / Replace Metering (De-energised)	Direct	Direct	Direct		Direct	General	Broad
	Install / Replace Metering (Live)	No	No	No	Direct	Direct		Direct
	Install Services Overhead and Underground (De-energised)	Direct	Direct	General		General		Broad
	Install Services Overhead and Underground (Live)	No	No	No	Direct	Direct		Direct
	Undertake NST/Polarity Test	No	No	No	Direct	Direct		Direct
Live LV Work	Live Low Voltage Work	No	No	No	Direct	Direct		Direct
	Make LV Dead	No	No	No	Direct	Direct		Direct
	LV Bridging	No	No	No	Direct	Direct		Direct
	Change LV Cross Arm Alive	No	No	No	Direct	Direct		Direct

Type of Work		First six Months	Second six Months	Year Two		Year Three		Year Four
Cable Jointing	LV Cable Jointing (Under EAP or Not Commissioned)	Direct	Direct	Direct	General	General		Broad
Cable Jointing	Live LV Cable Jointing	No	No	No		No	Direct	Direct
Cable Jointing	HV Cable Jointing	No	No	No		No	Direct	General
	Undertake Vegetation Control (EAP)	No	No	No	Direct	Direct		General
	High Voltage Operating [2]	No	No	No		No	Direct	General

[2] Network Operator issued HV Operating Authority must be held.

TABLE 4 PLANT TYPES

Type of Work	First Six Months	Second Six Months	Year Two	Year Three	Year Four
Chainsaw	No	Direct	General	Broad	Broad
Self-Loading Cable Trailer	No	Direct	General	Broad	Broad
Cable Recovery Unit	No	Direct	Direct	General	Broad
Forklift	No	Direct	Direct	General	Broad
Truck-mounted crane ≤ 20 tonne	No	Direct	Direct	General	Broad
EWP	No	Direct	General	Broad	Broad

Prior to operation, the plant operator must meet all regulatory requirements, ie age, training and hold the relevant WorkSafe licence to perform high risk work i.e.:

a) Slewing mobile crane operation (up to 20 tonne)
b) Forklift truck operation
c) Boom-type elevating work platform operation

ELECTRICAL THEORY SECTION 2

ELECTRICAL THEORY

1. INTRODUCTION

It is important electrical workers have a good working knowledge of the principles and theory of electricity so that they can work safely on electric lines and associated equipment. This is especially so because electricity cannot be seen and is only evident from the effects that can be experienced, (for example, light, heat and force).

Unfortunately this increases the risk of harm to people working on or using electric lines or associated equipment. Electrical workers must use their training in electrical principles and theory to anticipate how electricity may flow and to ensure they work safely without causing harm to themselves or others.

2. WHAT IS ELECTRICITY?

Electricity may be explained by means of the "electron theory".

In nature, all substances can be grouped into two classes, compounds and elements. Compounds are combinations of elements in definite proportions. For example ordinary water consists of two parts hydrogen combined with one part oxygen, while common salt consists of one part sodium combined with one part chlorine. The substances hydrogen, oxygen, sodium and chlorine are known as "elements". If a small amount of any element is divided into smaller and smaller parts, eventually a very small amount known as an "atom" is obtained.

The "electron theory" assumes that these atoms are made up of smaller particles, electrical in nature, called "protons", "electrons" and "neutrons".

A proton is a positively charged particle.

An electron is a negatively charged particle, much lighter in weight than the proton.

A neutron is about the same weight as the proton but has no charge – it may be a combination of a proton and an electron.

The protons and neutrons form the nucleus of the atom and the lighter electrons are imagined to revolve around this nucleus much the same as the planets revolve around the sun.

In all normal materials, there are as many electrons as protons in the atom. The atom therefore, shows no electric charge. Figure 1 shows an atom of hydrogen with one electron and one proton while Figure 2 shows an atom of helium with two electrons, two protons and two neutrons.

In materials containing more complex compounds (some may have atoms with as many as 92 electrons and 92 protons and 146 neutrons) the electrons are presumed to rotate in orbits of different diameters. When there are only a few electrons in the outer orbits they are considered to be able to leave the atom fairly easily. These "free electrons" may then be captured by another atom that may also have lost an electron.

This action takes place more readily in metals such as copper, aluminium or steel.

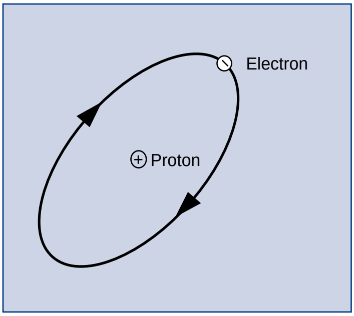


Figure 1. Hydrogen atom

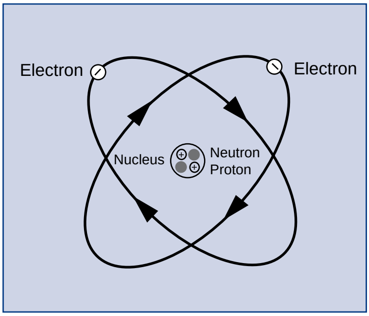


Figure 2. Helium atom

Flow of electrons

Under certain conditions "free electrons" can be caused to travel from atom to atom in a definite direction. For example, when a piece of copper wire has its ends connected to the positive and negative poles of a battery a definite drift of electrons will take place towards the positive pole of the battery, (see Figure 3).

The drift of electrons in a definite direction constitutes an "electric current" and if the number of electrons taking part is great enough, the current can be detected by suitable means. This theory is used mostly in the application of electronics, (semi-conductors, diodes etc).

However, owing to certain conventions adapted in the early days of research, the actual current (conventional current flow) is assumed to flow from the positive terminal and through the conductor to the negative terminal of the battery, that is, in the opposite direction to the drift of electrons.

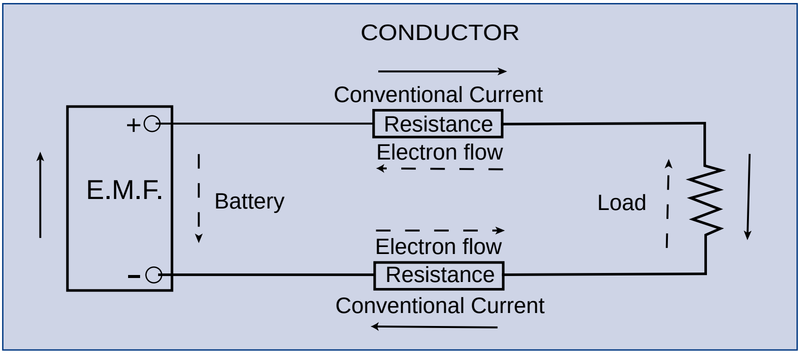


Figure 3. Conventional current flow compared with electron flow in an electrical circuit

The "force", as it might be termed, supplied by the battery, that causes this drift of electrons is called an "electromotive force" (E.M.F) or "voltage".

It is important to note that the battery has the voltage or force available without any current flowing, as shown in Figure 4. The voltage available is then referred to as the voltage on an open circuit and has been labelled E.M.F.

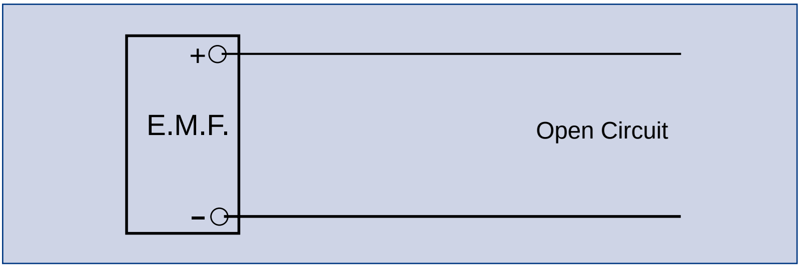


Figure 4. Open circuit

Conductors

Substances such as copper, aluminium and steel, in which the electrons readily move from atom to atom, are known as "good conductors".

Other examples are gold, silver and platinum. Silver is a better conductor than copper, copper better than aluminium and aluminium better than steel.

Insulators

In some materials the electrons are very strongly attached to their atoms and require a very considerable force to dislodge them. Such substances are considered very poor conductors of electricity and are known as "insulators". Examples are porcelain, rubber, glass, dry wood, and the various types of plastic coverings in use today such as polyvinyl chloride (PVC) and polyethylene.

In the best insulators, breakdown of the material takes place before any appreciable current can flow. Good insulators are therefore used to confine the flow of current to its desired path. Typical examples are the insulators used on crossarms to support conductors. Practically no current can flow from the conductor to the crossarm.

Electric circuit

An "electric circuit" is the complete path that the electric current follows from its source of supply through the electric line conductor to the electrical installation or equipment that requires electricity and then back to its source.

Definitions and units

A simple electronic circuit as shown in Figure 3 has:

a. Electromotive force, (E.M.F), voltage, or pressure, being that force that causes the current to flow through the electric circuit. The unit of E.M.F is the volt.

b. Current, being the rate at which electrons flow (or "drift") in the circuit. The unit of current is the ampere.

c. Resistance, being the measure of the opposition offered to the flow of the current by the material of the circuit. The unit of resistance is the ohm.

These units are so related that an E.M.F of one volt causes a current of one amp to flow in a circuit of one ohm resistance.

Difference between voltage and current

It is important to distinguish between voltage and current and also to realise that voltage can exist without a flow of current.

To produce a flow of current two conditions are necessary. There must first be available an electrical pressure or, as it is technically called, a voltage or potential difference.

In addition to the voltage there must be a continuous or complete electric circuit provided for the current to flow through.

For example, when a switch that controls a lamp is open, or set to the "off" position there is a voltage across the switch terminals. But because there is a break in the circuit (the switch being open), there is no flow of current and the lamp does not glow. As soon as the switch is closed, or set to the "on" position, the circuit is completed allowing the current to flow and the lamp glows.

In this case, although there is a voltage present there is no flow of current as long as the switch remains open. The closing of the switch completes the necessary circuit and then the current flows.

Failure to distinguish between voltage and current and understand the condition needed for current to flow has led to a number of accidents that have harmed electrical workers and the public.

Electrical resistance

An E.M.F. must be applied to maintain a steady flow of current in a circuit. This indicates that there must be some opposition to the flow of current and this opposition is known as "resistance".

Under steady voltage conditions, if more resistance is offered, less current flows. On the other hand if less resistance is offered with the same voltage applied, more current will flow. The electrical symbol for resistance is Ω.

Impedance

Impedance is the total opposition to the flow of current in a circuit and comprises three elements – inductance, capacitance and resistance.

Inductance

When current flows in an electric circuit, a magnetic field is set up around the conductor. In some cases this will affect the behaviour of current in the circuit or induce a voltage in a conductor that passes through the magnetic field. The property that causes these effects is known as inductance.

Typical examples where electrical workers may see the effect of inductance are:

a. In the operation of a transformer.

b. When voltage is induced in a de-energised line that runs parallel to, or across, a live line.

A magnetic field stores energy that builds up due to current flow in an electric circuit. When the magnetic field strength changes or collapses, any energy stored is released back into those conductors that pass through the magnetic field. Should this occur, a voltage is induced into these conductors that can present a hazard to electrical workers or equipment.

The properties of magnetic field and inductance are also put to good use in an electric circuit. An example is described under transformers in this section.

Capacitance

When two conductive materials are separated by an insulation material and connected to a voltage source, the circuit builds up an electric charge between the conductors. This charge will be maintained until it is discharged. The property that causes this effect is know as capacitance.

Typical examples of capacitance are:

a. Capacitor devices in street light control circuits and,

b. The charge that is stored in an electric cable after it has been de-energised.

Unlike inductance, the energy stored in the electric charge across a capacitor is not released when the circuit current is removed. Some capacitors can hold their charge of electricity for a long time. For this reason, steps must be taken to discharge any electrical charge before beginning work on equipment (e.g. cables).

3. OHM'S LAW

In 1825, Dr Ohm experimented with the flow of electric current and found that there was a simple relationship between voltage, current and resistance. The relationship is known as "Ohm's law" and is one of the most useful and important laws in the theory of electricity.

Ohm's law is that, if one volt is applied to a circuit with a resistance of one ohm, then one ampere of current will flow.

It is expressed as:

TABLE 1

Electrical Quantity	Unit	Relationship
Current (I) =	Ampere	Voltage ÷ Resistance or E ÷ R
Resistance (R) =	Ohm	Voltage ÷ Current or E ÷ I
Voltage (E) or (V) =	Volt	Current x Resistance or I x R

A method of remembering this law is outlined in Figure 5.

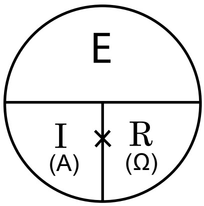


Figure 5. Representation of Ohm's law

Examples of the use of Ohm's law

The following are simple applications of Ohm's law.

Example 1

The resistance of conductors in a circuit is 4 ohms. The resistance of a heater in a circuit is 20 ohms. If the voltage of supply is 240 V what current would flow in the circuit?

Resistance of conductors = 4 ohms

Resistance of heater = 20 ohms

The total resistance (R) = 4 + 20 = 24 ohms

Voltage of supply (V) = 240 V

To find the current using Ohm's law

I = V/R

= 240 / 20 = 10 amps

Figure 6 shows the example set out in a diagram. (In solving electrical problems like this, setting the information out in a diagram often suggests the methods to use. The starting point of this diagram would be the supply, then the conductors connecting the heater to the supply).

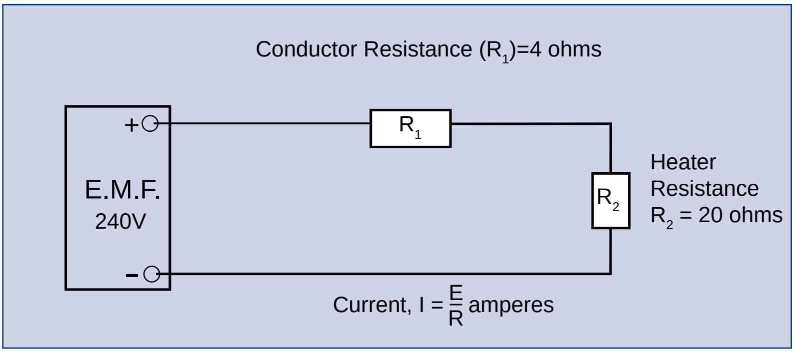


Figure 6. Example 1 set out in a diagram

Example 2

What voltage would cause a current of 20 amperes to flow in a circuit of 12 ohms resistance?

I = 20 amperes

R = 12 ohms

By Ohm's law	V	=	I x R
		=	20 x 12
		=	240 volts

4. POWER

When an electric motor, lamp or other appliance is connected to a supply of electricity, a voltage is applied across the terminals of the appliance and a current flows. This enables:

a. The motor to run and do work in driving machinery;

b. The lamp to light the room; and

c. The radiator element to become cherry red and heat the room.

In fact, the voltage and the current act together to do useful work.

Power is the rate at which work is done. For example, the motor in a) above drives a water pump that fills a container with water in 2 minutes. If the same amount of water is to be pumped in 1 minute, it is necessary to double the power output of the motor as twice as much work has to be done to pump the water.

In mechanical terms, power is expressed as watts, (W); this is also the unit of electrical power. For example, car engines have their outputs expressed in kilowatts (kW, or thousands of watts), e.g. a 30kW engine's power is equivalent to 30,000 watts.

The usual bar-type domestic radiator is rated at 1,000 watts per bar, so the customer knows that if the radiator is connected to a power outlet of 240V supply, the radiator will deliver 1,000 watts of heat.

Unit of power

The unit of power is the watt and one watt is the power being used where a voltage of one volt causes a current flow of one ampere.

In other words:

Power (P)		=	Volts x Amperes
		=	Watts (W)
	or P	=	E x I

Now referring to Ohm's law:

	E	=	I x R
Since	P	=	E x I then substituting (I x R) in place of E
	P	=	I x I x R
	P	=	I^2 R

The symbol or index "2" means that current is squared or in other words is multiplied by itself once.

The main point to remember is that P = I^2 R

= W

Power (or watts) used over a period produces heat in conductors or loads so that wherever voltage and current are combined to produce power, heat is produced in some form or other. Examples are:

a. The lamp becomes too hot to handle

b. The frame of the electric motor becomes warm

The heat is produced because the circuit and electrical equipment will also have resistance that has to be overcome by the current flow required to do work in an electric circuit.

5. ENERGY

Energy is the measure of capacity to do work.

To obtain a clear picture of the meaning of energy, assume that two people are each digging a hole of the same size.

One person is big and muscular, but slow in movement; the other person is small, not so muscular but is quick in movement. The larger person uses a large shovel and digs slowly, while the smaller one uses a shovel half the size of the other but shovels twice as fast.

They both dig holes of the same size in the same time and they both have expended the same energy to do the same job.

The larger person puts twice the force into moving but moves half as fast the smaller person.

In both cases:

Energy	=	Force x Speed x Time
Energy	=	Power x Time (actual shovelling time)

In electrical terms:

Energy	=	Power x Time
	=	Watts x Time
	=	Watt-hours

Example 3

A 100 watt lamp burning for 10 hours would expend 100 x 10 = 1,000 watt-hours of energy.

Example 4

A motor takes 500 watts to drive a drilling machine and runs on this load for 4 hours.

The energy expended	= power x time
	= 500 x 4
	= 2,000 watt-hours

Unit of energy

The amount of electrical energy (electricity) supplied to a customer is generally measured in terms of the kilowatt-hour (kWh).

The kWh is the energy expended in one hour when the power being drawn is one kilowatt. It is equal to 1,000 watt-hours.

Although this unit is known as the kilowatt-hour (kWh), it is frequently referred to simply as the "unit". This unit is well known to those who pay electricity accounts and in order to measure these units, meters called "kilowatt-hour meters" or "kWh meters" are installed.

6. VOLTAGE DROP

When current flows along the conductors of an overhead electric line, it flows against resistance. The total resistance offered is made up of two parts:

The resistance offered by the connected load, that is the lamps, motors etc. and

a. The resistance of the conductors themselves.

b. Conductor resistance is important because it constrains the capacity of an electric line. The effect of the resistance is to reduce the voltage available to do useful work.

Example 5

Referring to Ohm's law again, E = I x R

If the resistance of an overhead conductor in its entire circuit is 2 ohms and a current of 10 amperes is flowing, then the voltage necessary to cause this current to flow against the resistance of the conductors alone will be 10 x 2 = 20 volts; this is the voltage drop in the conductor.

If at the supply end the voltage is 240 volts, then the voltage available to the customer whose appliances are causing 10 amperes to flow will be (240 – 20) = 220 volts.

The need for voltage to provide the force for the current to overcome resistance in the conductors from the supply to the load (and return to the source) has reduced the voltage available for the customer's appliance.

If the demand for electricity increased from 10 to 20 amperes, the voltage drop in the conductors would increase from 20 to 40 volts. The voltage drop would reduce the voltage available for the customers appliances to 200 volts. At this level the operation of many appliances will be adversely affected.

In addition to the undesirable effects of excessive voltage drop (eg. fluctuation seen in filament lamps and on television screens), the resistance of the conductors will determine the power lost in the conductors, because work has to be done to overcome the resistance.

In example 5 using the formula

$P = I^2 R$

where P = power in watts

I = current in amps

R = resistance in ohms of the conductors

then $P = 10 \times 10 \times 2 = 200$ watts

This power loss for five hours would expend one unit of energy.

watts x hours (Wh) = 200 x 5 = 1,000 watts

= 1kWh (or unit)

It can also be shown that, for the same material and current:

a. Voltage drop increases with the length of the conductor.

b. Voltage drop decreases with the increase in cross-section (thickness) of the conductor.

Since voltage drop is a product of current and resistance, it is essential that the resistance of electric lines is kept to a minimum to obtain the rated value of voltage at the receiving end of a line. The number of joints in a line should be kept down to an absolute minimum and the joints themselves must be clean and well made to have as low a resistance as possible, as every joint or connection introduces some amount of resistance to the flow of current.

When current passes through a resistance, however small, some voltage drop is experienced; these small voltage drops may add up to an appreciable amount where there are a number of joints or any badly made joints.

7. CURRENT SYSTEMS

Electric currents are of three classes: (a) direct, (b) alternating, and (c) pulsating. Distribution & Transmission electrical workers are mainly concerned with alternating currents.

Pulsating currents do not come within the scope of this Handbook, and will not be addressed.

Direct currents

A direct current (d.c.) system is one in which current flows in one direction in the conductors of that system. An everyday example is the car battery, which has two terminals, one positive (+) and the other negative (-).

The accepted convention is that the current flows from the positive terminal to the external circuit and returns to the negative terminal.

High voltage transmission of electricity by direct current has been developed over recent years. In general, however, d.c. distribution is limited to use in:

a. Tramway and traction systems with a voltage of usually 600V;

b. Railway d.c. traction systems with a voltage of 1.5kV between rail and overhead collector wire;

c. Lifts, printing presses and various machines where smooth speed control is desirable;

d. Electroplating; and

e. Battery charging.

Usually d.c. systems are of 2-wire or 3-wire types. In a 2-wire system one wire is positive and the other negative. The difference in potential for tramways is 500V with the rail negative and in the d.c. railway system the difference in potential is 1.5kV, again with the rail negative.

In a 3-wire system the standard voltages are 460 and 230V.

There are three wires, one being at 230V positive (or + 230 volts potential), the second 230V negative (or – 230 volts potential), with the third called the "common" or neutral being at zero potential (see Figure 7).

Supply at 230V is taken from the "outer" (or positive) and the common conductors, or from "inner" (or negative) and the common conductors.

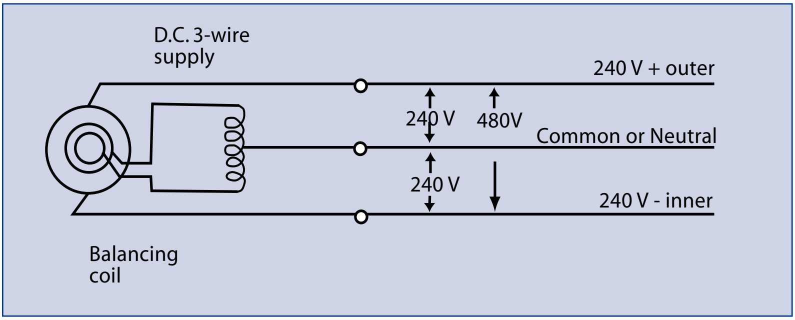


Figure 7. Potential in a 3-wire system

Energy for motors at 480V is taken from the outer and the inner conductors.

Alternating current

An alternating current (a.c.) flows in an electrical circuit that is energised with an alternating voltage. This voltage is one that reverses its sense of direction in a regular manner, and this is caused by the method by which it is generated.

In simple terms, the generator is a copper coil, which is mounted on a shaft between opposite poles of a magnet. When the shaft spins, the copper cuts the magnetic field and a voltage appears at the ends of the coil.

The generator (or alternator) is shown in Figure 8.

As the coil rotates one revolution the voltage follows the variation shown in Figure 9.

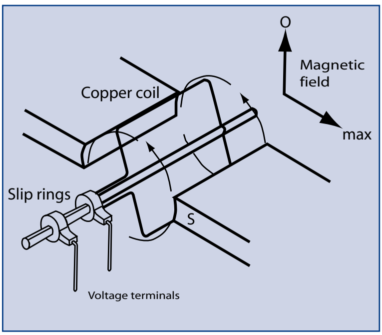


Figure 8. Simple a.c. generator

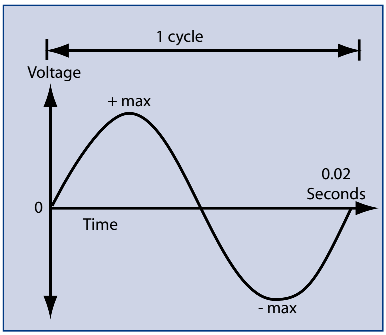


Figure 9. a.c. voltage wave form

When the coil is at right angles to the magnetic field, it is not cutting the field and the voltage is zero.

The maximum rate of cutting occurs when the coil is in line with the magnetic field and there is a maximum voltage output.

From zero to maximum and beyond maximum back to zero occurs in one half revolution and the voltage rises and falls.

In the next half revolution, the generated voltage is opposite to the first half. One full revolution of the coil produces one "cycle" of variation.

The number of voltage cycles in one second of time is called the frequency of the supply, and is given the name Hertz (Hz). The standard frequency in Australia is 50Hz.

Advantage of a.c. for distribution

Alternating current has an important advantage over direct current in that the voltage can be changed by transformers to a high value for transmission over long distances and then reduced at the customer's point of supply to a lower level suitable for operating lights, motors and other appliances.

As power = volts x amps, for the same power level to transmitted, a high voltage can be used so that the current can be kept to a low level thereby minimising the voltage drop.

Transmission of high power levels therefore requires:

a. Resistance of the transmission line to be as small as possible;

b. The transmission line current to be as low as possible.

The first condition cannot always be met, as it needs conductors of large cross-sectional area. Large conductors are expensive and their great weight would require strong and costly supports.

On the other hand, the second condition can be met by raising the transmission line voltage so that high power levels can be transmitted with relatively small currents. The small currents in turn require relatively small cross-sectional area, lightweight conductors with correspondingly lighter supports. Therefore, when high amounts of power levels are involved, it is general practice to use high transmission voltages and relatively small currents with correspondingly small voltage drops.

This condition is much more efficient than if an equivalent power level were transmitted at low voltage and high current with a relatively high voltage drop.

Transformers are used to provide the high voltages necessary for the transmission of high power levels over long distances.

In keeping with the value of the transmission line voltage employed, it is necessary to insulate the conductors against leakage to earth.

8. VOLTAGE VALUES

In the following, "voltage" means the voltage between the conductors.

The standard voltage values used are:

1. Extra low voltage (ELV) – means any voltage not exceeding 50V a.c. or 120V ripple free d.c.

2. Low voltage – means any voltage exceeding 50V a.c. or 120V ripple free d.c. but not exceeding 1kV a.c. or 1.5kV d.c. Thus the normal voltages of 240V and 415V delivered to most customers are "low voltage".

3. High voltage (HV) – means and voltage exceeding 1kV a.c. or 1.5kV d.c.

4. Extra high voltage (EHV) means any voltage exceeding 220kV.

Standard line voltages

The standard line voltages in use are:

240/415V (3 phase) 240/480V (1 phase)	Used to supply customers installations
6.6kV 11kV 22kV 12.7kV (SWER) 22kV	Used for urban and rural HV distribution
33kV 66kV	Used for sub-transmission of larger power levels in distribution over middle distances[1]
110kV 220V 330kV 500kV	Used for transmission of large power levels over long distances

[1] In some urban areas of Victoria there are pockets of 22kV subtransmission.

Voltage between live conductors and voltage to neutral

The voltage between any two live conductors is often referred to as the "line voltage".

The voltage to neutral, often referred to as the "phase voltage", is the voltage between any live conductor and the neutral point or earth of the system.

Figure 10 shows the line and phase voltages in a three-phase system. The neutral point is usually earthed at the supply end (for protection and safety reasons) and each live conductor is then

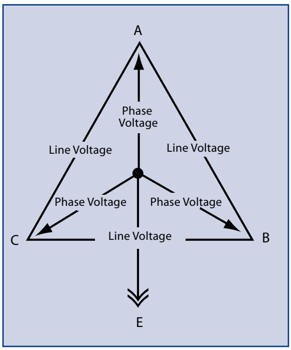


Figure 10. Three-phase system with earthed neutral

at a definite potential to earth. For instance, in an 11kV three-phase system, the voltage between any two live conductors gives a line voltage of 11kV while the voltage between any live conductor and neutral (or earth) gives a phase voltage of 6.35kV.

9. VOLTAGE SYSTEMS

High voltage overhead systems

The two systems most commonly used for transmission and distribution are:

Single-phase
Three-phase

High voltage single-phase system

This system is generally associated with the distribution of low power levels over relatively short distances. Single-phase systems are generally fed from a three-phase line.

The single-phase line consists of two conductors, neither directly earthed to the general mass of earth. In this system there is no neutral conductor (see Figure 11).

It is usual to have the three-phase system earthed (at the neutral point of the transformer or generator supplying the system) either solidly or through some current limiting resistance (for safety and protection purposes). As the single-phase HV system is part of the three-phase HV system, each phase of the single-phase system has a definite voltage to earth.

For safety reasons alone, it is important to remember that each phase is alive to earth and that a definite voltage exists between each phase and the equipment connected to the ground.

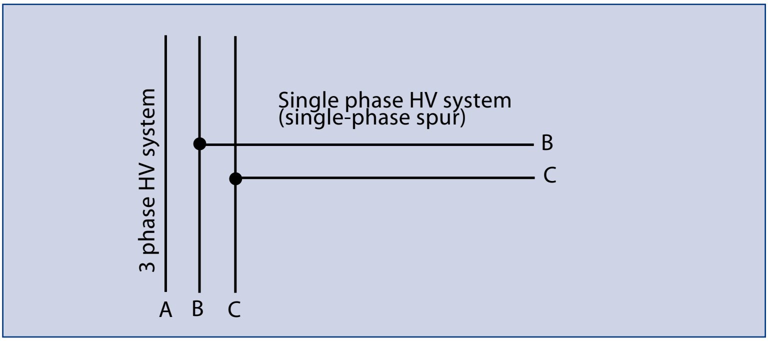


Figure 11. Three-phase high voltage system with single-phase spur

High voltage three-phase system

This system is widely used for the transmission of high power levels and is also the standard system used in distribution and reticulation.

It consists of three conductors, each called a "phase". To standardise the identification of the phases, they are known as A, B and C phases or red, white and blue phases respectively.

The voltage in each phase alternates, in a similar manner to the alternating voltage shown in Figure 9 but one follows the other in regular order (see Figure 12).

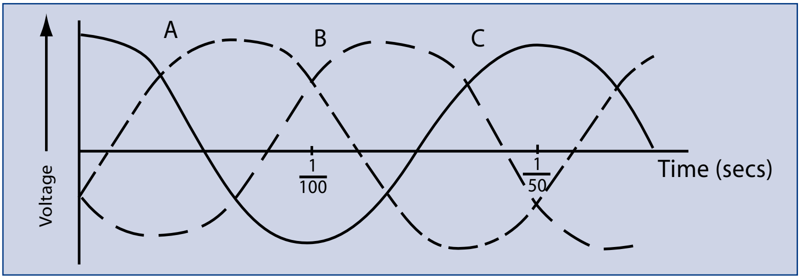


Figure 12. Representation of the three sine waves in a three-phase system

Briefly, phase A reaches its maximum positive value first, then is followed by phase B, then by phase C and so on. The order in which the phases reach their peak is called the phase sequence.

Phase sequence

It is essential that the order of phase sequences and the identity of the A, B and C be known. In the case just cited, the order of phase sequence was from A to B to C because the voltage in phase B reached its maximum value after that in phase A and the voltage in phase C reached its maximum value after that in phase B.

Phase sequence has an important bearing on the direction of rotation of three-phase a.c. motors, which depend on the phase sequence and the relative position of the three-phases connected to the motor terminals.

A reversal in the order of the phase sequence (eg. by interchanging any two of the three wires connected to its main terminals) will cause the motor to run in the reverse direction of rotation. For this reason alone, it is important that electrical workers know what happens if there is an inadvertent change in the position of the phases supplying a factory in which motors are installed.

Low voltage single-phase 2-wire overhead system

In this system there are two conductors, one generally solidly earthed at the transformer and known as the "neutral", while the other is known as the "live", "active" or "phase" conductor.

The voltage between phase and neutral is nominally 240V and the voltage of the phase or active conductor to earth is therefore also 240V (see Figure 13).

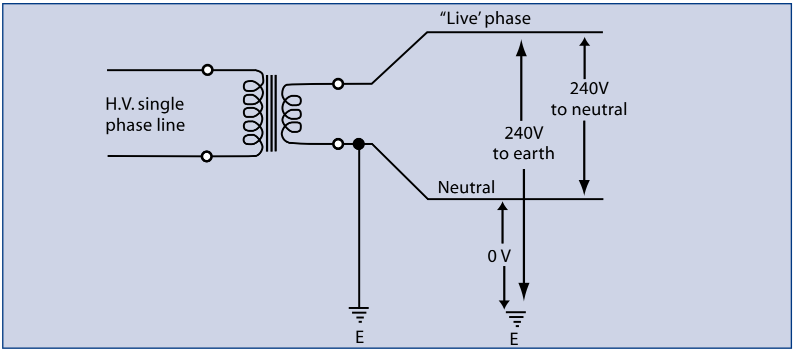


Figure 13. Single-phase 2-wire system

Low voltage single-phase 3-wire system

In certain rural areas, it is often more economical to install a single-phase high voltage line, saving the cost of the third high voltage phase and to supply the load by stepping down through a transformer to a 3-wire system. One conductor is earthed and known as the neutral while the other conductors are both "actives". (see Figure 14).

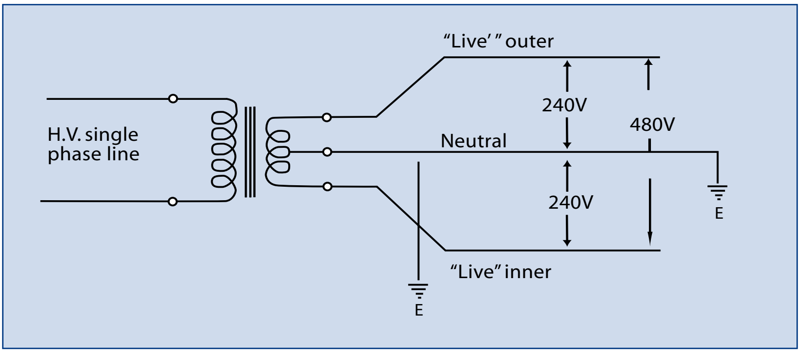


Figure 14. Single-phase 3-wire system

ELECTRICAL THEORY

SEC2:

The voltage between either of the actives and the neutral is 240V while the voltage between the two active conductors is 480V. It is the a.c. equivalent of the three-wire d.c. system. It facilitates the supply of larger loads or loads at greater distances from the transformer than the single-phase 2-wire system.

Half of a domestic 240V load is connected between one active and the neutral and the other half between the other active and the neutral. This balances the load on each phase and reduces, if not eliminates, the residual current in the neutral.

Low voltage three-phase 4-wire system

This system employs four conductors and is widely used in all areas where it is considered economical to supply large amounts of energy for industrial and domestic purposes. The system is shown in Figure 15; a, b and c are the active conductors and n is the neutral which is connected to the "star point" of the transformer. It is usual for the "star point" to be earthed as shown.

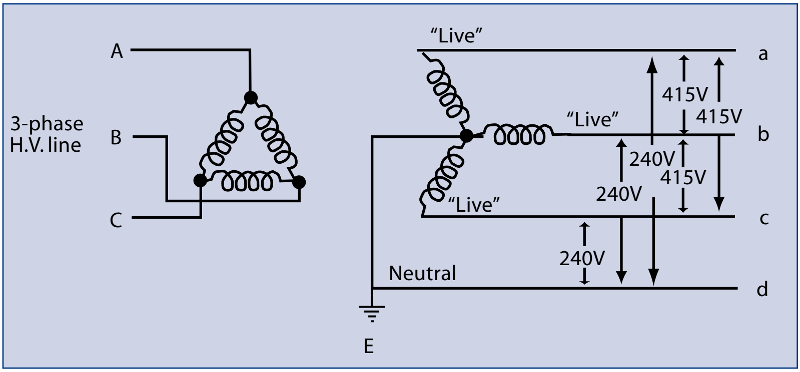


Figure 15. Three-phase system with earthed neutral

The standard voltage between actives is 415V, while the voltage between any one of the actives, (a, b and c respectively) and the neutral is 240V.

The same phase relationship of "phase sequence" exists on the LV as on the HV side of the transformer, so care must be taken when renewing mains to avoid upsetting the phase sequence to the supply of motor loads.

High voltage single-wire earth return (SWER) system

The power system known as the SWER system uses only one HV conductor with the earth being used as the return conductor, (see Figure 16). This system was first developed in New Zealand and is now used in Australia, South Africa and many other countries. It can have great economic advantages in hilly areas where the loading is relatively light, where long distances are involved and where the line can be strung from ridge top to ridge top. Because of the generally lower impedance of the line to earth circuit, it usually has better voltage regulation than a conventional single-phase 2-wire circuit.

To restrict noise interference in telecommunications systems, the amount of earth current allowed to flow in the earth return circuit is limited. Furthermore, there must be a minimum separation between SWER lines and any telecommunication lines.

A special transformer is used to isolate the SWER line from the main distribution line. The SWER line voltage is 12.7kV to earth. The distribution transformers fitted to the SWER line can be either single-phase 2-wire 240V supply or single-phase 3-wire 240/480V supply.

Particular attention must be paid to the good earthing of the transformers on a single-wire line and to the protection of these earth wires from physical damage.

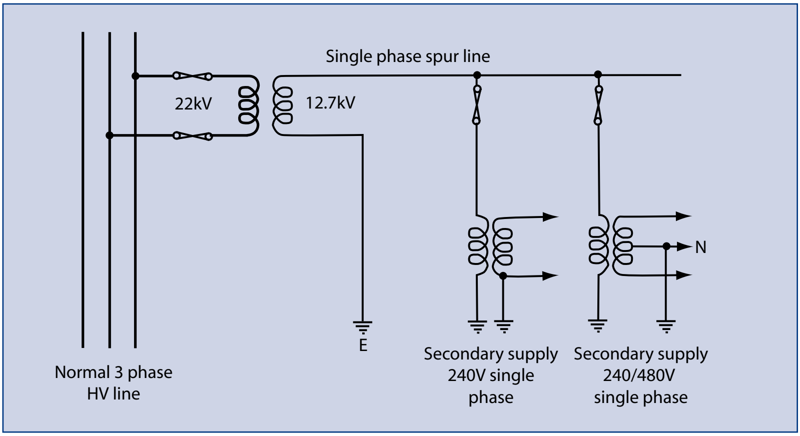


Figure 16. Single wire earth return system

10. THE NEUTRAL CONDUCTOR

In a low voltage single-phase 2-wire system, one conductor is earthed as shown in Figure 13. Both conductors are necessary and the neutral conductor may carry as much current as the active conductor, depending on the earth resistance and other factors.

In the case of the three-phase 4-wire system as shown in Figure 15, a different condition is found. The neutral conductor is necessary to be able to obtain a 240V supply (between any of the three actives and the neutral).

It is found that when each phase is equally loaded, there is no return current in the neutral conductor. This can be easily demonstrated as shown in Figure 17. Three 1kW heaters for example are connected as shown, one on each phase. When heater A for example is switched on, the ammeter records the current taken by the heater, that is 1000/240 = 4.2 or about 4¼ A. On switching on heater B, the current recorded by the ammeter does not increase to 8½ as might be expected but remains unchanged. Finally when heater C is switched on to give a three-phase balanced load, the ammeter reading falls to zero. If there are equal amounts of current in all of the three phases, then there will be no neutral current flowing in the neutral. In practice, the neutral is always required and since, in fact, a perfect balance is very seldom achieved, there is always some current in it. This current is usually considerably less than the current in the active conductors and consequently the size of the neutral can theoretically be smaller than that of the active conductors. In modern practice, the neutral is often left the same size as the active conductors to ensure the lowest possible resistance for the return current.

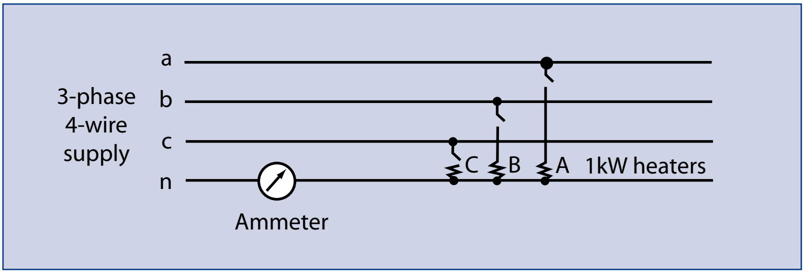


Figure 17. Three-phase 4-wire supply

For example, with 50mm^2 copper active conductors, a 35mm^2 copper neutral is sometimes used. In certain circumstances (for example if one fuse blows), the current in the neutral can be as great as in the active. Neutral current can also be large when transformer neutrals are interconnected. For these reasons, it is usual for the neutral to be the same size as the actives.

A good neutral conductor provides a low-resistance path back to the transformer for out-of-balance currents. If the neutral should be broken under these conditions, quite a considerable voltage can develop between the broken ends and, if both ends are held in the hands, a severe shock will result. Therefore it is as important with the neutral as it is with actives, not to handle both ends of a broken conductor unless supply has been isolated.

The multiple-earthed neutral system

The multiple-earthed neutral (MEN) system is widely used in Australia. Under this system, the neutral, in addition to being connected to earth at the supply end (that is, at the transformer), it is also connected to earth at each customer's premises. In addition, it is frequently earthed at other points and at the ends of distribution lines. From this arises the term "multiple-earthed neutral".

Under the system, the neutral is connected to earth at one point only at each customer's premises. The metal frames of electrical appliances such as ranges, motors and so on are separately earthed, the neutral being kept insulated from the frame of the appliance or apparatus, except at the switchboard where it is connected to the customer's main earth.

For further detail on earthing systems, see Subs, Caps & ACR's.

Active-neutral connection

It is vital to ensure that in connecting the customer's premises, that active and neutral are not reversed. If this happens, the customer's earth main should cause the service fuse to blow but, if the customer's earth is faulty, broken or of high resistance, there may be insufficient current to blow the fuse. In this case, all metal connected to the customer's earthing system, eg. range, water pipes, becomes alive and extremely dangerous, this situation is known as a "reverse polarity".

TRANSFORMERS

11. ELEMENTARY PRINCIPLES OF TRANSFORMERS

A transformer has three principal parts:

a. An iron core, which provides a continuous magnetic circuit

b. A primary winding, which draws current from the supply circuit

c. A secondary winding, which receives energy by electromagnetic induction from the primary winding and delivers it to the secondary circuit

NOTE: The primary winding is always considered to be the winding supplied by the voltage to be changed, whether it is the higher or lower voltage winding. The secondary winding is the one supplying the load.

In its most elementary form, a single phase transformer consists of an iron core with the primary and secondary windings wound on separate limbs of the core as shown in Figure 18.

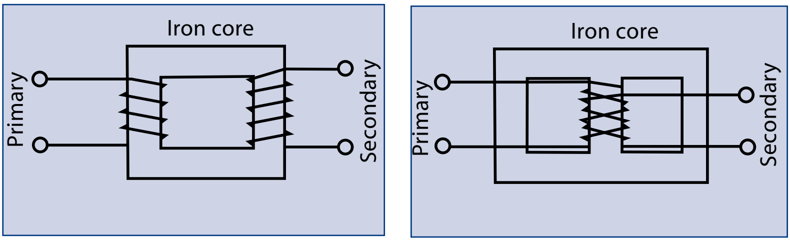


Figure 18. Iron core and windings

The two windings are quite independent of each other. In practice, part of each winding would be wound on each limb of the core.

As with any other piece of electrical equipment, the output from the transformer is equal to the input, less any losses occurring in the transformer. If losses are ignored, then:

Output (kVA) = Input (kVA)

Where kVA = (volts x amps) / 1,000 (volt amps)

This means that the higher the voltage, the smaller the current for the same kVA. For example, if the rating of a single phase transformer is 50kVA, the primary voltage 22kVA and the secondary voltage 240V, then:

$$\text{Primary current} = \frac{(50 \times 1000)}{22000}$$

$$= 2.3 \text{ amps approximately}$$

and

$$\text{Secondary current} = \frac{(50 \times 1000)}{240}$$

$$= 208 \text{ amps approximately}$$

The high voltage winding can therefore be made of fine wire but the low voltage winding will be required to be of much heavier wire.

The number of turns and the voltage of either winding are proportional to one another:

$$\frac{E_p}{E_s} = \frac{N_p}{N_s}$$

Where:

E_p is the primary voltage

E_s is the secondary voltage

N_p is the number of turns on the primary winding

N_s is the number of turns on the secondary winding

Taking the transformer in the previous example, the primary voltage was 22kV and the secondary voltage 240V. If then the secondary winding had 23 turns, the number of turns on the primary winding would require to be:

$$\frac{22000}{240} \times 23 = 2108 \text{ turns}$$

12. TRANSFORMER COMPONENTS

Tank

With small distribution transformers, the tank may be quite plain. Heat is radiated from the sides of the tank or carried away by air movement. In large transformers, external cooling tubes or fin-type radiators are fitted and the larger zone substation type transformers may be equipped with separate radiator banks. Fans may be mounted on radiators to increase the rate of heat transfer to air, and oil pumps may force circulation of the insulating oil through the core, windings and radiators where the heat is released to air.

The tank has a tight fitting lid. Others fittings may include a breather or open or silica-gel type (to keep moisture out of the transformer), oil gauge and an oil drain/sampling valve near the bottom of the tank and a thermometer pocket for temperature monitoring purposes. Distribution transformers with a sealed tank are becoming more common. These transformers do not breathe to the outside but have an air space above the oil or flexible sides to permit expansion and contraction of the oil with changing temperatures. The advantage of this design is that, because there is no air movement into or out of the tank, the transformer oil is not exposed to contamination by dirt or moisture laden air.

Smaller transformer tanks may also include termination cubicles either welded or bolted to the tank to enclose the bushings and house items such as low voltage fuses.

Hooks or eyes are fitted to the transformer tank so that it may be lifted with chains or wire slings.

Bushings

The primary and secondary leads have to be brought outside the tank to permit connection to the electricity supply and the load by means of porcelain or cast resin bushings. These may be enclosed in an air-spaced termination cubicle or a cable box or they can be exposed without other protection. Bushings are brittle and easily broken so care must be taken when handling any exposed fittings.

Iron core

The core of a transformer provides the magnetic circuit that permits the transfer of energy between the primary and secondary windings. The core is normally manufactured from a special grade, low resistance, steel sheet cut into laminations and then clamped together to form the core. The purpose of using laminations is to prevent excessive induced currents (eddy) circulating in the core and causing heating of the transformer.

Air gaps between laminations resist the path of the magnetic circuit and assembly techniques have been developed so that the laminations on modern transformers are now assembled with very small air gaps between lamination butt joints.

Advances in the types of material used for the core and in the methods of assembly have greatly improved transformer efficiency and reduced the sizes of the cores required for the same power output.

Windings and connections

Windings around the core can be assembled in a variety of ways. The primary and secondary windings are efficiently magnetically coupled and have low electrical impedance. The windings themselves are of either copper or aluminium and may be either in conventional wire form or long strips of sheet. Normally the aim is to make the length of wire or strip wound on the core as short as possible to reduce losses caused by the winding's resistance.

Star connections

In this method of connection, the "ends" of the windings (shown in the diagram as 2) are connected together and normally connected to earth (or Neutral). The remaining ends (shown in the diagram as 1) are then connected to the phases, a, b, c of a three phase line. The common connection is known as the "neutral" or star point.

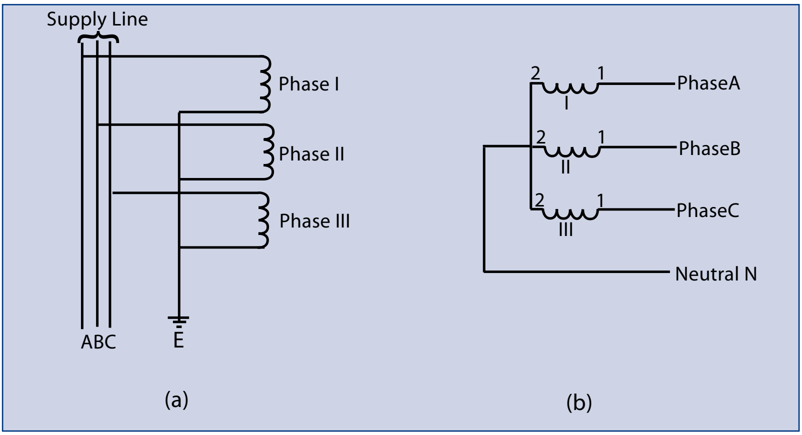


Figure 19. Star connected 3-phase windings

Delta connections

In this method the connections are made as follows; the end of winding I (shown in the diagram as 2) is connected to the beginning of winding II and so on, until the end of winding III is joined to the beginning of winding I. This connection does not give a neutral connection.

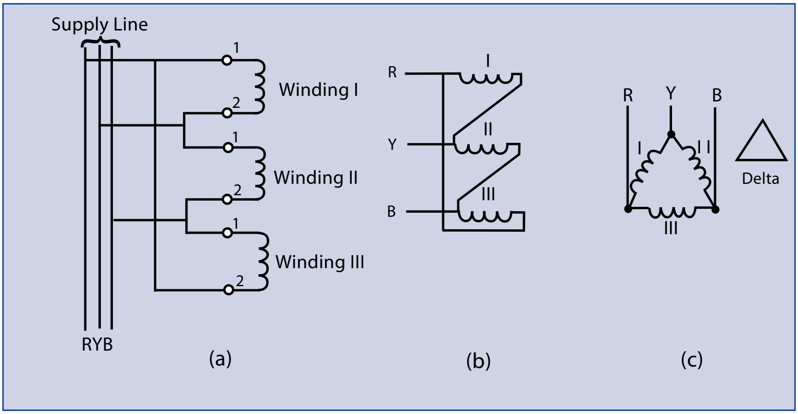


Figure 20. Delta connected 3-phase windings

WORKSITE TRAFFIC MANAGEMENT SECTION 3

It is the intention of this section of the Fieldworkers Handbook to provide high level traffic management guidance to employees and contractors of Victorian electrical distributions companies that will complement their organisational specific traffic management policy and procedures.

1. TRAFFIC MANAGEMENT - GENERAL

Standards Australia Traffic Management Standards and the Worksite Safety – Traffic Management Code of Practice (Road Management Act) detail specific requirements for traffic management measures. Each Victorian electrical distribution business is required to comply with the provisions described within these documents and other relevant legislation when carrying out traffic management.

2. THE PURPOSE OF TRAFFIC MANAGEMENT

1. Provide a safe workplace, and to protect both employees and members of the public.
2. Warn the road user of the hazards ahead.
3. Guide traffic (both vehicular and pedestrian) safely through, around or past the worksite.

3. TRAFFIC CONTROL RESPONSIBILITIES

1. Persons involved in traffic management must be appropriately trained and qualified to carry out traffic management functions for the activities they are required to perform.
2. All work locations shall be assessed for the risk of traffic hazards and where traffic management is required, a traffic management plan shall be in place.
3. Primary risk factors such as traffic speed, work area clearance to traffic, traffic volume, visibility, road conditions, cyclists and pedestrians need to be considered.
4. Traffic management safety measures are required to be selected on a practicable basis using the "Hierarchy of Controls" :
   - Elimination /Substitution, e.g. Road closure
   - Engineering /Isolation, e.g. Lane closure
   - Administrative /Behavioural, e.g. Traffic controller
5. Specific traffic management scenarios such as work on freeways, closing a lane on an arterial road and erecting speed limit signs require consent from the relevant responsible road authority.
6. As part of job planning, notification to other organisations such as councils, police and VicRoads should be considered.

7. Poles laying in road reserves, materials or trenching shall be managed as part of the overall traffic management plan for the work site.

8. The required signs and devices shall be obtained before beginning any job.

9. Suitable high visibility protective clothing shall be worn at all times when working on or near roads.

10. Consideration must be given to locating vehicles and equipment at the work site in the least possible hazardous location to other road users.

11. Vehicle mounted warning devices such as flashing yellow lights are designed to assist in warning traffic that a vehicle is a possible obstruction. They normally complement other devices used to identify a work site and they indicate the presence of workers on the roadway.

12. Signs and devices must comply with standards.

13. When installing signs and other warning devices, they should be positioned so that they:

    - Are clearly visible.
    - Cannot be obscured by vegetation or parked cars.
    - Do not obscure other devices.
    - Are not a hazard to the workers, pedestrians or road users.
    - Are generally placed one metre clear of the travelled path.

14. Signs and devices shall be regularly checked and maintained throughout the duration of the work to confirm the adequacy of the traffic management plan, i.e. visible and in original position.

15. Signs and devices shall be removed as soon as the work has been completed and the hazard ceases to exist.

16. Audit and review of traffic management activities is required to be undertaken as part of an organisations safety management system.

17. The Traffic Controller shall:

- Wear suitable high visibility clothing.
- Be responsible for the setting up and removal of the "Prepare to Stop" sign.
- Stand in a location so they can be clearly seen by approaching traffic.
- Have an emergency escape plan, should a driver fail to stop.
- Give clear signals and instructions to road users.
- Be courteous.

4. TRAFFIC MANAGEMENT PLANS

The following diagrams are provided as an example for basic guidance. These diagrams have been referenced from the Road Management Act 2004, Worksite Safety – Traffic Management Code of Practice.

For further information with more specific detail refer to the relevant Code of Practice and/or Australian Standard Field Guides.

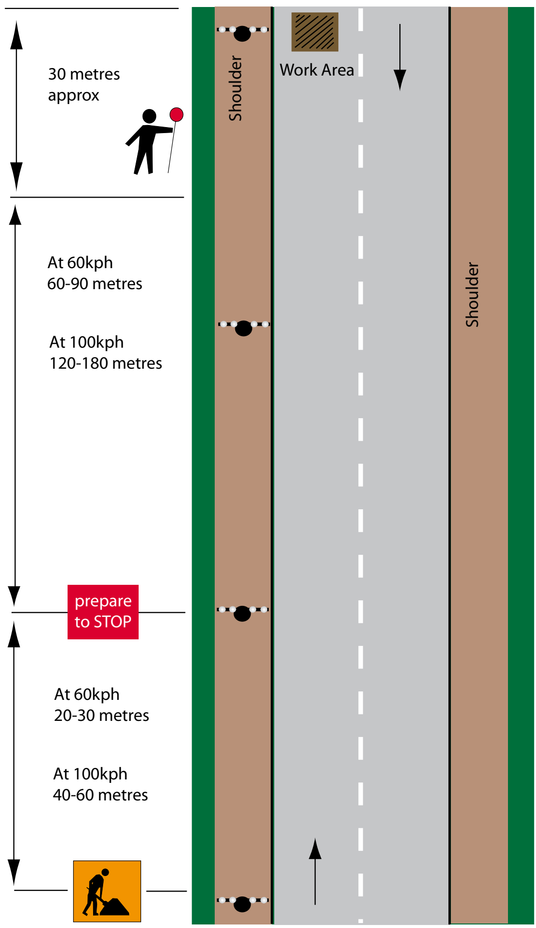
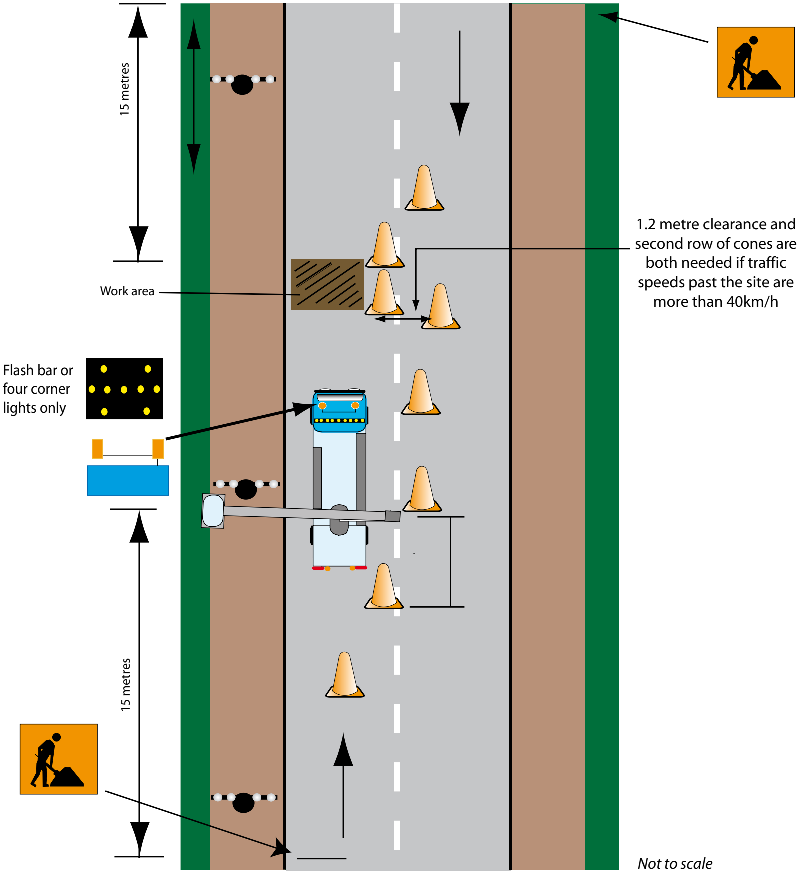


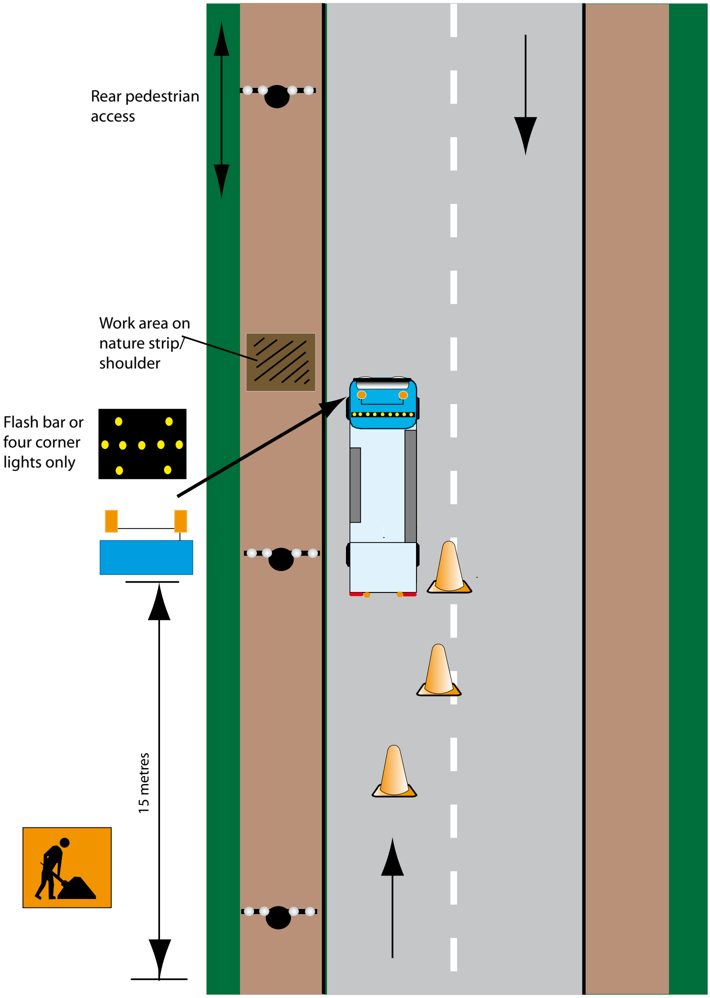
Figure 1. Advanced Signing for Traffic Controller

NOTE: Additional signs to these as required for the overall job site need to be placed as set out in AS1742.3



This traffic management plan can be used when traffic volumes are less than 40 vehicles per hour and are only occasional vehicles travelling at a speed greater than 50km/h

Figure 2. Partial closure, 50km/h residential street



This traffic management plan is appropriate for works on a nature strip or off the roadway, where a work vehicle is used as a filter between the work area and passing traffic. The speed of passing traffic should be 60km/h or less. Pedestrian and bicycle access past the work area should be retained.

Figure 3. Work on a nature strip/shoulder

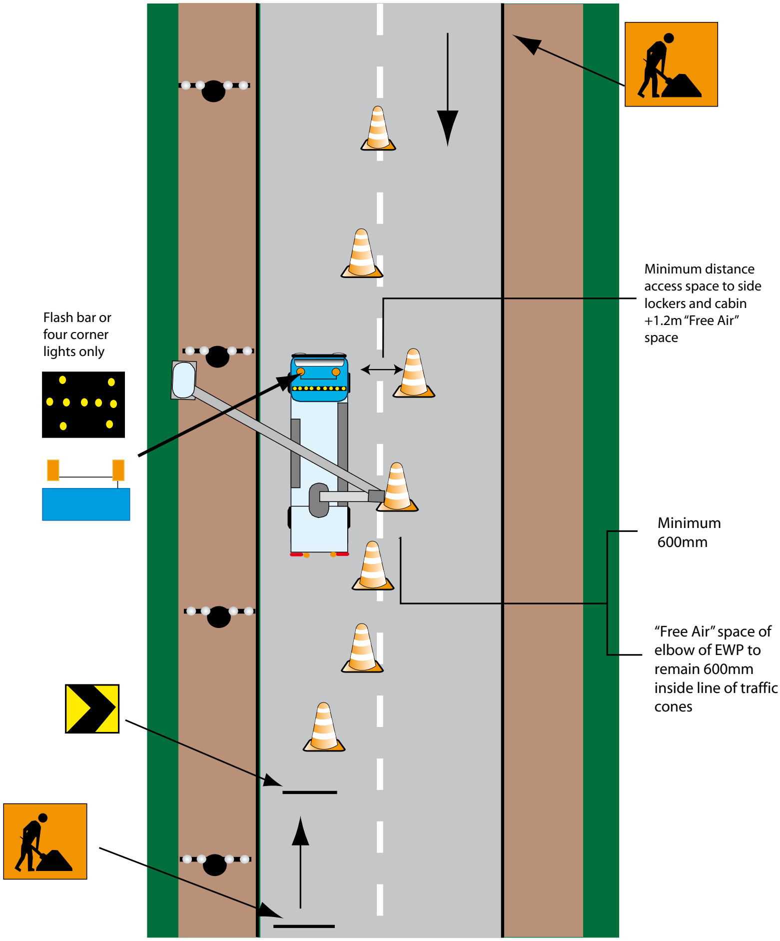


Figure 4 . Elevated work platform vehicle

OVERHEAD LINES SECTION 4

1. GENERAL

Work on electrical assets shall be performed only by:

a. Electrical workers, apprentices or persons who have passed an approved training course appropriate to the activity being performed and whose competencies are current, or

b. An apprentice working in accordance with the provisions of their defined training requirements whose competencies are current.

When working on energised conductors, employees shall:

- Be appropriately trained and authorised for the purpose of the work.
- Make a safety assessment and ensure that the job can be performed safely whilst energised.
- Work on only one phase at a time and remain isolated and insulated from all other potentials.
- NOT rely upon conductor insulation for protection.
- Whenever possible, work from a position below the conductors.
- Use barriers when working adjacent to energised conductors or equipment that cannot be adequately insulated with cover-up materials.
- Wear appropriate insulated gloves and approved safety glasses.
- Wear approved overalls or work suit, and safety footwear.
- Cover all exposed conductors and conductive structures (e.g. stays, conductive poles, public lighting brackets, roofs, etc…) that are within reach.
- Be given appropriate first aid training at commencement, and thereafter subject to annual competency testing.
- Ensure the work is performed under dead conditions if the work cannot be performed safely whilst energised.
- Have an approved rescue device readily available at the site.

A person working on or within reach of live exposed apparatus may work alone in the following situations:

a. Testing and/or inspecting customer's premises.

b. Engaging in metering work as described in Section 5.

c. Routine switching of circuits.

d. Where a risk assessment has been carried out and procedures documented.

- In situations that are not described above, a person working on or within reach of live exposed apparatus shall be accompanied by a safety observer who is trained for the same class of work and has received appropriate first aid and rescue training at intervals not exceeding 12 months.

When working on or near de-energised lines and equipment, employees shall:

- Clearly identify and isolate the conductors to be worked on, including capacitor banks.
- Tag and lock where practicable, any isolation points.
- Identify the switching, isolation, disconnection and other precautions on an appropriate Access Authority.
- Treat all conductors as energised until proven de-energised, by an approved voltage tester that has been proven functional, and earth and/or bond all conductors in an approved manner.
- Avoid the risk of inadvertent contact with adjacent live conductors or electrical apparatus in the vicinity of the work site.
- Isolate and discharge as required, any capacitor bank in the circuit.
- Measures shall be taken to protect persons and apparatus from induction and/or inadvertent contact between new, not yet commissioned overhead conductors and existing live overhead line(s). This may include barriers, covers and earthing as appropriate.
- Where a newly constructed HV or LV UG circuit reaches the stage where it can be made alive by normal operating means, an appropriate Access Authority or clearance shall be raised to cover the circuit.

2. LOW VOLTAGE

8 most important steps

The following are the most important steps to ensure safety when working on live low voltage:

1	Make a safety assessment.	Ensure the job can be done safely alive. Plan your work – complete a JSA. Ensure that all necessary equipment is available. Complete the Safe to Climb test where necessary. Check the condition of your body belt/harness.
2	Arrange for a Safety Observer where required.	Use an observer who has received PTR, EWP escape and first aid training, and who has the skills and knowledge to undertake the task or work practice being observed.
3	Wear PPE.	Wear LV gloves, hard hat, issued overalls or work suit, safety glasses, and safety footwear.
4	Fasten your body belt/ harness.	As soon as you reach the head of the ladder or get into the EWP.
5	Ladder work.	Use an approved method to secure the ladder.
6	Tie handline with quick release knot.	Stow the handline in a temporary position (e.g. on step iron or arm brace). Shift the handline to the correct position (preferably above you), tying it with a quick release knot, leaving a tail (600mm minimum). Shift the handline as necessary during the course of the work.
7	Cover all conductors within reach.	Use mats or protective sleeving as required.
8	Check that you are not making a second point of contact.	Ensure you are not making a second point of contact by making a visual inspection. YOU MUST CHECK EVERY TIME: You change your working position. You work on a different conductor. You re-climb the pole (or ladder). You reposition the EWP.

Making LV dead

To prepare an LV line for de-energised work, employees shall:

- Identify the neutral.
- Establish the direction of supply.
- Where applicable isolate LV capacitors.
- Isolate all the conductors except the neutral.
- When using an LV hopper, ensure that during removal, the supply side of the hopper is disconnected first.
- Test that all conductors are de-energised.
- Prove the tester.
- Bond the conductors.
- Display warning signs.
- Issue EAP.
- Have an approved rescue device readily available at the worksite.

NOTE:

In-line breaks may be installed in midspan situations to create isolation points on a low voltage circuit. When selecting a position to install the break the following shall be considered:

- Installation must be a minimum of one secured span from the position of the intended work.
- They should be installed as close to the pole as possible to reduce conductor sway and sag.
- Approved insulating devices are to be used to create the in line break.

Paralleling low voltage circuits

Low Voltage lines are paralleled so that supply can be maintained to an area while work is in progress. It is usual to disconnect one of the sources of supply after the parallel is made.

When paralleling Low Voltage circuits employees shall:

- Identify both neutrals.
- Connect the neutrals together.
- Test for correct reading between an active of each circuit.
- Prove the tester on an active and neutral or two actives on the live circuit.
- Connect each pair of actives having no acceptable voltage difference.

NOTE: LV paralleling switches (isolators) may be closed with an operating stick without prior test.

Energising previously de-energised circuits

When energising previously de-energised circuits, employees shall first:

- Cancel any Access Authority on issue involving the circuit.
- Remove any earths/bonders.
- Remove any warning tags.
- Energise the circuit.
- Conduct NST, polarity and phase rotation tests where required.

3. HV LIVE LINE

General

- A visual inspection shall be conducted on the structure where work is to be performed and the structures on either side to identify potential hazards that might directly influence the safety of the work being performed.
- A tailgate session shall be held to identify any potential safety issues and to develop a job plan for implementation.
- Before commencing either Glove and Barrier or Live Line Hotstick work, appropriate devices shall be either enabled or suppressed to give the highest level of protection available.
- To enable additional materials to be raised to the work location a handline or suitable lifting device should be carried.
- Insulating Barriers shall be applied to all second points of contact within the work area. Two levels of insulation shall be applied to prevent phase to earth and/or phase to phase contact.
- Steel or metallic hoists shall not be used for high voltage live line work. Nylon webbing hoists shall only be used in conjunction with an approved insulating medium when straining from a conductive structure.
- Live line techniques shall be used at all times when working on electrical assets, unless those assets are isolated and proven dead (earthed) and covered by an appropriate Electrical Access Authority.
- The area directly below the immediate work area is considered the "Drop Zone". Where any conductor or live line equipment connected to live apparatus could become uncontrolled or drop into any sources of potential difference, then these sources shall be covered with insulating barriers.
- During all live line work, one member of the work team shall be appointed as the designated Safety Observer. The designated safety observer's role is to alert the work team to any potentially unsafe actions or lack of compliance with approved work practices, procedures or documentation. The safety observer shall be certificated for the type of work being observed.

- Before undertaking any live line task, a live line risk assessment shall be carried out. This risk assessment shall be a formalised and documented process. The risk assessment document shall contain a range of prompts to help the electrical worker consider a wide range of risk factors.
- Glove & Barrier work shall never be performed directly from a structure. Glove & Barrier work shall be performed from either an EWP fitted with a 50kV tested basket liner or from an approved insulated platform. The lineworker's belt / harness shall remain at the same potential as the lineworker, and prevented from contacting any component at a different potential to the lineworker.
- While Live Line work is in progress on a particular structure, no other work shall be performed on that structure or any adjoining structure. No Live High Voltage work can be conducted within an access permit area concurrently with any other line work, unless isolations are established and maintained through normal operating means and or live line techniques between the live structure / circuit and the access permit area.

Example: Where work is to be undertaken on a double circuit structure such as a 66kV pole with a 22kV subsidiary circuit and the top circuit conductors are under access permit while the subsidiary circuit remains alive, isolations between the two circuits are to be maintained using live line techniques. No other work parties are to be working on the circuit under access permit conditions at the same time unless an isolation is established on that circuit. (e.g. Bridges tied back or removed).

NOTE:

As the gap between an over/under crossing can be compromised, no live line work shall be carried out on the first adjacent poles of an over/under crossing where construction/maintenance work is being carried out concurrently.

- In line with relevant ESAA guidelines, auto-reclose equipment controlling a circuit on which live line work is to be performed shall be suppressed for the duration of the work unless specific and careful engineering and safety analysis indicates otherwise, and additional safeguards are considered to ensure that the work can be performed safely.
- Live line rules, practices, procedures, guidelines, insulated gear and equipment are all designed and intended to provide the primary safety protection for live line work. All persons working on live high

voltage lines must be aware of system protection capabilities and not under the false assumption that protection trip devices are failsafe in the event of an incident. System protection devices are used to provide additional safety aspects, however, depending on a range of factors, it should not be assumed that system protection devices will always operate to remove hazards, and may not operate in time frames to be of critical benefit.

- Adequate light must be available to perform Live Line tasks. This can be achieved by providing sufficient light so as to eliminate distractive shadows from the worksite.
- Conductive poles being lifted into live HV conductors shall be bonded to the lifting plant (prior to lifting) and the plant vehicle shall be earthed.
- Only hydraulic tools meeting the requirements contained in the ESV Live Line Minimum Rules document may be permitted to make contact with live apparatus. All live line persons undertaking tasks utilising hydraulic tools shall be instructed in these procedures.
- Any lineworker changing from glove and barrier method to stick method shall move outside the contact area, remove their insulating gloves and sleeves, and re-enter the work area observing the live line minimum approach distance appropriate for the live line stick method for the voltage concerned.
- The following combinations of live line Glove and Barrier and Stick methods are not permitted:
  - One lineworker carrying out stick work and one lineworker carrying out glove and barrier work from the same EWP.
  - One lineworker on a pole or structure carrying out Stick work and one lineworker on an Insulating platform carrying out Glove and Barrier work.
- Appropriate Live Line tools and equipment are essential for safe live line work. Any and all equipment used, created, manufactured for the purpose of live line work shall be designed, tested and approved specifically for live line work, capable of being safely used on energised high voltage conductors / apparatus.

Clearances & contact area

- 1 metre or closer to energised high voltage conductors is considered as the "Contact Area." Any body part or extension of the body (i.e. tools in the outstretched hand), which encroaches this dimension, is considered to be within the "Contact Area" and as such shall require Glove and Barrier techniques to be used.
- When persons are performing Glove and Barrier or Live Line Hotstick work from an EWP or approved insulated platform, all (LV and HV) conductors within 380mm of the basket or boom shall be covered when work is being performed, to prevent a second point of contact.

OVERHEAD LINES

Live Lineworkers shall always observe the Minimum Approach Distances as outlined in the table below

LIVE LINE MINIMUM APPROACH DISTANCE (mm) up to 66kV			
Type of Work Plant	**Hot Stick**	**G&B**	
	22kV	**66kV**	**Up to 22kV**
Live Line Worker *(The use of covers should be considered when working to 380mm clearances for Hot Stick work up to 22kV)*	380mm	680mm	Contact wearing gloves & sleeves
Live Line EWP insulated section	380mm	680mm	Contact with covers
Live Line EWP & Mobile Plant non-insulated section *(to Un-covered conductors)*	1000mm	1000mm	1000mm
Live Line EWP & Mobile Plant non-insulated section *(to Covered conductors)*	380mm	680mm	380mm
Mobile Plant Load (i.e. Pole) *(Double insulated where the load is covered and the conductors are covered)*	380mm	680mm	380mm
Insulated Lifting Equipment *(to twice the voltage)*	Contact	Contact	Contact
Non-Insulated Lifting Equipment *(to Covered conductor)*	380mm	680mm	380mm
Non-Insulated Lifting Equipment *(to Uncovered conductor)*	380mm	680mm	1000mm
Phase to Phase distance *(Distance to be maintained between phases when moving conductors)*	450mm	900mm	450mm
Tool Insulation Distance *(Hand Sticks)*	450mm	900mm	450mm
EWP Basket Separation *(Utilising more than 1 EWP's working together)*	Where two EWP's are utilised for live line work, two phases may be worked on simultaneously provided that a minimum separation of 2 metres (air gap) is maintained between the baskets & booms of the EWP's is maintained at all times. No tools and/or equipment are to be passed between the EWP baskets while working in close proximity. Care shall be taken to ensure that the work of one person does not compromise the safety of another.		

Plant

- In all cases, plant and equipment such as EWP's, Cranes, Peru's, Task Trucks and any other plant items being used in close proximity to live HV conductors in connection with HV live line work shall be electrically connected to earth. This shall be achieved via a conductor from the vehicle chassis to a permanent or driven earth.

  NOTE: *The lowering of an earth chain is not an adequate means of earthing when undertaking HV Live Line work.*

- Plant items parked closer to each other than 6 metres shall be bonded together to a common earth system / electrode. If a 6 metre separation can be maintained between items of plant as well as the earth electrodes the items of plant should be separately earthed.

Plant that has control levers or remote controls that can be operated whilst standing on the ground shall not be used unless:

- The operator is standing on a mat that is electrically connected to the vehicle, or
- The operator shall be positioned on the vehicle, or
- The operator is 6 metres from the vehicle earth (in the case of remote controls) before operating any crane controls.
- The EWP should be slewed out of the Contact Area prior to raising or lowering materials.
- Only materials related to the immediate task being performed are permitted to be transported in the basket of the work platform.

Equipment

All live line rubber gloves, mats & hoses shall be inspected daily for:

- Pin holes, cuts, scratches, abrasions, ageing, corona cutting, or other mechanical damage.
- Rubber gloves shall be field air-tested before use to ensure their integrity as an insulating medium. If at any stage the electrical integrity is suspect the equipment shall be withdrawn for retesting or discarded.

- Only approved clothing shall be worn. All personal protective equipment shall be utilised including hard hat, eye protection and ear protection when required.
- All live line insulating equipment shall be electrically tested on a regular basis (as per table below) or where the integrity of such insulation is suspect.

PERSONAL EQUIPMENT	TEST INTERVALS
Insulating Gloves & Sleeves	6 months
Insulating blankets	12 months
Insulating line hoses, connectors covers	12 months
Conductor support equipment, insulating platforms & temporary dropout tools	12 months
Insulated jumpers	12 months
PLANT EQUIPMENT	**TEST INTERVALS**
Insulated EWP's	6 months
Insulated EWP basket liner	6 months
Insulated hoses	6 months

Conductors

- Conductors must be restrained in proper equipment designed for such use.
- Conductors shall only be placed or rested upon the work platform after an appropriate weight assessment has been conducted, and at no stage shall the safe working load of the work platform be exceeded.
- Only one conductor shall be placed on the basket at any time. Two forms of insulation shall be maintained at all times.

Weather

- Live line work should not be performed in unsuitable wet, windy and stormy weather conditions. Prior to commencing any Live Line task weather conditions for the day shall be considered. Weather conditions for the day may be unsuitable because of:

a. Electrical storm

b. Rain, fog, snow, mist, or sleet

c. Excessive wind velocity

d. Excessive heat

e. Excessive humidity

- If Live Line work is in progress and the weather conditions deteriorate to a point where it becomes unsafe to continue, the Live Line work shall be suspended. Where temperatures rise above a comfortable level the risk of heat stress and fatigue increases and as such Glove & Barrier work should be suspended.

Washing insulators on HV lines and equipment

- Employees required to wash HV insulators shall be trained and authorised to carry out this type of work.
- Only approved washing equipment shall be used and the equipment shall be used in accordance with approved procedures.
- Washing procedures shall include precautions which protect the worker from exposure to unsafe leakage currents and prevent insulator flashover.
- Water purity, water pressure, nozzle size and minimum permissible washing distance are related and shall be observed as specified in the procedure.
- The procedure shall also include independent precautions to protect the worker from exposure to unsafe leakage currents. Depending on the procedure, this may require working from an insulated platform, maintaining an earth on the nozzle of the washing gun or using an insulated washing gun.
- Water purity tests shall be made on the water supply daily when live washing and each time the water storage tank is refilled, regardless of whether the equipment is to be used for energised washing or not, water shall have a resistivity value of 2.5kΩcm or more.
- A pressure gauge shall be located at the pump of the washing equipment to indicate the water pressure. At no time shall this pressure exceed the manufacturers recommended ratings. Labels shall be provided on each unit specifying this rating.

- The insulator washing equipment shall be provided with hoses rated to withstand the maximum water pressure that the equipment is capable of producing at the pump.
- The washing gun shall be a pressure type, equipped with a spring-loaded trigger or other type of device, which will automatically shut off when released. The nozzle size shall be as specified in the approved washing procedure.
- All components of the insulator washing equipment shall be thoroughly inspected prior to each use. All hose connections, including the nozzle, shall be checked to ensure that they are securely fastened. Work shall not proceed until defects are corrected.
- The insulator washing trailer shall be earthed according to company specific procedures.
- The nozzle of an uninsulated washing gun should be bonded to the surface on which the operator stands to ensure that they remain at the same potential.
- Inspect insulators prior to washing. Generally, damaged, sparking or excessively noisy insulators should not be washed alive. In the case of transmission insulators, a small number of cracked or broken discs may be permissible subject to procedures.
- The water stream shall be at full pressure before being brought into contact with insulators and moved clear before being reduced.
- Dirty insulators may flashover if wetting is not controlled. The insulators should be washed in sections, ensuring that each section is clean before progressing to the next. Avoid wetting adjacent sections until the section being washed is clean.
- For pin and post type insulators, start from the base and work up. For suspension and strain construction, commence at the disc insulator closest to the conductor.
- High pressure washing is not permitted on certain equipment such as circuit breaker and oil switches due to the risk of water entry into the equipment.
- Polymeric insulators should not be washed with high pressure equipment.

Single person tasks

- All live line lineworkers undertaking single person aloft tasks shall be suitably instructed and authorised for this type of work.
- A single person aloft cannot perform any task that involves moving or displacing a conductor, or installation / removal of a hopper.

Allowable tasks by a single person aloft are as follows:

a. Install / Remove fault detection and recording equipment

b. Install / Remove insulating barriers / covers

c. Install / Remove vibration protection

d. Install / Remove bird covers

e. Install / Remove "D" loops (off load only / no circuit connection)

f. Install / Remove spreader ropes

g. Replacement of insulator ties (pre-form ties not allowed)

h. TVI rectification (limited to lubrication)

i. Tighten hardware (crossarms and insulators)

j. HV crossarm inspection

4. POLES, TOWERS AND STRUCTURES

General

When working on poles, towers or other structures, employees shall:

- Be suitably trained and authorised.
- Ensure poles, towers and structures are sound prior to commencing work.
- Inspect all assets to ensure that they are safe prior to climbing.
- As required, secure all structures to ensure employee and public safety.
- Report any asset, which could present an immediate danger.
- Raise or lower lightweight equipment and tools by means of a handline and canvas polebag, or other suitable container. Care should be taken by employees working overhead to prevent tools or material from falling.
- Avoid shock or out of balance loads on structures during work and install temporary stays when necessary.
- NOT rely upon cross-arm braces or other pole attachments to support an employee's weight.
- Wear an approved pole belt/harness.
- Use non-conductive taglines and handlines near energised lines and equipment.
- Not withstanding the fact that the electrical apparatus has been disconnected from all sources of supply, due regard shall be given to the possibility of inadvertent energisation from adjacent electrical apparatus, induction, lightning, static charges, or other means.
- When erecting poles, consideration shall be given to the weight of the pole which can vary for both wood, steel and concrete poles due to moisture content, age, type of wood, steel gauge and in the case of concrete poles the manufacturer. (See Table 1. Wood & Concrete Pole Data page 21).
- When erecting poles, the appropriate hole depth shall be achieved. (See Table 1. Wood & Concrete Pole Data on page 21).

Safe to climb test for poles

1	Conduct Visual Inspection	Look for: • Condemned pole markings • Disc height (1.5m above ground level)[1] • Rotting • Splitting • Termites • Rust stains, cracks and bulges on concrete poles • Crossarm, insulator and tie damage • Excessive leaning • Damage by vehicles [1] See page 22 for pole disc information
2	Conduct Push Test	**Where a pole has fittings to push against.** • Extend a ladder hard against a bracket, step iron or arm brace. Do not push against stays or a line of conductors other than slack services. See Figure 1 • Position ladder as high as possible on the pole. This will ensure that the maximum amount of stress is placed on the pole, especially at the butt, which is most important when testing for rot. • Ensure that all persons and vehicles are in safe positions, including the public. • Two persons push on the ladder, first gently and progressively increase the force. The ladder must be lifted clear of the ground to make an effective test. **Where a pole has no fittings to push against.** • Erect ladder fitted with 12mm handline as shown in Fig. 2. • Tie handline off to base of pole. • Test pole by pushing on ladder.
3	Discontinue Test	Immediately the pole shows signs of failure OR After the pole withstands the full force and proves to be sound

Make poles safe

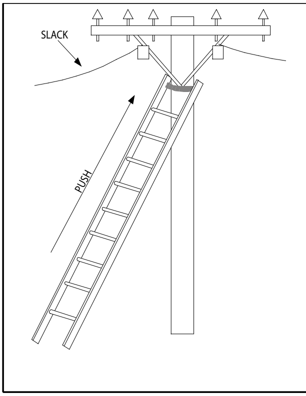


Figure 1

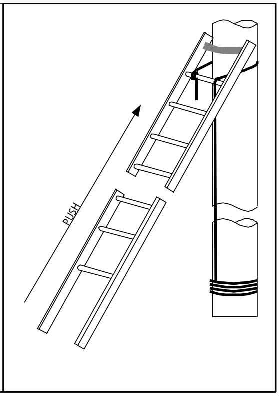


Figure 2

4	Make Safe	Where a pole fails the Safe to Climb Test it must be made safe. **Secure the butt:** a) Drive 3 ground pins around the pole as shown in Figure 3. b) Lash pins and pole securely with 12mm rope c) Lash to an adjacent pole, (300mm maximum spacing) d) Lash to PERU if close enough **Support the pole:** a) With the PERU, keeping the winch rope high for maximum support, or; b) With 4 x 16mm rope stays. Push stays up with HV operating stick or set 4 temporary pikes to support the pole and fit stays from ladder. Tie to ground pins set at 90° apart.

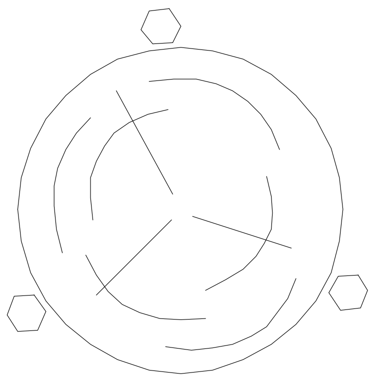


Figure 3

Pole weights & hole depths

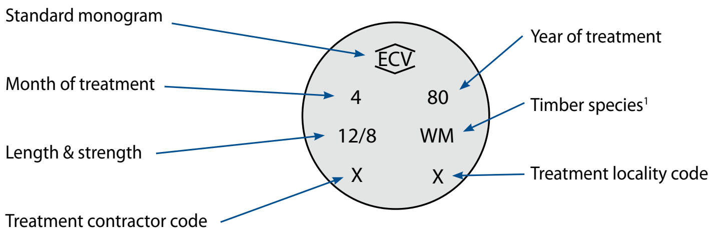
TABLE 1

Wood Poles	Approx. Weight (kg)	Depth (mts)
11/5	500 – 900	2.1
11/8	700 – 850	2.1
11/12	800 – 1600	2.1
12/5	600 – 750	2.2
12/8	800 – 950	2.2
12/12	1000 – 1200	2.2
12.5/5	850 – 1100	2.3
12.5/8	850 – 1100	2.3
12.5/12	1100 – 1200	2.3
13/5	800 – 1100	2.3
13/8	1000 – 1200	2.3
13/12	1200 – 1700	2.3
14/8	1100 – 1400	2.4
14/12	1200 – 2000	2.4
15.5/12	1400 – 1650	2.5
17/12	1700 – 1900	2.5
18/12	1800 – 2100	2.6
18.5/12	1800 – 2150	2.6
20/12	2100 – 2400	2.7

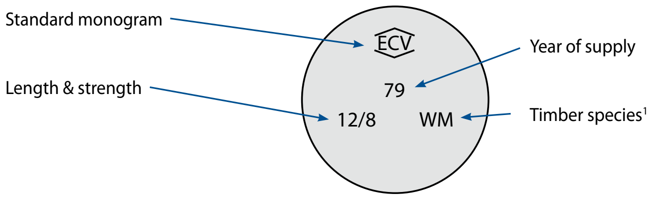
Concrete Poles	Approx. Weight (kg)	Depth (mts)
13/3	1400 – 1550	2.3
11/8	1500 – 1650	2.1
11/12	1900 – 2000	2.1
12/8	1750 – 1950	2.2
12/12	2100 – 2300	2.2
12.5/8	2200 – 2400 (Sub)	2.3
12.5/12	2250 – 2450	2.3
13/8	2000 – 2200	2.3
13/12	2300 – 2500	2.3
14/8	2200 – 2400	2.4
14/12	2600 – 2800	2.4
15.5/12	3100 – 3250	2.5
17/12	3300 – 3800	2.5
18/12	3500 – 4000	2.6

Pole identification discs

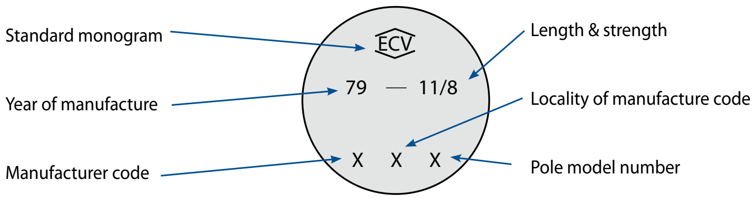
PRESSURE TREATED POLES



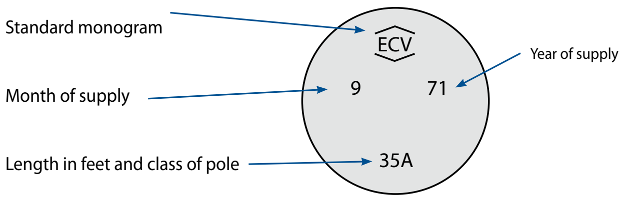
NON-PRESSURE TREATED POLES



SPUN CONCRETE POLES



EARLY IMPREIAL POLES



[1] See timber species codes listed on page 23.

Timber species commonly used for poles in Victoria

Class 1 (Mainly dressed but some natural round poles are used)		**Class 2** (Mainly natural round but some dressed poles are used)		**Class 3** (Mainly creosote but some CCA treated poles are used)	
Species	Code	Species	Code	Species	Code
Grey Box	GB	Blackbutt	B (Also BB)	Messmate	MS (Also MM)
Grey Gum	GG	Spotted Gum	SG	Silvertop Ash	MT (Also GG)
Grey Ironbark	GI	White Stringy-bark	WS (Also WSB)	Mountain Grey Gum	CG
Red Bloodwood	RW	Yellow Stringy-bark	YS (Also YSB)		
Red Ironbark	RI				
Tallowwood	TW			Radiata Pine *(Class 4)*	PR
White Mahogany	WM				
White Topped Box	QB				

Periods of use

Pre 1947	Metro – dressed Class 1 timbers. Other – mixture of dressed and natural round Class 1 & 2
1947 > 1956/57	Mainly natural round Class 2 (WS and YS) but some dressed Class 1 & 2
1956 > 1971	Wholly Class 3 timbers, creosote pressure treated. **NOTE**: In this period, the Mountain Grey Gum poles were identified GG, but they should not be confused with the highly durable Grey Gum which had been bought in the dressed condition and also in smaller numbers from 1972 to 1983 for pressure treatment. Gippsland region continued to use untreated white and yellow stringy-bark throughout this period and right up to 1976.
1972 > 1983	Creosote pressure treatment continued in this period. Poles treated were mainly Class 3 and some Class 1 & 2. Mountain Grey Gum were properly identified MT from the introduction of metric poles
Mid 1983	Dressed Class 1 poles only
1996	CCA treated poles introduced across Victoria

Multiple circuits

When working on structures with multiple circuits, ensure that:

- All personnel can identify the correct circuit to be worked on.
- Limits of approach are observed/maintained.
- Safety Observers are appointed as required.
- When relocating to another work position, reconfirm the circuit to be worked on each time.
- As part of the on site risk assessment, the work crew shall establish appropriate methods of communicating which circuit is to be worked on and of the intended method of action.
- When working on conductive structures with a circuit under Access Authority, cross-arms and conductors shall be bonded together by standard earthing techniques.

When undertaking work on 'dead' circuits with other circuits alive, (multiple circuits), employees shall adhere to the following access procedure.		
1	Identify the circuits to be worked on.	Assemble the work party at the foot of the structure and identify the circuit/s to be worked on.
2	Climb under continuous observation. (One person only).	Appoint an observer. Climb and STOP before getting within reach of the lowest HV conductor.
3	Use approved signals.	Indicate the conductors to be worked on by pointing across the body.
4	Obey signalled instructions.	Watch the observer who will: a) Signal 'all clear' in response to correct indication; or b) Signal 'recall' in response to incorrect indication.[1] After receiving 'all clear' continue to working position. Stop and again indicate the conductors to be worked on. [1] If an incorrect indication is made, the person climbing must return to the ground and recommence the procedure.
5	Do not touch the conductor/s until the second 'all clear' is received.	Watch the observer who will: a) Signal 'all clear' in response to correct indication; or b) Signal 'recall' in response to incorrect indication.

6	Climb in turn. (Other persons).	The person now established in their working position will act as safety observer. Each person climbing will then follow the procedure already described.
7	Follow the procedure every time.	Each employee must follow this procedure every time the structure is climbed. Be particularly alert when, after climbing a series of poles from one side (i.e. the road or line side), you climb the next pole from the opposite side. This reverses the relative positions of the live and dead conductors. See Figure 4.

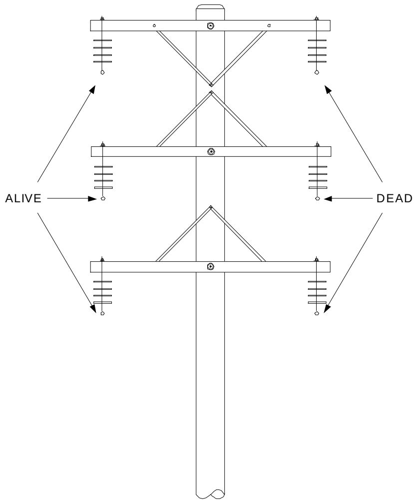


Figure 4

NOTE: The dead conductors illustrated on the right would be on the left of a person climbing from the far side.

8	Prevent all possibility of accidental contact.	Avoid moving a dead conductor in any way likely to cause contact with live conductors. Be aware of under and over-crossings as well as conductors attached to the same pole.

Pole type junction boxes

Pole Junction boxes are used to house the connection of cables. They contain no protective element such as a fuse and are generally located on poles where they are used as a junction point between bridging cables connected to LV mains and one or more service cables feeding a customers premises.

There are two different types of junction boxes:

'J' Type Junction Boxes

- This type of junction box consists of three terminal blocks contained in a one piece porcelain insulation housing. The porcelain has been found to crack or break easily when disturbed and due to the size of the box has minimal clearances.
- When working near to these junction boxes avoid disturbance to the leads and services to the box and wear full protective apparel, including safety glasses.
- Work on J type junction boxes **SHALL** be carried out under de-energised conditions only.

Isolating Type Junction Boxes

- This type of junction box is an isolating type, they are designed so that the services connected in the junction box can be easily isolated from the LV mains.
- The isolation is achieved by the disconnection of the bridging conductors from their terminals, which are then held in a disconnected position by means of nylon screws.

5. CONDUCTORS & STAYS

Conductor stringing

When stringing conductors, employees shall:

- Ensure conductors are kept under positive control by the use of adequate tension reels, guard structures, tie lines or other means.
- Ensure conductor pulling and tensioning lines, reels, load bearing hardware and other equipment are of adequate capacity, are periodically inspected for defects, and are operated in accordance with the manufacturer's instructions.
- Ensure overhead lines (other than insulated low voltage service lines) being erected, dismantled, or replaced, where there is any possibility of contact with, or induction from, adjacent live conductors, are earthed before work commences. They shall remain earthed until the work is completed.
- NOT position themselves on cross-arms while a conductor or pulling line is being moved by truck or stringing equipment.
- NOT position themselves inside the angle.

Conductor bridging

When carrying out LV conductor bridging, employees shall:

- Identify and tag neutrals.
- Confirm phasing and voltage prior to and after bridging.
- Establish direction of supply.
- Use approved hoppers to make or break load.
- Apply and remove hoppers using the line/load, load/line method.
- Clean conductors and apply jointing compound as appropriate.
- Use appropriate cover up and PPE.
- When connecting bridges, confirm that the hopper is correctly connected by conducting a "splash" test.
- Avoid contact between Line and Load conductors.

Conductor ties

Intermediate Tie

For intermediate and angles of deviation up to 3 degrees.

1. Halve the tie. Place centre at start point, (see Figure 5). Take 1½ turns around insulator, passing each tie end under the conductor
2. Make 3 turns around the conductor.
3. Pass ends of tie around insulator and under the conductor on the opposite side.
4. Make 8 turns.
5. Make 1 open turn, (approximately 20mm).
6. Make 5 turns.
7. Make 1 open turn.
8. Make 3 turns.
9. Cut off surplus tie wire.

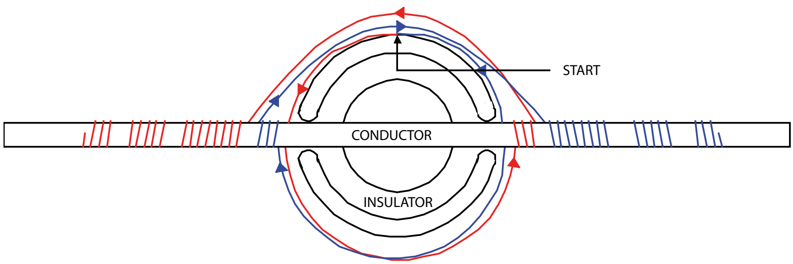


Figure 5

Angle Tie

For angles of deviation greater than 3 degrees.

1. Halve the tie. Place centre at start point, (see Figure 6). Bring ends of tie around insulator and under conductor on each side.
2. Make 2½ turns around the conductor.
3. Pass ends of tie around the back of the insulator and under the conductor.

4. Make 2 turns around the conductor.
5. Pass ends across the front of the insulator and under conductor.
6. Make 4 turns around the conductor.
7. Make 1 open turn, (Approx. 20mm).
8. Make 5 turns around the conductor.
9. Make one open turn.
10. Make 3 turns around the conductor.
11. Cut off surplus tie wire.

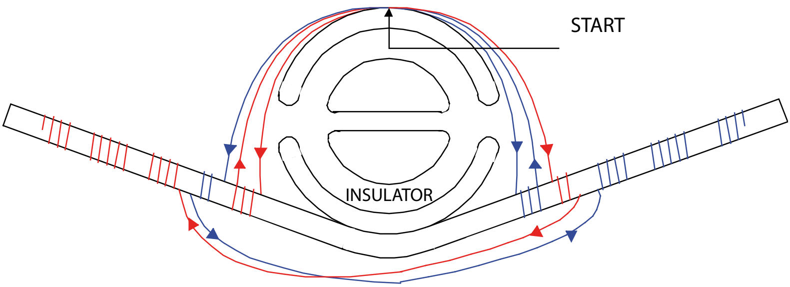


Figure 6

Fallen conductors

When dealing with fallen conductors, employees shall:

- Treat all conductors as alive until proven dead.
- Construct/erect visual warnings such as signs, flashing lights, barriers, ropes, etc.
- Issue verbal warnings to those present that the area is unsafe to approach.
- Where possible maintain a 6 metre clearance distance.
- Issue an appropriate Access Authority prior to handling.
- Notify emergency services as required to provide site security or assistance.

Conductor weight and tension

It is important to maintain an awareness of the weight of and tension in conductors to avoid shock and out of balance loads or overloading of equipment.

Conductor Tension - the following formula can be used to determine conductor tension where the supports are on similar levels. Reference should be made to Table 2 on page 33 for conductor weights.

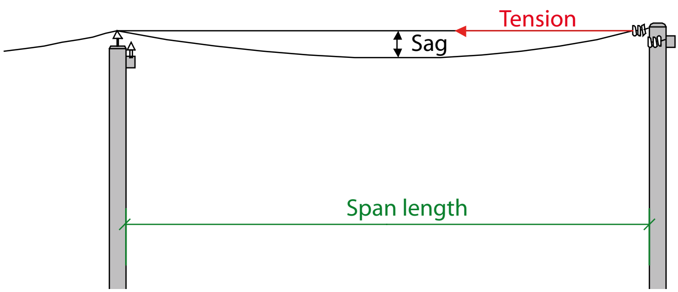
$$T = \frac{W \quad x \quad S^2}{8 \quad x \quad Sag} \text{ kg (for spans up to 300m)}$$

Where:

T = Tension in kg's

W = Weight of conductors per metre

S = Span length



SAMPLE CALCULATION

The following calculation determines the tension of a single conductor in a 60m span of 19/3.25 having a sag of 1.25m. The weight of the conductor is 0.433 kg/m

$$T = \frac{0.433 \times 60^2}{8 \times 1.25}$$

$$T = \frac{0.433 \times 3600}{10}$$

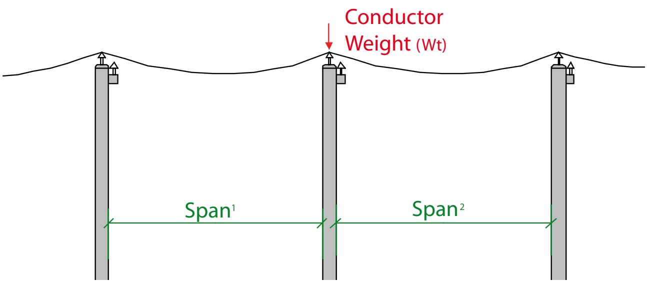
$$T = \frac{1558.8}{10}$$

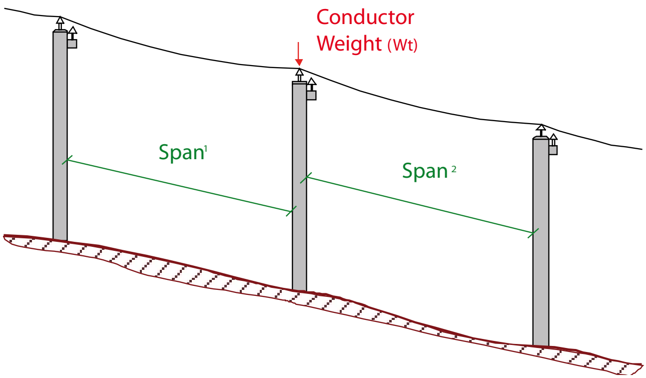
155.88kg or rounded to 156kg

Conductor Weight

The following formula can be used to determine conductor weight at a point as indicated in the diagrams below.

$$Wt = W \times \left(\frac{Span^1 + Span^2}{2} \right)$$





SAMPLE CALCULATION

The following calculation determines the weight of a single 7/4.75 conductor in a situation where Span 1 = 80m and Span 2 = 70m.

$$Wt = W \left(\frac{\text{Span}^1 + \text{Span}^2}{2} \right)$$

$$Wt = .340 \left(\frac{80 + 70}{2} \right)$$

$$Wt = .340 \left(\frac{150}{2} \right)$$

$$Wt = .340 \times 75$$

$$Wt = 25.5 \text{ kg}$$

TABLE 2

Conductor[1]		Linear Mass (kg/m)
Type	**Stranding & Wire diameter mm**	
AAC	7/2.50	0.094
	7/3.00	0.135
	7/3.75	0.212
	7/4.75	0.340
	19/3.25	0.433
	19/3.75	0.578
	19/4.75	0.926
	37/3.75	1.130
ACSR	3/4/2.5	0.193
	6/1/2.5	0.119
	6/1/3.0	0.171
	6/1/3.75	0.268
	6/4.75, 7/1.60	0.404
GALV. STEEL	3/2.75	0.118
	7/2.00	0.177
	7/2.75	0.326
	19/2.00	0.483
	19/2.75	0.888
Cu	7/1.63 (7/.064)	0.130
	7/2.03 (7/.080)	0.204
	7/2.64 (7/1.04)	0.344
	19/2.11 (19/.083)	0.599
	19/2.57 (19/1.01)	0.887
CdCu	7/1.63 (7/.064)	0.130
	7/1.85 (7/.073)	0.171
	7/2.36 (7/.093	0.277
	7/2.87 (7/.113)	0.409
	19/2.26 (19/.089)	0.691
LVABC	2 X 25	0.20
	3 X 25	0.30
	4 X 25	0.40
	4 X 35	0.52
	4 X 95	1.35
	4 X 150	2.02

[1] Reference: ECV Drawing # VX9/7020/30 K

Aerial supervisory cable

The general function of Aerial Supervisory Cable is to protect and operate zone substations.

Aerial Supervisory Cable when running in parallel with overhead conductors is subject to induced voltages, which may be as high as 25kV as a result of a fault situation. The catenary wire is subject to the same induced voltage but as it is connected to earth at each sectionalising box the magnitude of this voltage would be expected to be less but still of sufficient magnitude to be treated with caution.

When working on poles supporting Aerial Supervisory Cable the following precautions shall be taken:

Wood poles <u>dead</u> work

When working on/near dead LV conductors and simultaneous contact can be made between those conductors and the catenary wire, either the catenary or the appropriate conductor shall be covered using LV mats or sleeving.

Wood poles <u>live</u> work

When working on/near live LV conductors within reach of supervisory cable, the exposed catenary shall be covered as well as all other conductors within reach to avoid a second point of contact.

Concrete poles <u>dead</u> work

If simultaneous contact can be made between the bare catenary wire and any dead conductor or the concrete pole, the catenary wire shall be bonded to the concrete pole. LV gloves shall be worn when making the bonder connection and the bonder must be removed at the completion of works.

Concrete poles <u>live</u> work

As for wood poles. Where work is undertaken on the catenary wire itself, the catenary shall be bonded to the concrete pole.

Disconnection of catenary from permanent earth

Any work involving the disconnection of catenary from the permanent earth at sectionalising poles, must not proceed until the catenary is earthed by means of temporary earths applied to both sides of the sectionalising pole.

Electrolysis cables

Traction electrolysis cables (also known as drainage bonds) are erected on distribution poles to enable underground metal structures such as water mains to be bonded to the rails of the electric Rail and Tram traction systems. By this they provide a return circuit for stray DC leakage currents produced by the traction systems, thereby reducing electrolytic corrosion of the underground structures.

The bond or connection is made in a pole mounted control box by either of two methods:

a. a diode which allows DC current to flow in only one direction from the underground asset to the rails or;

b. an electrical contactor that closes automatically when the DC voltage polarity between the rails and the underground asset is such that current would flow from the underground asset to the rails. These installations require an un-metered LV supply to the electrolysis equipment box and are quite rare.

Work on electrolysis cables

It is important that electrolysis cables are not earthed at any point other than the bonding point in the control box and therefore must not be earthed at the worksite unless the cable is isolated with the proper approval of the Rail or Tram Authority.

Although most electrolysis cables are insulated in the vicinity of each pole or structure to which they are attached, all such cables must be treated as live LV conductors. If work is to be carried out on live LV conductors adjacent to the electrolysis cable; an adequate number of LV mats must be applied to the cable on all poles on which work is to be carried out.

When working on electrolysis cables for the purpose of changing poles, if an electrolysis cable is not broken and earthed, it must be treated as "Live LV" and appropriate gloves and mats shall be used.

Continuity of electrolysis cable NOT BROKEN

Where the work being carried out is such that the continuity of electrolysis cables will not be broken, or the electrolysis cable will not contact or be contacted by any earthed apparatus (including the ground and other earthed conductors), isolation of the electrolysis cable is not necessary.

Continuity of electrolysis cable <u>BROKEN</u>

Where the work being carried out is such that the continuity of electrolysis cables be broken, and/or the electrolysis cables will be, or are likely to be earthed by contact with other earthed apparatus or conductors, the electrolysis cables must be isolated at the work site as follows:

a. Isolation of electrolysis cable must be preceded by notification to the relevant Rail or Tram authority who will advise the applicant whether it is in order to isolate the cable at the requested time.

b. Network Control and the relevant authority will co-ordinate the switching sequence.

c. Work party to ascertain whether the electrolysis box/es has an LV supply and where applicable isolate supply.

d. Apply LV hoppers across the suitable cable bridges on both sides of the work site. Open bridges and remove hoppers.

e. Apply earths or bond electrolysis cable to other earthed conductors.

Restoration

a. Remove earths or bonders from electrolysis cable.

b. Apply LV hoppers across the electrolysis cable bridges on both sides of the work site. Close bridges and remove hoppers.

c. Restore LV supply where applicable.

d. Notify Network Control that electrolysis cable is restored.

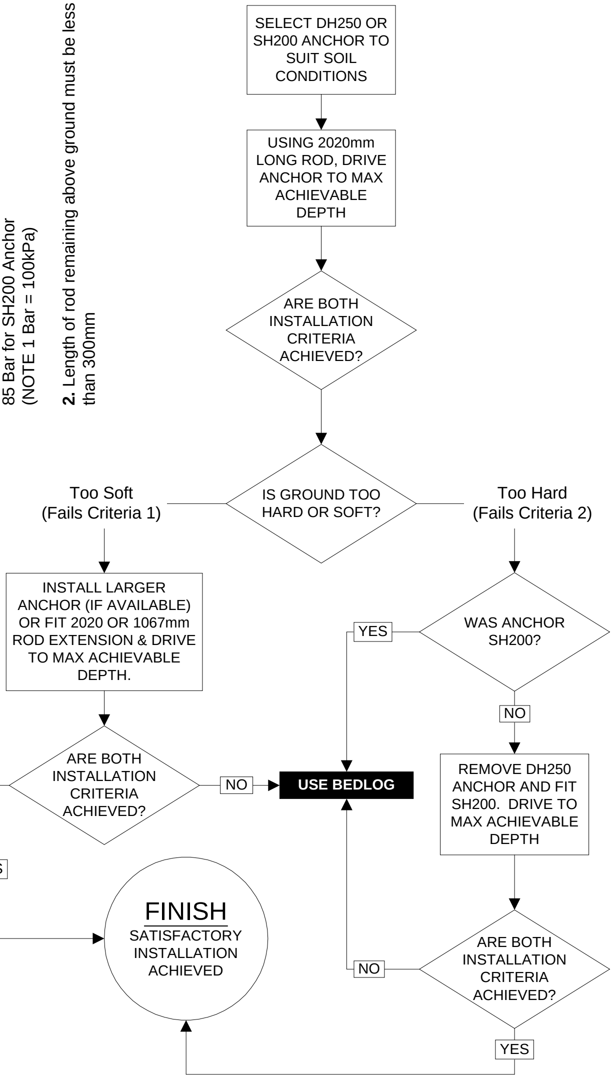
Screw in anchors

Process Flow for No. 5 Screw in Anchor

No. 5 ANCHOR INSTALLATION CRITERIA

1. Pressure Gauge reading over the last 750mm must be greater than:
70 Bar for DH250 Anchor
85 Bar for SH200 Anchor
(NOTE 1 Bar = 100kPa)

2. Length of rod remaining above ground must be less than 300mm

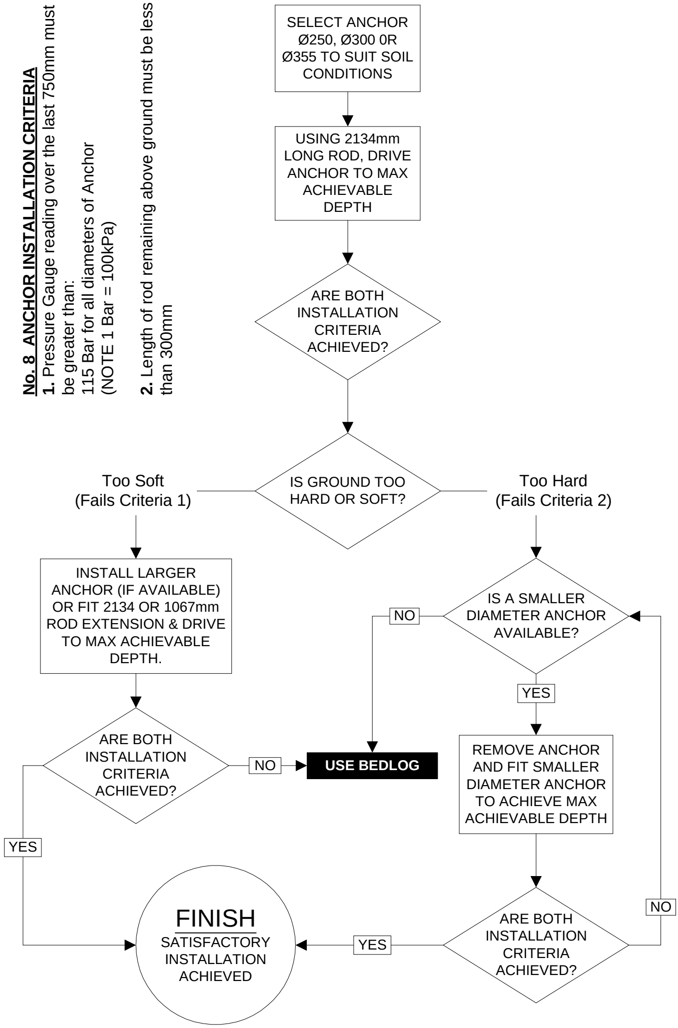


Process Flow for No. 8 Screw in Anchor

No. 8 ANCHOR INSTALLATION CRITERIA

1. Pressure Gauge reading over the last 750mm must be greater than:
115 Bar for all diameters of Anchor
(NOTE 1 Bar = 100kPa)

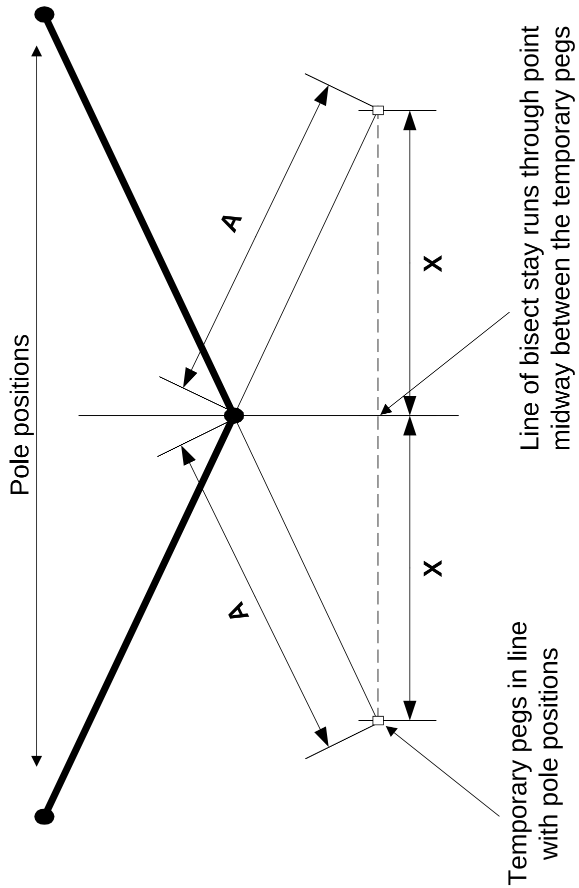
2. Length of rod remaining above ground must be less than 300mm



Stay holes

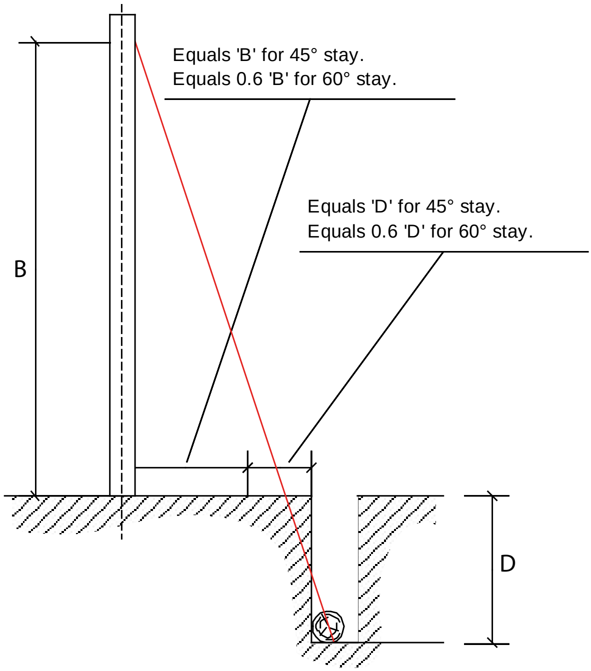
Determining the Stay line

Sight through line of poles for in-line stays or plot for bisect stays where A = A and X = X.



Calculating the Stay Hole Position

Plot distance of stay hole from pole.



6. PUBLIC LIGHTING

When working on public lighting, employees shall:

- Be appropriately trained and authorised for the purpose of the work.
- Treat lanterns, brackets, stays and hauling wires as alive at all times.
- Cover all conductors and fittings within reach that are not being worked upon.
- Only handle a hauling wire if standing upon an approved insulating medium (e.g. line workers mat).
- Test all lantern brackets and hauling wires to earth with an approved tester before commencing work, unless changing tubes or lamps from an approved and tested EWP.
- Disconnect the supply to a public light when the lantern bracket or hauling wire is found to be alive. The fault shall immediately be rectified or reported.
- Ensure unauthorised persons remain at least 2 metres from brackets and do not touch hauling wires or cable television systems.
- Ensure the safe disposal of mercury and sodium vapour lamps.
- Ensure the safe disposal of components containing either asbestos or PCB's.

Prior to the use of photoelectric (PE) cells, public lighting systems were controlled by a system known as the 'Cascade Control System' or more simply as the 'Switchwire' system. Street lights were connected to the switchwire and neutral and in effect the system used a series of contactors to energise the switchwire at each distribution substation.

The switchwire system is now obsolete and is being progressively removed from service, however in some parts of Victoria they are still functioning. Figure 7 shows the wiring arrangements for the Master PE Control Switch & Contactor Box, Figure 8 shows the wiring arrangements for a Contactor box and Figure 9 shows a schematic representation of the Cascade system.

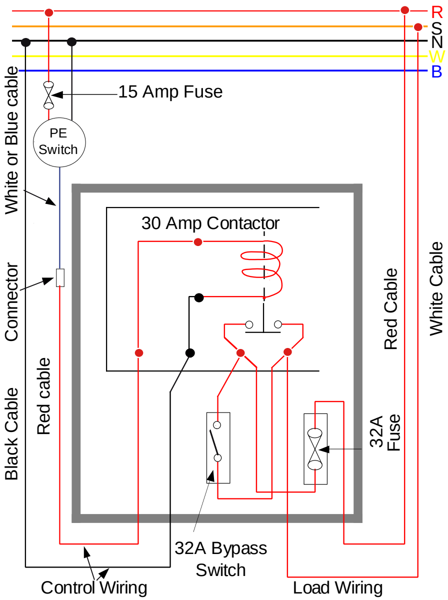


Figure 7

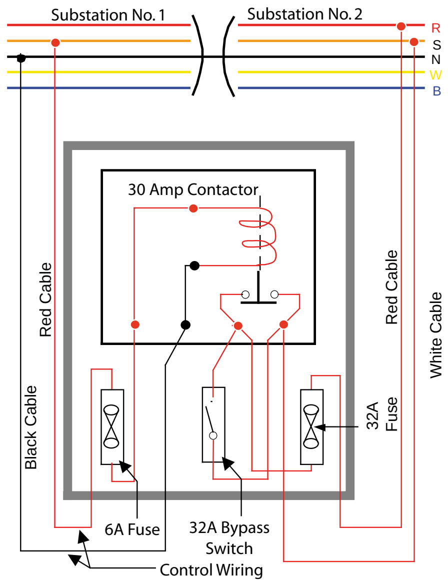


Figure 8

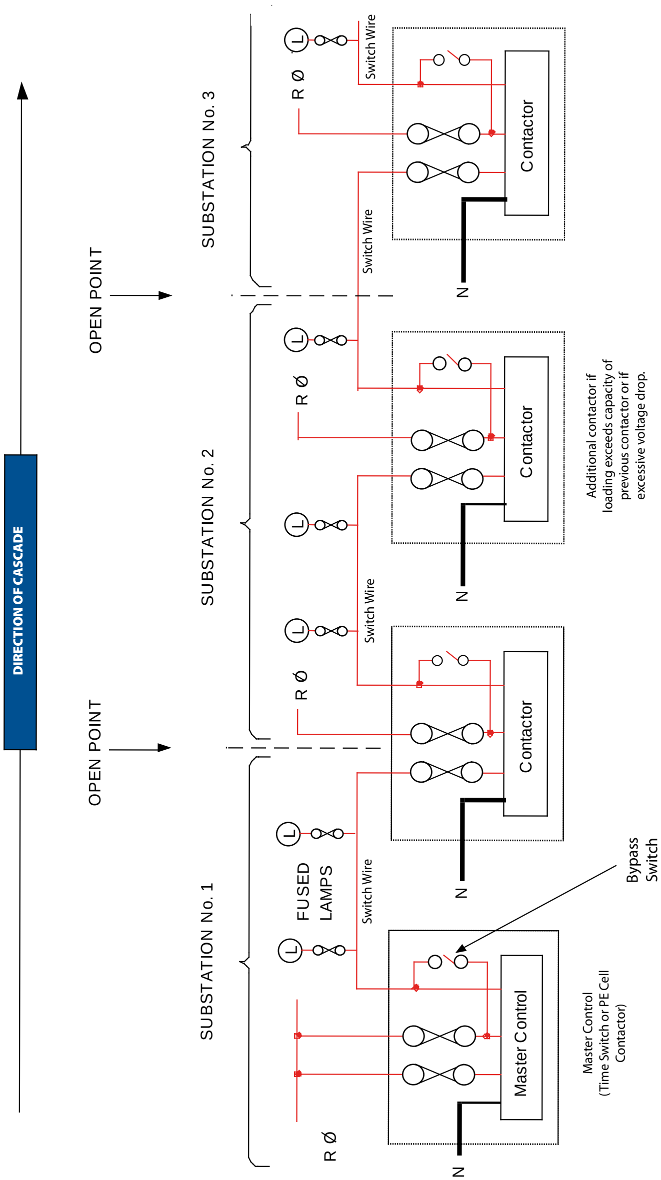

DIRECTION OF CASCADE
OPEN POINT
OPEN POINT
SUBSTATION No. 1
SUBSTATION No. 2
SUBSTATION No. 3
R Ø
FUSED LAMPS
L
Switch Wire
Contactor
Master Control
N
Bypass Switch
Master Control (Time Switch or PE Cell Contactor)
Additional contactor if loading exceeds capacity of previous contactor or if excessive voltage drop.

Figure 9

7. TREE TRIMMING

Generally, vegetation management is to be undertaken by approved specialists. The information below relates to required tree trimming under fault conditions:

- When trimming trees, the appropriate worksite traffic management is to be employed for protection of the public and the work group.
- Only authorised live line persons are permitted to clear tree limbs overhanging live high voltage conductors.
- When using chainsaws or brushcutters, the operator is to consider the hazards associated with its use, including environmental (weather, terrain, light, etc.) and electrical conditions, and the proximity of other persons. Such considerations should be noted on the job site assessment.
- Appropriate PPE shall be worn at all times.
- Instructed or authorised persons may clear tree limbs overhanging live low voltage conductors provided the movement of limbs being cut can be controlled.

8. OPTICAL FIBRE CABLE

With the introduction of Optical Fibre Cables, (OFC) in the Telecommunication networks it is important to understand the risks involved with working with and handling OFC.

OFC is used to transmit communications and video signals over long distances with very little loss of signal. These signals are pulses of high frequency light.

OFC is generally a round black, grey or blue polyethylene covered cable with multiple bundles of fine glass fibres in the core of the cable. OFC can consist of 12, 24, 36 and 60 fibre strands.

Self supporting cable has an outer Aramid yarn layer covered by a second polyethylene sheath for self supporting strength.

See Figure 10 next page.

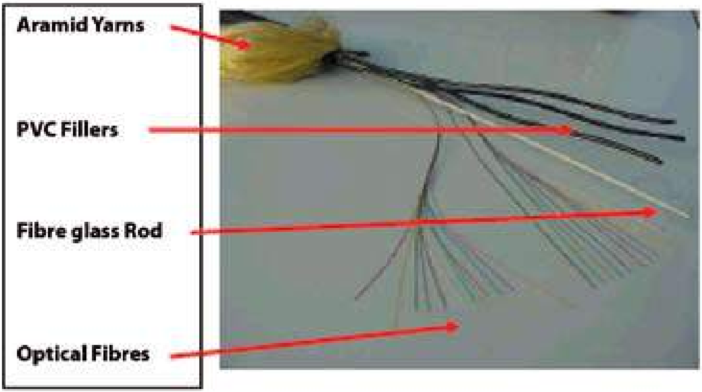


Figure 10

Hazards

Glass Fibre Hazard

If the glass fibres are exposed there is the risk of tiny fragments of glass causing a severe injury. This could occur with a new cable or with a damaged cable that has been in service. Broken fragments could penetrate the skin or inadvertently come in contact with your eyes causing a serious injury.

Always wear gloves & safety glasses when working with OFC!

Laser Light Hazard

The fibres carry pulses of light generated by a laser. This light is invisible to the human eye and can cause damage to the eye if looked into.

Do not look into the fibres at the end of OFC as severe damage to the eyes can occur!

Working with optic fibre cable

Handling OFC

When working with Fibre Optic cable care must be taken to prevent damage to the fibres as OFC repairs are time consuming and very costly.

The fibres may be damaged by:

- Bending the cable past its minimum bending radius.
- Crush damage if the cable is strained incorrectly.
- Crush damage if cable is driven over.
- Pinch damage if weight is placed unevenly on the cable.

Bending Radius

Care must be taken not to exceed the minimum bending radius. The minimum bending radius of the cable will be specified by the manufacturer. This is measured as shown in Figure 11.

A simple template can be made to indicate the bending radius of the cable to indicate if the bend is too tight.

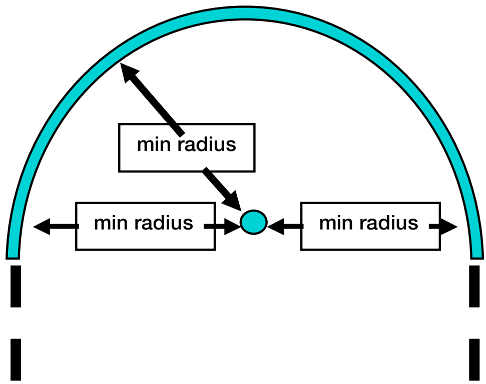
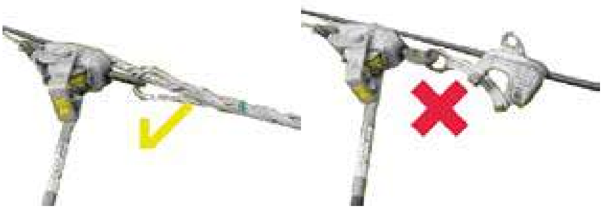


Figure 11

Straining Optic Fibre Cable

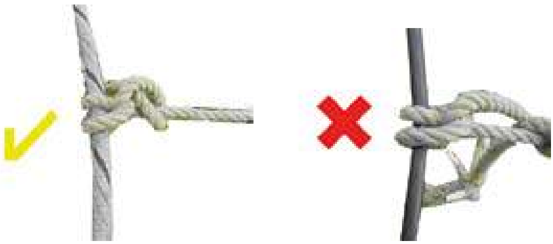
When straining cable the only acceptable method is to use a helical termination placed over structural rods.

Crescent clamps, comealongs or rope snodders are not to be used in any instance, as these will crush the cable causing severe internal damage to the fibres.



Pulling OFC cable away from poles

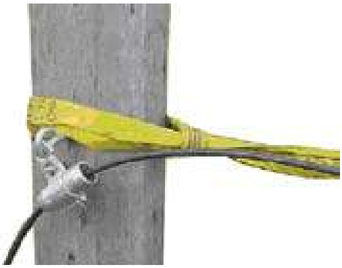
When it is required to pull the OFC away from a pole, ie during a pole changeover; tie the rope over a structural rod as this will prevent pinch damage to the cable.



Temporary support of OFC at adjacent poles

When handling OFC, shock loading must be avoided as this can result in pinching and/or breaking of the optic fibres at the adjacent support structure clamps.

It may be necessary to support the cable at these adjacent structures to ensure no damage occurs. Do this by securing the cable with a temporary termination wrap-on (over the top of a structure rod) at the adjacent poles. This will spread the load over the cable and remove the tension at the support clamp.



Maintenance

Damage prevention - Intermediate Pole Changes

- Secure the cable with temporary termination wrap-ons (over the top of a structure rod) at the adjacent poles.
- Carefully lower or move the cable away from the pole using a rope tied over a structure rod.

Damage prevention - Termination Pole Changes

- Take up the strain using temporary support method on the adjacent pole.
- Then let back the cable slowly.
- Avoid shock loading and maintain the minimum bending radius or more as the cable is being lowered.

Damage prevention – Strain Pole Changes

- Take up the strain across the cable using a winch device.
- Apply wrap-ons only over a structure rod for tensioning.
- Handle the cable in such a way so as not to bend the cable past the minimum bending radius. This includes the cable and jointing box assembly.

Faults

When responding to a fault where an OFC is damaged:

- Under no circumstances look into the fibres of the cable.
- Contact the report/control room and advise of:
  - Specific location
  - Damage to OFC
  - OFC owner if known
- If the cable needs to be cut to make the site safe, cut and apply heatshrink caps to the two ends of the cable.
- Roll up cable ensuring not to exceed the bending radius of the cable and secure.

9. RAILWAY CONDUCTOR / CABLE CROSSINGS

Overhead crossing design pre-approval

Design plans for the particular site demonstrating compliance with the relevant Railway Authority requirements shall be submitted to and approved by the Railway Authority prior to commencement of programmed work.

Access to railway property

Access arrangements with the relevant Railway Operator are essential prior to entering railway property or carrying out work in the immediate vicinity of railway infrastructure, particularly relating to the provision of appropriate safety requirements.

Overhead conductor construction conditions

- Overhead crossings must be constructed to an approved design plan for the particular site.
- Overhead lines and supporting structures shall be erected clear of all railway structures, drains, access roads, signalling/communications equipment, overhead masts and buildings.
- Crossings shall be terminated at each end of the span with strain type insulators and for this purpose the supporting structures (poles) shall be a strained construction design.
- Where stays are on railway property, their position shall be approved by the Railways Engineer.
- Splices or joins shall not be made in conductors of spans crossing railway lands and tracks.
- If, in a fault or emergency situation, a sleeve or join is made in a conductor crossing Railway land, a fault follow up is to be raised to replace the repaired conductor.
- No current carrying connection of any kind shall be made to any portion of a crossing span which is under tension.
- Crossarms not fitted to the top of the pole, shall be fitted to that side of the pole which is farthest from the railway tracks. The use of "Offset Crossarms" is not permitted.
- Conductor stringing activities shall stop and conductors are to be secured during the passage of trains in the vicinity of work.

- Construction crews shall as far as practicable, leave the Railway Authorities property in the condition it was prior to the installation of the overhead crossing.
- For transmission line crossings, the type of structure (steel towers) is to be specified in the approved design plans.

Underground cables

Special conditions apply to bores crossing under the railway lines as specified by the Railway Authority, and the construction of bores shall not proceed without authorisation by the Railway Authority. These conditions are necessary to ensure that the integrity of the railway tracks is maintained.

10. STRINGING CONDUCTORS BELOW & ADJACENT TO LIVE CIRCUITS

General

Where cricital supplies could be affected or network integrity is at risk it may be required to string new and/or replacement conductors below or adjacent to live circuits.

Planning & communication

Conductor stringing below or adjacent to live conductors can involve a number of different situations and can be completed using a variety of works practice methods. It is vital that correct planning and adequate safety precautions are put in place before the job commences to remove any risks that may occur during the completion of the job.

When evaluating the safe completion of conductor stringing where conductors are to be run below live conductors, it is important to ensure that the line of sight between the stringing points at each pole does not infringe on the Safe Approach Distances (SADs) to the live conductors above, (see Figure 12)

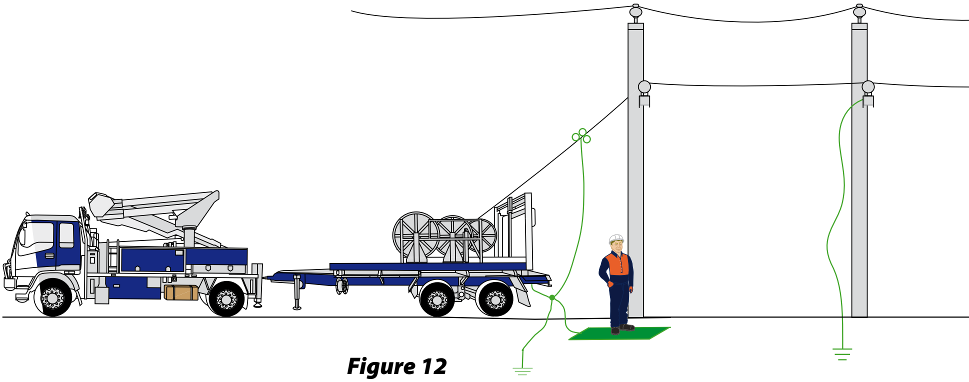


Figure 12

As with all conductor stringing jobs, effective communication (visual and sound) is a vital part of ensuring the safe completion of the job. TMRs, Flot channel, hand-held 2 way radios, mobile phones and the most effective positioning of persons and equipment for line of sight are mandatory considerations.

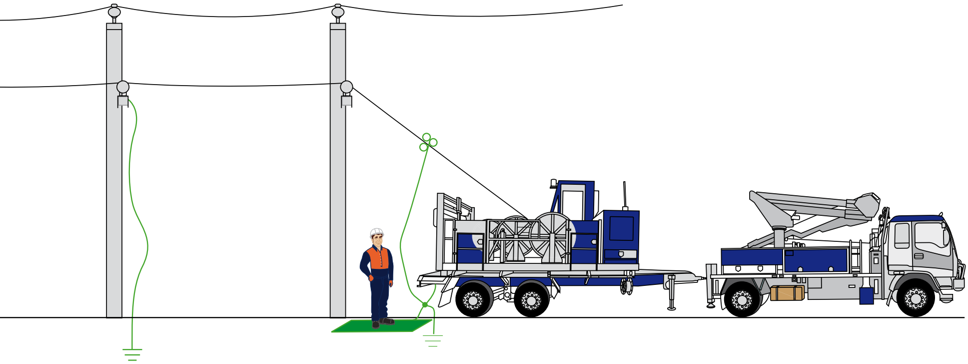
The utilisation of experienced personnel at key locations or tasks is also of vital importance. Where line of sight is not obtainable for key personnel or equipment, consideration is to be given to the posting of Safety Observers who can facilitate effective reporting, updates or equipment functionality confirmation.

Electrical hazards

To prevent electric shock either via accidental contact or induction it is vital that operational earthing is in place during this type of work.

The installation of earth rollers one span from each end of the run is the most effective manner of achieving this. Earth rollers are installed one span from each end to allow the conductors to be hung, sagged and terminated whilst still at earth potential. These poles would then be tied in last to ensure effective electrical protection.

Induction should also be considered when operating plant or equipment. In this regard, operators shall ensure they are protected from step and touch potential when operating plant and equipment or managing the cables as part of the run.



Precautions for this could include earthing the plant or equipment, using personal separation such as an HV mat, the use of equipotential mats bonded to conductors and drum supports, or using ropes to manoeuvre or pull cables.

Suppression of auto-reclose shall also be enabled whenever this type of work is performed.

Re-conductoring methods

Where the stringing involves utilising the pull in - pull out method, it is important to consider the quality and condition of the conductor or rope that is being used. Some older type conductors are prone to breaking and this may cause a flicking hazard.

Where the conductor is deteriorated or deemed too small to pull in the new conductor, rope may be pulled through using the existing conductor and then the rope utilised for the new conductor pull. It is also important to be aware of the straining capabilities of the pull through conductor/rope as it may not be capable of withstanding the full sag while straining the new conductor. Where this occurs, pulling of the new cable right through to the straining device or for three rolls on the recovery unit drum are effective solutions.

Consideration can also be given to using other methods to assist with safety and increasing clearances such as lowering the rollers down the pole and lifting conductors to the final position once sagging has been completed.

Equipment

The use of the correct equipment plays a vital role in safe and effective conductor stringing. It is important to utilise equipment that is sufficiently rated and capable of completing the job safely. The utilisation of correct equipment reduces manual handling, limits the risk of damage to plant, equipment and materials and includes the following:

- Correct sized and appropriate rollers.
- Cable Recovery Units
- Cable trailers (with operational drum brakes)
- Cable stockings
- Ropes
- Come-alongs
- Correct sized Lug – Alls
- Equalizer blocks
- Chains, strops, blocks and rollers for hanging on poles and below xarms.
- Equipotential mats
- Earth rollers

SERVICING AND METERING SECTION 5

1. SERVICING

1. When undertaking work under live conditions, appropriate PPE, mats, sleeves, etc, shall be used at all times. Where required, a Safety Observer shall be posted.
2. Persons about to work on, or within reach of live circuits shall be appropriately trained and authorised for the purpose of the work.
3. The work crew nominated to carry out the work shall make a safety assessment before any work is commenced. The surrounding conditions shall be carefully examined to determine whether the work can be done safely. Possible hazards such as earthed situations, exposed live metal, weather conditions and the movement of persons, material and equipment in the vicinity shall be considered.
4. Only appropriate and functional testers in combination with an independent earth shall be used to undertake neutral supply (NST), polarity, insulation resistance, installation checks and voltage testing.
5. The supply neutral only shall be connected to an installation neutral. Conductors shall be visually identified, the neutral tagged and all appropriate NST and polarity tests performed prior to energising a customer's installation.
6. When connecting, replacing or reconnecting a service, all tests shall be performed in accordance with the VESI Installation Supply Connection Tests and Procedures including specific individual Distributors requirements.
7. If incorrect test results are detected and cannot be corrected, immediately isolate the service and report back to your Team Leader or Report Room.
8. Before disconnecting multiphase services, identify and tag the existing phase sequence.
9. A phase sequence check shall be undertaken on multiphase installations.
10. If incorrect phase sequence test results are detected and cannot be corrected, immediately isolate the service and report back to your Team Leader or Report Room. Phase rotation of customer's equipment must be considered prior to altering or rectifying.
11. At both the supply and customer's end, make sure all tails are secure and safe, and always identify and tag the neutral.
12. Ensure appropriate clearances are maintained at all times.
13. Underground service cables shall be insulation resistance (meggered) and continuity tested prior to energisation. Refer to Section 3 of the VESI Installation Supply Connections Tests & Procedures manual.

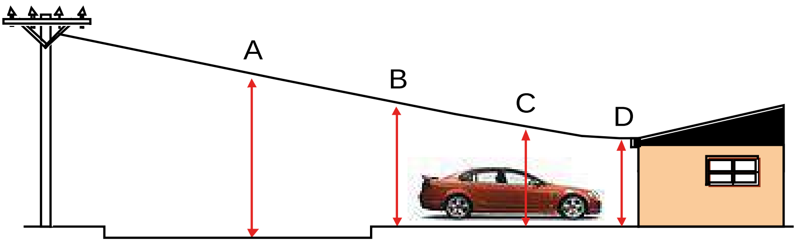
14. Ensure that customer load is removed (i.e. fuses removed or circuit breaker open) before disconnecting or reconnecting services.
15. When re-connecting a customers premises by fuse insertion, (ie for new tenants in a rental property) and load is present and nobody home, leave the installation "OFF" at either the switchboard or by the service fuses.
16. TABLE 1 shows the regulatory height requirements for service lines according to the Network Assets Regulations, 1999. Where a new or replacement service does not meet these requirements, refer to company procedures.
17. Where a premise is deemed electrically unsafe it should be isolated, "Defected" and Dispatch notified. Individual circuits of an installation shall only be inspected, and/or isolated by a Licensed Electrical Worker or a Licensed Electrical Inspector. Where a premise has a minor electrical fault that does not pose a risk to employee or public safety, i.e. faulty FMJB, it should be "Defected" and Dispatch notified.

TABLE 1.

	SERVICE CABLE LOCATION	Minimum Distance
A	**Above a public roadway**	
	Over a 2m wide strip in the centre of each carriageway of a road	5.5m
B	**Over any other part, eg. kerb line of:**	
	A freeway, highway, primary road, main road or OD route	5.5m
	A secondary or collector road[1] or forest or tourists road[2]	4.9m
	Any other road, eg Local traffic streets	4.6m
C	**New Service**	
	Over a driveway or ground traversable by vehicles	4.6m
	Existing Service	
	Over a driveway or ground traversable by vehicles	3.9m
D	**All Services**	
	Elsewhere, i.e. garden beds, lawns and footpaths Point of Supply	3.0m

[1] For the definitions of roads see Melways Map Symbols

[2] For the definitions of roads see Vicroads Townships Maps



Overhead service heights

2. NST IMPEDANCE TESTING

The purpose of testing with a Neutral & Supply Tester (NST) in accordance with the VESI *Installation Supply Tests & Procedures Manual* is to demonstrate that the active and neutral connections from the network supply to the customers installation are correct.

The tester performs a self check test of its internal operations and a number of other functions which prove:

- That the supply voltage is between 205 and 264 Volts AC (+ - 5 %)
- That the neutral to earth volts are less than the active to earth volts. (Polarity)
- That the impedance of the independent earth is less than 10 kΩ to earth.
- That the supply neutral has less than 5 Volts (+ - 5 %)
- If the results of these tests are suitable, the NST is then capable of testing the impedance of the circuit, which is the last function performed.

Impedance is best described as the opposition to current flow in an alternating current circuit. As voltage (Electro Motive Force) is the force used to push current, impedance is the resistance, which opposes the current and results in a subsequent voltage drop within the circuit. It is upon this principle that the NST determines impedance.

The NST does this by measuring the active to neutral voltages over three consecutive alternating current cycles. The NST applies a 13.3 amp load to the second of these cycles and compares the voltage variations of this loaded cycle with the first and third cycles that are measured with no load applied. By calculating the voltage drop between the active and neutral conductors under this known load the NST can determine the amount of impedance present in the circuit.

Important points to remember when testing are that:

- The instrument is testing the loop impedance of the active and the neutral conductors. Subsequently if the instrument was to fail its impedance test the impedance may be present in the neutral conductor, the active conductor or a collective combination of both.
- The instrument will pass its impedance test if there is any path of less than 1 Ω impedance to earth and this may include other paths within the MEN system such as installation earths.
- As the instrument only applies the testing load for one cycle (1/50th of a second) this does not necessarily prove that the neutral conductor will definitely function efficiently under full or consistent load conditions.

For test procedures and descriptions of approved test equipment refer to the VESI, "Installation Supply Connection Tests & Procedures".

3. METERING

General Requirements

Persons about to work on live apparatus shall:

- Subject to the job safety assessment:
    - Wear protective clothing and use protective equipment suitable for the proposed work.
    - Before proceeding with the installation of metering equipment on the premises of new customers, employees shall test all components of the installation to be worked upon in order to prove that they are not alive, and to make the work area secure by locking off switches and/or fitting earthing bonds and/or other physical breaks as appropriate.
    - Inspect all test equipment and test leads to ensure that they are in safe working condition.
    - Use insulated tools as appropriate.
    - Use particular caution when working on metal cased equipment or in enclosed spaces or areas where body movement is restricted.
    - Apply an approved insulating sheath over any conductor, which is removed from its terminal.

Direct Metering

Installation and removal of electric meters and metering devices shall be performed by trained, authorised personnel using appropriate personal protective equipment and test equipment.

Other than where exemptions are granted, work on customer's low voltage installations shall only be performed by persons licensed by ESV.

Direct Meter Types

Mechanical Clock Face Meter

Mechanical Digital Read Meter

EMS 2100 Meter

EMS2600 Meter

To ensure the metering is correct, it is essential that the following requirements are met:

1. The metering equipment must be appropriate for the load and tariff.
2. The connections must be made correctly.
3. Metering equipment must be fixed to meter panels in a manner that prevents accidental penetration or abrasion of a conductors insulation. This can be achieved by the use of nylon hardware or approved metal screws.
4. The location must be permanently accessible and suitable for the equipment used. Refer to the current edition of the Victorian Service & Installation Rules.
5. A record must be taken of the equipment installed and/or removed.
6. All metering equipment must be transported carefully as they could be damaged internally or made inaccurate by rough treatment.
7. Always seal metering equipment including metering panels with the correct seal and tag neutral conductors.
8. At the completion of the installation of the metering equipment, all tests shall be carried out in accordance with the VESI Installation Supply Tests & Procedures.

Existing Installation – Replacement of Direct Metering

Refer to VESI Installation Supply Connection Tests & Procedures Manual, Section 4.

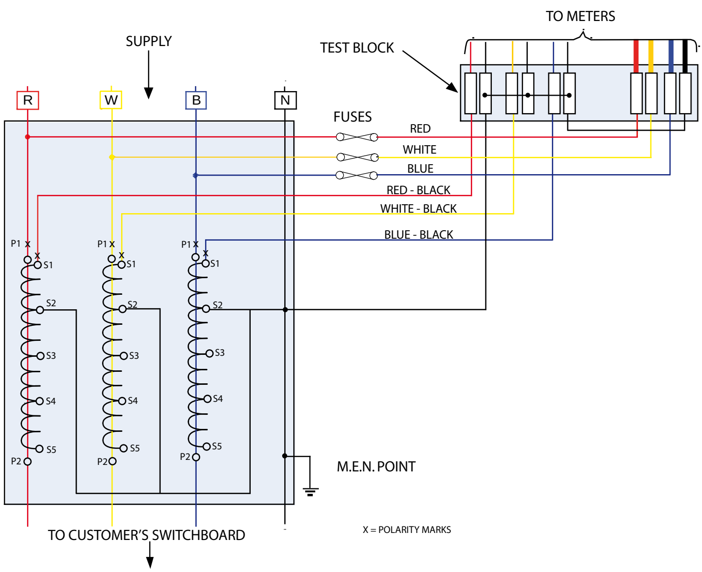
4. CT METERING

General

All works conducted on CT metered equipment shall be in accordance with clause 14.5 of the *Green Book* 2006 - Code of Practice on Electrical Safety for the Distribution Businesses in the Victorian Electricity Supply Industry and the VESI *Installation Supply Tests & Procedures.*

CT Metering – General Requirements

The purpose of CT metering is to accommodate customers requiring a load greater than 100amps. This has been adopted because conductors of higher rating cannot be satisfactorily terminated on direct connected meters.



CT Schematic Diagram

Other than where exemptions are granted, work on customer's low voltage installations shall only be performed by persons licensed by ESV. Employees shall perform as much of the installation inspection and testing work as practicable, de-energised.

Work on CT Metering (Alive)

Work on live metering equipment is permitted for testing or investigative purposes by authorised persons. Test equipment may only be connected/ disconnected from live metering equipment terminals when it can be done safely and the actions of connection/disconnection do not involve the making or breaking of customer load.

Persons undertaking live work shall be appropriately trained and authorised for the purpose of work.

CT Chamber showing LV buswork and CT's

The person nominated to carry out the work shall make a safety assessment before any work on live apparatus is commenced. The surrounding conditions shall be carefully examined to determine whether the work can be done safely. Possible hazards such as earthed situations, exposed live metal, weather conditions and the movement of persons, material and equipment in the vicinity shall be considered.

In situations which present the possibility of making inadvertent simultaneous contact with exposed live metal of different phases and/or earth, eg, when entering the space behind a switchboard or when working on a cubicle type switchboard or control panel, persons shall wear protective clothing and use protective equipment and methods.

At no time shall the secondary circuit of the CT be opened while the primary is energised. The transformer must be shunted before opening the secondary metering circuit.

Before working on the secondary circuits of current transformers, the person shall ensure that all necessary precautions are taken:

- To prove that secondary conductors are at earth potential.
- To prevent an open circuited secondary situation.

Before working on voltage circuits on a meter panel the circuit shall be isolated by:

- Removing the fuse cartridges for permanently fused voltage circuits; or
- Opening the voltage links in the meter test block.

When testing or inspecting voltage circuits that are not permanently fused, the voltage links at the meter test block shall be opened and temporary fused links inserted.

- Voltage circuits connected to the supply side of a meter panel shall be isolated before work commences.
- No work shall be carried out on a bonded secondary installation. The installation shall be de-energised and replaced with metering to current standards.

Work on CT metering (De-energised)

Where the JSA reveals that the work cannot be performed live in a safe manner, the work party shall:

- Isolate in an approved manner.
- Test the conductors to prove that they are not alive.
- Make the work area secure by locking off switches and/or fitting earthing bonds and/or other physical breaks as appropriate.

Existing Installation – Alterations and/or Additions

When conducting works on CT Meter Panels the worker shall consider the wiring arrangement of the particular installation and where appropriate supplement this procedure with additional practices as required within the Code.

CT Metering enclosure showing meters and separate CT Chamber

1. Test primary and secondary work areas for de-energised.
2. Install "Installation Under Test" notice.
3. Identify current, voltage and any switching active and neutral conductors and mark as appropriate.
4. Establish existing phase sequence.
5. Insert 'shorting' plugs into the current circuit of the meter test block. (All Phases)
6. Open the current links of the meter test block (All Phases)
7. Isolate the voltage/potential circuits from the meter by removing the fuse cartridges or opening the voltage links in the meter test block.
8. Test for De-energised
9. Conduct Metering Replacement/Alterations.
10. Restore voltage/potential supply to meters by inserting fuses or closing voltage links in test block as appropriate.
11. Close the current links at the meter test block (All phases).
12. Remove the 'shorting' plugs from the current circuit of the meter test block (All phases).
13. Test Phase Sequence.
14. Check meter for correct meter registration under customer load.
15. Check correct Voltage and Current phase relationships, for each phase.
16. Conduct specialist-metering checks/tests in accordance with meter provider requirements.

17. Check if correct constant is applied to the meter label.
18. Check all connections and equipment.
19. Seal metering and associated equipment.

5. READING ELECTRICITY METERS

Occasionally fieldworkers will be asked to read customers electricity meters. When asked to do so it is vital that the correct information is recorded as this is billable information to a customer.

Clock Face Mechanical Meters

- Stand directly in front of the meter
- Read from left to right, obtaining one number from each clock face
- If the hand is between two numbers, always record the lesser of the two, not necessarily the closer. (The exception is when the hand is between 9 and 0, in which case you write down 9).
- Using the example at Figure 1, the reading would be 04508 kWh's

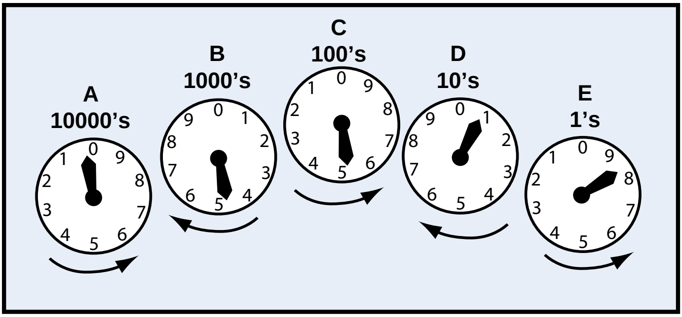


Figure 1

NOTE: When the hand appears to be exactly on a number, look at the dial to the right.

In the example below in Figure 2, if the hand at 'C' has not passed 0, the number 5 at 'B' has not actually been reached and so the reading is the lower number, which are 4. The total reading is therefore 04980 kWhs.

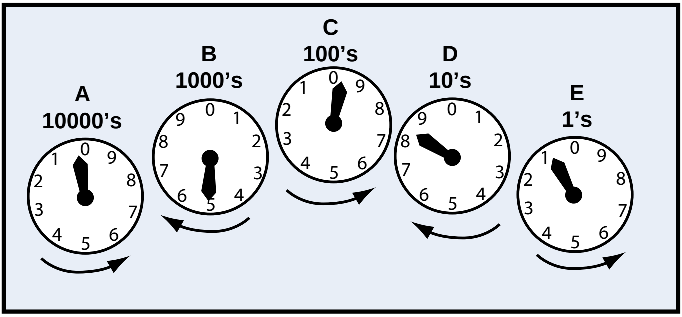


Figure 2

Digital Read Mechanical Meters

To read this type of meter, simply read the digits from left to right. In the example at Figure 3, the reading would be 425836 kWhs

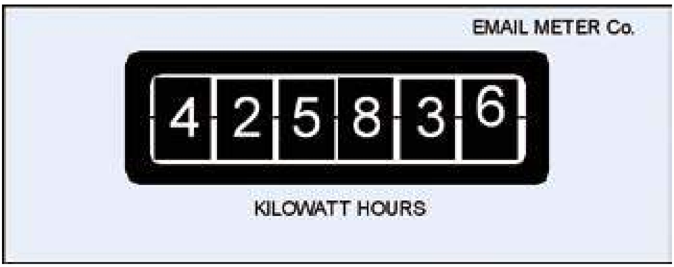


Figure 3

Where there are 2 rows of digits, this indicates a 2-rate meter reading a high and a low tariff, (see Figure 4). In this case, simply record the readings from left to right making sure to note which is the high and which the low tariff.

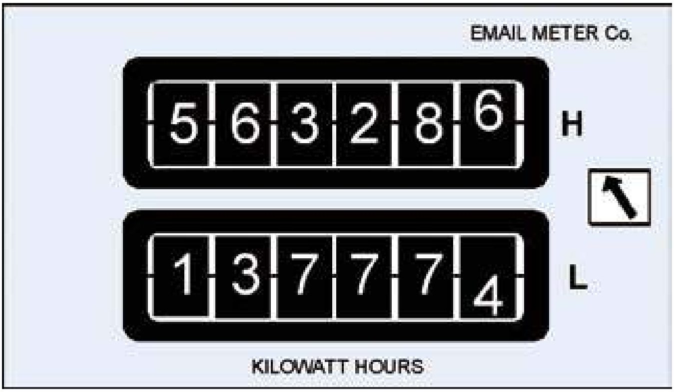


Figure 4

EMS 2100 & 2600 Electronic Meters

When the Display button is pressed, the meter will automatically scroll through a series of up to 20 displays. Each display will have a number on the left-hand side of the reading.

As the meter scrolls through each display, note down the readings for the following display numbers:

- 03 – Total kWh
- 04 – KWh usage,Peak
- 06 – KWh usage, Off-Peak
- 07 – KWh usage, Off-Peak Hot Water

NOTE: *The Boost button can be used if there is a single element electric hot water service. If the hot water service has run out of hot water, press the boost button once. The unit will automatically switch itself off when boosting is complete.*

6. ADVANCED INTERVAL METER INFRASTRUCTURE (AIMI)

In early 2006, the Victorian Government formally endorsed the deployment of advanced interval meters to all Victorian electricity consumers taking supply of less than 160 MWh per annum.

Currently, most Victorian electricity supply points are metered with electro-mechanical accumulation meters that only record total consumption and are subject to manual reading every three months. Starting at the end of 2008, more than 2.5 million new meters (often referred to as "smart meters") will be installed over a 4 year period. These meters will allow Victorian consumers to better manage their energy use by providing more detailed information about their consumption with the opportunity to save money on their power bill and reduce greenhouse gas emissions.

Further advantages are expected to be gained by remote or wireless technology, such as reading and disconnect reconnect.

SWITCHING, ISOLATING AND EARTHING SECTION 6

Should you require further information, please refer to the following manual:

> Code of Practice on Electrical Safety for the Distribution Businesses in the Victorian Electricity Supply Industry (The Green Book).

1. PERSONS AUTHORISED TO OPERATE ELECTRICAL APPARATUS

1. Switching and associated duties on electrical apparatus should be performed by either Electrical Operators or persons whose training, duties and instructions cover the particular apparatus. However, any person who has the ability may perform operations in the following circumstances:

   - When specifically instructed by, or authorised by the appropriate Operating Authority; or
   - In an emergency involving serious risk to persons or property.

2. All switching shall be directed and controlled by the appropriate Operating Authority.

2. SWITCHING - PERSONAL SAFETY

1. When operating electrical apparatus, you shall:

   - Wear approved safety headwear.
   - Wear approved clothing (e.g. overalls).
   - Wear approved and appropriate eye protection.
   - Wear approved insulating sole footwear.
   - Only use devices to open circuits under load that are capable of interrupting the current involved.
   - Avoid contact with any earthed conductive equipment.

2. When operating electrical apparatus via a metal handle (including isolating or restoring rackable metal clad switchgear) you shall always wear appropriate insulated gloves, which are regularly tested and maintained, with one of the following:

   - An insulated platform (e.g. ladder, EWP).
   - A HV mat.
   - Two interleaved LV mats.
   - A HV operating sleeve (appropriately tested and maintained).

3. When operating electrical apparatus via operating sticks, they shall be:

   - Of the appropriate length for the voltage involved.
   - Appropriate for the task involved.
   - Appropriately tested, maintained and within test date.

3. SWITCHING - GENERAL

1. When switching electrical apparatus the following shall apply:

   - Switching instructions given over the radio, telephone or in person should be repeated back for confirmation, to prevent errors. Apparatus shall be referred to in sufficient detail to enable positive identification.
   - After operating a piece of equipment, the operator shall confirm the equipment's status.
   - Appropriate tags shall be attached to all switches and/or control circuits operated to de-energise equipment or line sections on which an Access Authority is required.
   - If during the course of switching a piece of electrical apparatus it is found to be defective it shall be reported to the appropriate control centre or authorised individual and an appropriate tag attached.
   - Employees shall not remove or alter in any way, without consulting the operating authority or individual who attached the tag, any tags that have been applied to a device.

2. For the purposes of identification, wherever practicable, electrical apparatus shall be clearly labelled.

3. Before making any apparatus alive, the operating authority shall ensure that:

   - In the case of new apparatus, all necessary clearances have been verified by the operator. This may include certificates for electrical certification for HV customers.
   - Any Access Authorities, or other documents pertaining to the apparatus have been cancelled.

- The results of any pre-activation tests required to be carried out on the apparatus are satisfactory.
- All earths are removed and a visual inspection shows that to all appearances the apparatus is ready for service.

4. Before any electrical connection is made whereby new electrical apparatus or any electrical apparatus previously out of commission can be made alive, the person in charge of the work shall:
   - Notify the Operating Authority of the intention to make such connection.
   - Warn all persons associated with the work, and any others likely to be affected, that no further work on the electrical apparatus is authorised unless they are in receipt of an appropriate Access Authority.
   - Arrange for the connection to be made under an appropriate Access Authority or by approved live working techniques.

5. An Operating Authority shall not consider new or changed electrical apparatus, or electrical apparatus previously out of commission, as being available for service until it has been cleared for service and handed over from the constructing or maintaining authority by written notification or by other appropriate procedure.

4. OUT OF COMMISSION

1. High voltage electrical apparatus may be declared "Out of Commission," and access gained thereto once the defined disconnection and other necessary precautions have been provided. The written "Out of Commission" declaration shall include a statement concerning the condition of all relevant auxiliary equipment (e.g. control circuits, secondary fuses and fan supplies).

2. Electrical apparatus that is declared "Out of Commission" may be approached and worked upon without the issue of an Electrical Access Authority.

3. Not withstanding the fact that the electrical apparatus has been disconnected from all sources of supply, due regard shall be given to the possibility of inadvertent energisation from adjacent electrical apparatus, induction, lightning, static charges, or other means.

5. EARTHING

1. When work is to be performed on conductors or equipment that have been alive, all phases of the circuits shall be properly earthed and bonded together or the work shall be performed as energised.

2. When earthing you shall:

   - Use only approved earthing devices applied following a safe to earth confirmation by an authorised person, and placed to ensure the safety of the work party.
   - Inspect earthing devices for damage, broken insulation or fittings, and withdraw from service if necessary.
   - Connect an earthing device to earth before it is applied to the conductors, and it shall be removed from the conductors before it is disconnected from earth.
   - Apply and remove an earth by an approved device whenever practicable. Removal by hand should be in accordance with Green Book requirements.
   - Regard an earthing device as liable to become alive until the circuit earthing is complete.
   - Apply earths wherever practicable between the point of access and all sources of supply and at the site of the work.
   - Ensure persons not involved in the earthing are at least 6 metres away.

3. The first earth on electrical apparatus shall be:

   - Applied by an Operator or a suitably authorised person acting under the direction of an Operator.
   - Deemed to be an Operational Earth.

4. Operational earths shall:

   - Be listed on the appropriate Access Authority.
   - Remain under the control of the Operating Authority.

- Not be removed without the permission of the Operating Authority and all persons affected by their removal.
- May act as an onsite earth.
- Be applied in accordance with the priority earthing system as outlined in the Green Book and point 9.

5. On site earths shall:
   - Be applied to maximise personal safety.
   - Remain under the control of the workparty unless it is an operational earth utilised as an onsite earth.
   - Be applied at the structure where the work is being performed wherever practicable by persons trained to do so.
6. If work is to be performed at more than one location in the line section, the conductor to be worked on shall be earthed at each work location.
7. Additional earths shall be applied as necessary to avoid creating open or unearthed circuits being worked upon.
8. When applying multiple earths to a structure ensure all portable earthing devices connect to a common earthing point.
9. The choice of connection for an earthing device should wherever practicable be made on the basis of the following order of preference:
   a. Permanently installed earthing system at the worksite, including the neutral conductor of a Common Multiple Earthed Neutral (CMEN) System. This is not to be confused with a Multiple Earthed Neutral (MEN) System.
   b. Permanently installed earthing system as close as possible to the worksite (within two kilometres).
   c. Earthing ferrule in a concrete pole at the worksite.
   d. Earthing ferrule in a concrete pole as close as possible to the worksite (within two kilometres).
   e. A permanently installed earthing system or concrete pole earthing ferrule within the isolation area.

f. The ground rod of an installed pole stay.

g. A temporarily driven spike.

Options f or g should only be used for the first (operational) earth if options a to e are not available and all the poles in the accessed area are non-conductive.

10. Insulated conductors and supervisory cables shall be:

- Considered energised at all times unless properly disconnected from all sources of supply, tested and earthed.
- Proven discharged and earthed before work is performed, otherwise live working techniques shall be employed.
- In the case of work involving the disconnection of the catenary wire, this work shall not proceed until the catenary wire is earthed by means of a temporary earth attached to both sides of the sectionalising point.

11. Earthing of a cable by spiking shall be carried out in the following manner:

- The remote ends shall be correctly identified.
- The person in charge of the work shall personally select the cable to be spiked after careful reference to the appropriate records and use of cable tracers where necessary.
- An approved cable-spiking gun shall be used by a qualified person trained in its use and the prescribed instructions shall be followed at all times.
- The Operating Authority shall be contacted immediately prior to, and after the spiking is undertaken.

12. To declare high voltage capacitors safe for the issue of an Access Authority, the neutral as well as the actives shall be earthed and, in addition, each individual capacitor shall be discharged to earth before it is touched.

6. ELECTRICAL ACCESS AND AUTHORITIES

1. An appropriate safe access system shall be applied before any work commences on electrical apparatus. No person shall touch the conductors of any electrical apparatus unless:

   - The person is working under an Electrical Access Authority covering that electrical apparatus. The equipment has been isolated from all sources of supply (including interconnected LV and generator sets), and the conductors have been discharged and/or earthed/bonded at the work site, and the Electrical Access Authority is available for reference at the site of the work; or
   - In the case of a rackable circuit breaker or rackable voltage transformer, the electrical apparatus is removed from its rack or cubicle position and placed in a designated maintenance position; or
   - The person is working under the terms of a Sanction for Testing on that electrical apparatus; or
   - That electrical apparatus has been declared "Out of Commission;" or
   - The person is performing live work methods in accordance with organisational procedures.

2. When making an application for an Access Authority, you shall:

   - Be authorised to make the application.
   - Establish that the proposed work has been properly planned and can be performed safely.
   - Correctly identify the apparatus to be covered and its location.
   - Accurately define the work to be performed.
   - Submit all relevant paperwork to the operating authority.
   - Have all switching instructions checked by an approved person.
   - Provide appropriate diagrams showing de-energised sections.

3. Access Authorities to both HV and LV assets on a structure shall be either:

   - Simultaneous HV and LV access arrangements (one authority for both); or
   - Non-simultaneous access arrangements (e.g. separate Access Authority for both HV Access Permit and LV Access Authority).

4. HV Electrical Access Authorities shall be issued and cancelled only by Electrical Operators.

5. LV Electrical Access Authorities shall be issued and cancelled only by appropriately trained persons.

6. An Electrical Access Authority and a Sanction for Testing shall not simultaneously be on issue for the same electrical apparatus.

7. When more than one Access Authority is issued on the same apparatus, or where separate parties are working under the terms of one Access Authority, there shall be co-ordination in planning and performing the work to ensure that the actions of one party do not endanger the safety of others. This co-ordination shall be performed by a nominated co-ordinator (e.g. Operating Authority, Recipient in Charge, etc).

8. A recipient may work alone under the terms of an Access Authority provided there is no chance of inadvertent contact with live apparatus, or barriers and warning notices are in place to prevent the recipient inadvertently infringing safe approach distances.

9. Examples of Access Authorities used are as follows (further information is detailed in the referenced Company Operations Procedures).

Access authorities

AUTHORITY	PURPOSE
Electrical Access Permit **(EAP)**	To allow work, in a dead condition, on electrical apparatus that is capable of being energised.
Permit to Work **(PTW)**	Issued to a non-VESI person required to perform work near exposed electrical apparatus.
Statement Of Condition of Apparatus - Plant **(SCAP)**	Used when switching operations apparatus controlled by non-VESI authorities or other VESI operating authorities.
Sanction for Test **(SFT)**	Issued when electrical testing of electrical apparatus is required.
Statement of Isolation of Customer Low Voltage Supply **(SILV)**	Issued to a customer or REC when isolation of a customer's LV supply is carried out by VESI employees.
Verbal Statement of Condition of Apparatus - Plant **(VSCAP)**	Used between VESI operating authorities.
Work in the Vicinity of Live HV Apparatus **(VA)**	Issued to VESI personnel, (including contractors under the control of VESI personnel, for work near electrical assets in zone and terminal stations.

7. ACCESS AUTHORITY RESPONSIBILITIES

1. **Access Authority Issuer (e.g. Operator) responsibilities:**

    - At the time of issue, the Issuer shall describe and, where practicable, show the electrical apparatus covered by the Electrical Access Authority and the precautions taken, to the Recipient in Charge and all the initial recipients.
    - The Issuer shall also describe or point out the nearest points of supply and adjacent live electrical apparatus.
    - Ensure each Access Authority is issued to a Recipient in Charge.
    - Ensure that the condition of the apparatus covered by the Access Authority is such that it is safe for the proposed work to be undertaken.
    - An issuer of an Electrical Access Authority shall not be the Recipient in Charge, but may sign onto the Electrical Access Authority form as a recipient.
    - Exclude any person whom they feel is unsafe from performing work under an Access Authority.
    - The Issuer shall complete the appropriate Access Authority in total.

2. **Access Authority Recipient in Charge responsibilities:**

    - Ensure that all members of the work party who will approach the electrical apparatus sign onto the Access Authority.
    - Ensure that the condition of the apparatus covered by the Access Authority is such that it is safe for the proposed work to be undertaken.
    - Satisfy themselves concerning the precautions taken, the location of the points of supply, and the proximity of any adjacent live electrical apparatus, and apply for additional precautions if they are not satisfied.
    - Ensure that each member correctly identifies the circuit being worked on before approaching any structure carrying more than one circuit.

- Provide appropriate instruction to allow additional persons to sign onto the Access Authority subsequent to the issue of the Access Authority.
- Ensure that non–authorised persons are bracketed on with an authorised person and placed under their direct supervision.
- Ensure that an authorised person supervises only one non-authorised person unless company specific procedures state otherwise.
- Raise as appropriate any "Clearances" or declarations of "Out of Commission."
- Ensure that all recipients who signed onto the Electrical Access Authority form have signed off at completion.
- Advise the Operating Authority of the condition of the electrical apparatus prior to handing it back to the authority.
- Before the Access Authority is released, employees are to inspect the work area to ensure that non-essential items and all on site earths have been removed and that the line and equipment components are intact and capable of operating properly.
- Exclude any person whom they feel unsafe from performing work under an Access Authority.
- Record the attachment and removal of work party earths on the Access Permit.

3. Access Authority Recipient responsibilities:

- Be authorised to sign onto the Access Authority.
- Ensure that the condition of the apparatus covered by the Access Authority is such that it is safe for the proposed work to be undertaken.
- Satisfy themselves concerning the precautions taken, the location of the points of supply, and the proximity of any adjacent live electrical apparatus, and apply for additional precautions if they are not satisfied.
- Not sign onto the Access Authority if they are not satisfied with the conditions of the Access Authority.

- Following a cessation of work or when temporarily absent, report to the Recipient in Charge to confirm the condition of the electrical apparatus under Electrical Access Authority and the adjacent electrical apparatus.
- Sign off before the Access Authority is relinquished.
- Avoid the practice of signing off an Access Authority on behalf of another person.
- After signing off, regard apparatus as ALIVE.
- Recommend the exclusion of any person whom they feel is unsafe from performing work under an Access Authority.

4. **Access Authority Non Authorised Recipient responsibilities:**
   - Seek approval from the Recipient in Charge prior to gaining access.
   - Ensure that they are constantly supervised by the Recipient whom they are bracketed on with (i.e. their guardian).
   - Sign off prior to their guardian.
   - Satisfy themselves concerning the precautions taken, the location of the points of supply, and the proximity of any adjacent live electrical apparatus, and apply for additional precautions if they are not satisfied.
   - Not sign onto the Access Authority if they are not satisfied with the conditions of the Access Authority.
   - Following a cessation of work or when temporarily absent, report to the Recipient in Charge to confirm the condition of the electrical apparatus under Electrical Access Authority and the adjacent electrical apparatus.
   - After signing off, regard apparatus as ALIVE.

5. **An Access Authority** may be issued to one Authorised Recipient, or a recipient may work alone under the terms of an Electrical Access Authority, only in accordance with organisational procedures.

6. **The conditions specified and the precautions listed** on the Access Authority shall not be changed unless mutually agreed upon by both the Operating Authority and the Recipient in Charge, and then only when a check has been made with the appropriate Operating Authority regarding the requirements of other Access Authorities.

8. SANCTION FOR TESTING PROCEDURE

1. A Sanction for Testing shall be issued when, for the purpose of testing, it is necessary to work on electrical apparatus in such a manner that the prescribed procedure relating to an Electrical Access Authority must be waived in order that the electrical apparatus may be made alive at high voltage or at a voltage or current considered hazardous by the applicant from either normal or test sources.

2. A Tester in Charge is an Authorised Tester to whom a Sanction for Testing has been issued and who is in charge of all members of the work party signed onto that Sanction for Testing.

3. A Tester in Charge's duties shall be similar to a Recipient in Charge's duties.

4. The Tester in Charge may have an authorised person placed in their charge only if their duties allow for the safe overseeing of the authorised person.

5. Only one Sanction for Testing shall be on issue for the same electrical apparatus at any time. However, where the testing requires work at remote locations, as well as the nominated main location, a complementary Sanction for Testing covering the same electrical apparatus shall be issued at each remote location.

9. BARRIERS AND SIGNS

1. Appropriate barriers shall be used where practical to indicate areas containing live electrical apparatus and the degree of hazard therein. These barriers shall be placed so as to guard against mistaken or inadvertent contact with adjacent or nearby electrical apparatus and must take into account all possible approaches to the worksite.

2. Appropriate signs shall be used where practical to identify apparatus covered by an Access Authority and to identify adjacent live apparatus and related hazards. Where there is an immediate and probable risk of contact with live electrical apparatus, "Danger" signs shall be erected.

3. Further information on use, erection and location of signs and barriers is available in Company Operations Procedures.

SUBSTATIONS, CAPACITORS & ACR'S SECTION 7

1. DISTRIBUTION SUBSTATIONS

General

1. Prior to the activation of a transformer, the work group shall:
   - Ensure that the reticulation system neutral is clearly identified and marked by the letter **"N".**
   - Identify and confirm the reticulation system neutral by conducting a visual and appropriate electrical test.
2. After both the transformer and reticulation neutrals have been positively identified:
   - Establish the connection between these two neutrals.
   - Connect the LV earth to the transformer neutral terminal, to the neutral busbar, or the neutral conductor between the transformer and the reticulation, whichever is appropriate.
   - Correctly identify and complete the connections between the reticulation active/s or phases and their corresponding transformer terminals via the transformer LV isolators, fused isolators or fuses.
   - On completion of all wiring work, ensure that the transformer LV isolators/fuses are left open.
   - Confirm the installation and accuracy of all labelling attached to installations prior to commissioning.
   - Set the transformer to the designated tap position for the substation location along the feeder.
   - Ensure all E&SC/bonders are removed and any Access Authority is cancelled, and in the case of new equipment, that the necessary clearance is available.

Distribution transformer phasing and connections

Overhead pole and platform mounted transformers are used to supply single and three phase Low Voltage power. For information regarding the electrical properties of transformers see Section 2, Electrical Theory.

Phasing

When erecting new transformers it is critical to establish the direction of supply and correct phase rotation. This will determine which side of the pole the transformer should be erected on. Figure 1 shows the options obtainable.

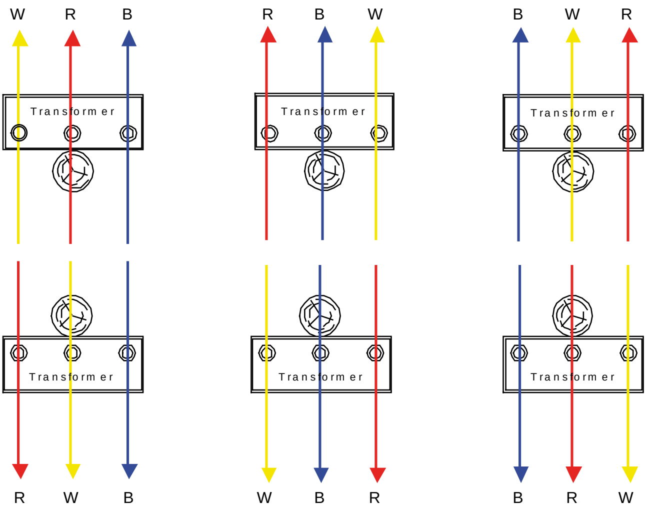
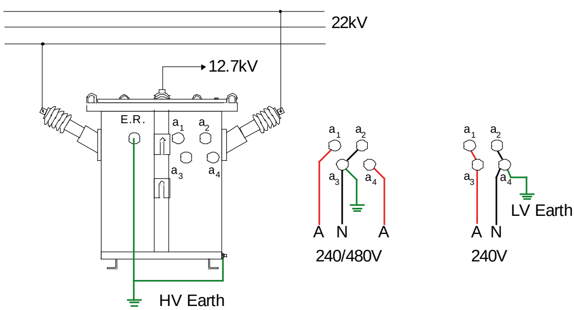


Figure 1

Transformer connections

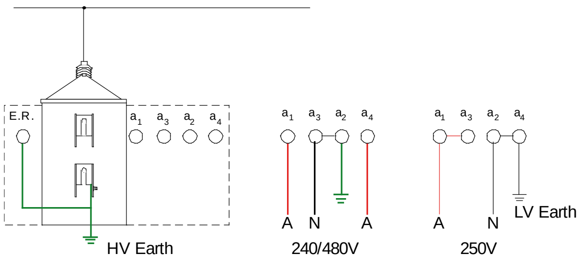
In the case of single phase transformers (including SWER Isolating and SWER distribution transformers), decide which of the LV terminals is to be designated the neutral. This will depend on the reticulation voltage required (i.e.: 240 volts only or 240/480 volts). Refer also to the connection diagram on the transformer nameplate to obtain the correct bridging of terminals.

SWER isolating transformer



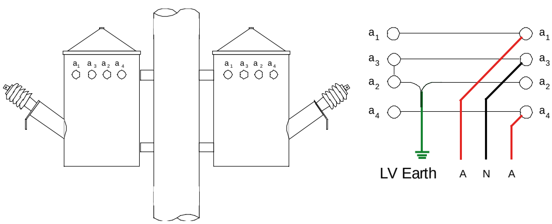
The physical arrangement of the LV bushings will vary from model to model. Check name plate details and terminal markings.

SWER distribution transformer



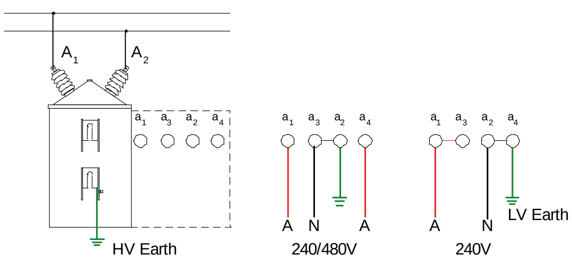
Some SWER transformers have only one LV winding, so either one of the terminals marked a_1 or a_2 can be made the neutral.

SWER distribution transformers in parallel

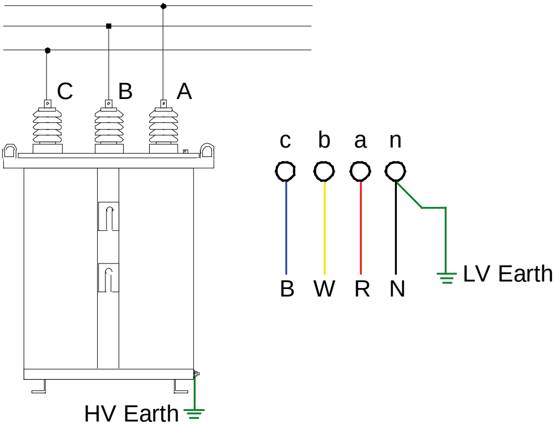


Both transformers should be the same make and tap selectors must be on the same setting.

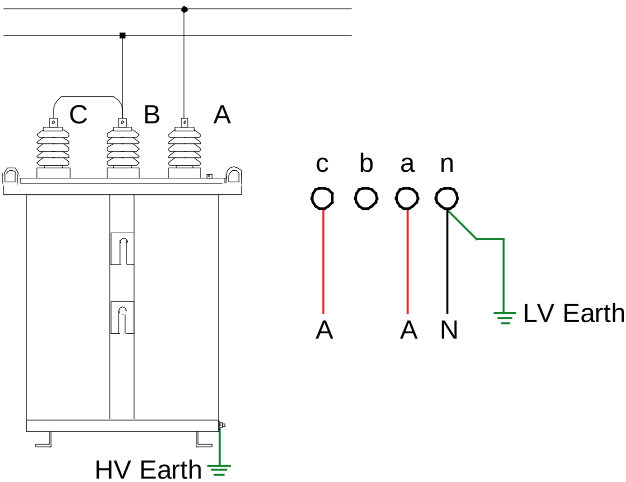
Single phase distribution



Three phase distribution



"Rodgers Connected" Three phase



Transformer kVA output is 82% of nameplate kVA rating, i.e. 200kVA will supply 164kVA of balanced load.

Voltage output is 250/500 volts.

Active LV terminals are 'a' and 'c'.

Vector group must be DYN11.

Distribution transformer commissioning

If all precommissioning installation and insulation test results are achieved, confirm cancellation of any outstanding Access Authorities, receipt of any service clearances the removal of operational earths and then energise the transformer on the HV side.

With the transformer LV isolators open, carry out the transformer NO LOAD checks:

- Using an approved voltmeter with a minimum range of 0-600V, test at the transformer side of the open LV isolators/fuses, to ensure that the voltage is acceptable.

Three phase transformer

TEST POINTS	ACCEPTABLE READING
R phase - Neutral W phase - Neutral B phase - Neutral	247 – 252 Volts (maximum 442V)
R phase - W phase W phase - B phase B phase - R phase	427 – 436 Volts (maximum 442V)

Single phase transformer

TEST POINTS	ACCEPTABLE READING
Actives - Neutral	247 – 252 Volts (maximum 255V)
Active - Active	494 – 504 Volts (maximum 510V)

A phase sequence test shall be carried out in the following situations when dealing with a three phase transformer:

1. Where the transformer **cannot** be paralleled with any other three phase transformer.

   - Using an approved phase sequence tester, connect the Red, White and Blue leads of the tester to the corresponding phases on the transformer side at the transformer LV isolators. The correct result is achieved when the tester indicates "sequence is correct".

   - Where there are no transformer blade isolators, such as a kiosk substation with a 3 phase LV switch, the test shall be conducted at the earthing point of the LV bus, at test points where provided, or when possible at the customers switchboard.

2. Where the transformer **can** be paralleled with any other three phase transformer.

- A phasing-out test shall be performed in all cases where a three phase transformer can be paralleled with another three phase transformer. Using a voltmeter, the test is to be conducted between the two live circuits at the transformer LV isolators or, where this is not considered appropriate an initial phase sequence test shall be performed at the transformer followed by a further test at the normal paralleling point, as follows:
  - Ensure that both circuits to be phased out are alive by conducting phase to phase and phase to neutral voltage checks on each circuit separately. Record readings of phase to neutral voltage when using voltage tester for voltage comparison.
  - Carry out a test from one circuit to another across the open points with a neon tube tester or voltage tester, i.e.:

Neon Tube Voltage Tester

Red phase > Red phase	No Lights
White phase > White phase	
Blue phase > Blue phase	

Voltage Tester

Red phase > Red phase	0 – 15 Volts See Note
White phase > White phase	
Blue phase > Blue phase	

NOTE: When using a voltage tester a voltage may indicate depending on the voltage difference of the tested circuits. (e.g. Transformer side volts minus circuit volts 252V – 243V = 9V voltage difference). If voltage range is higher than the voltage difference further investigation of the voltage should be as per distribution company procedures.

Only where a single phase transformer can be paralled with another single phase transformer by means of LV isolators shall a phasing out test be considered necessary.

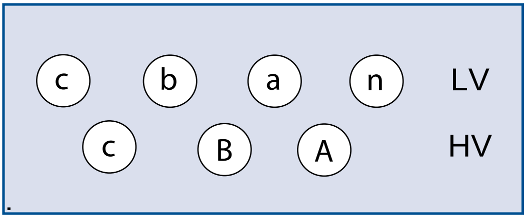
Distribution transformer insulation testing

In the case of existing installations, isolations and Access Authorities may be required.

When carrying out insulation testing, ensure no surge diverters are connected.

3 Phase Transformers

Identify the low voltage neutral bushing by checking for the letter "N" marked on the tank and/or by referring to the nameplate, which shows the relative physical position of all bushings.



Confirm that the transformer is isolated (HV and LV); if required issue an Access Authority and conduct the following tests.

TEST		CORRECT RESISTANCE (MΩ)
HV	A-B, A-C, B-C	ZERO*
	A to transformer tank	HIGH
LV	a-b, a-c, b-c, a-n	ZERO
	a to transformer tank	HIGH
HV-LV	A-a	HIGH

**** Repeat on all tap positions and then reset the tap changer to the required position.***

Single phase & SWER transformers

In the case of single phase transformers (including SWER Isolating and SWER distribution transformers), decide which of the LV terminals is designated the neutral. This will depend on the reticulation voltage, (i.e. 240 volts only or 240/480 volts). Refer also to the connection diagram on the transformer nameplate to obtain the correct bridging of terminals.

NOTE: with SWER transformers an "A" bushing is replaced by a SW (HV terminal) and an ER (the HV earthing terminal).

TEST		CORRECT RESISTANCE (MΩ)
HV	A-A or SW-ER	ZERO*
	A or SW to transformer tank	HIGH
LV	a1-a4, a1-a2/a3	ZERO
	a to transformer tank	HIGH
HV-LV	A or SW-a1	HIGH

Repeat on all tap positions and then reset the tap changer to the required position.

IMPORTANT NOTES:

The High Voltage Earth of Single Wire Earth Return (SWER) substations carries current (i.e. it is part of the HV circuit).

If the earth is disconnected (or broken) whilst the transformer is energised, then the transformer side of the open point **WILL BE ALIVE** at line voltage.

A Safe to Approach Test shall be conducted on approach and on energisation of SWER substations. Refer Sec7: page 14.

Personnel working at the site of a SWER substation shall double check the HV earth and its connections, to ensure its continuity prior to energising or re-energising the transformer, or before performing any work on an energised substation.

Distribution earthing systems

1. Common Multiple Earthed Neutral (CMEN)

A "common" earthing installation is a distribution earthing arrangement where all high voltage & low voltage equipment is connected to a single common earth.

A CMEN earthing system provides an effective earth to all distribution system installations within the CMEN area. The LV neutral conductor is permanently connected to earth and is connected to a number of "Common" or "Bonded" distribution substation earths, HV distribution equipment earths (e.g. concrete poles or HV installation), LV earths and customer earths.

The impedance to ground of a CMEN conductor formed in this way is less than 1 Ohm.

2. **Interconnected Multiple Earthed Neutral (MEN)**

   The Neutral conductor is earthed at each substation with the substation neutrals interconnected (bridged) at LV open points.

   The Neutral is earthed at each customer's premises.

3. **Individual (MEN)**

   Neutral conductor is earthed at substation and customer's premises, but NOT interconnected with any other substation.

4. **Direct Earthing**

   Neutral earthed at substation and continuous earth conductor between substation and customer's premises.

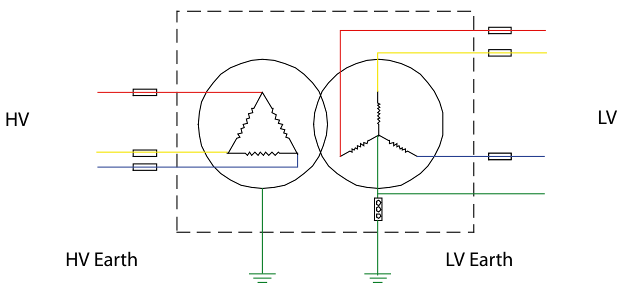
   Neutral is not earthed at the customer's premises.

Substation earthing arrangements

1. **Separate HV and LV Earths**

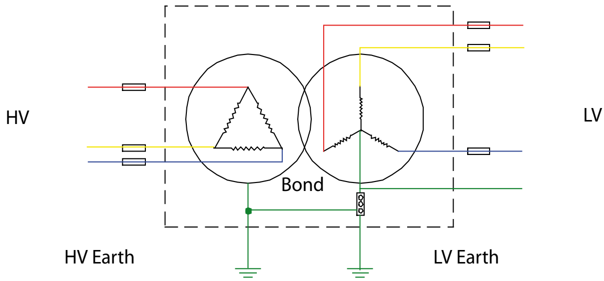
   H.V. and L.V. earths are separate and distinct both on the structure and in the ground.

   - The HV earth is bonded to the transformer tank, HV switchgear, HV surge diverter, any exposed metal parts containing or supporting the HV conductors, metallic HV cable sheaths and all metallic parts mechanically connected thereto.
   - The LV earth shall be bonded to the main LV neutral, any exposed metal parts containing or supporting the LV conductors, metallic LV cable sheaths and all metallic parts mechanically connected thereto.



2. Bonded HV and LV Earths

A bonded earth is a distribution substation earthing arrangement where separate HV and LV earths have been electrically bonded or connected. The bond is made on the earth side of the LV test link.



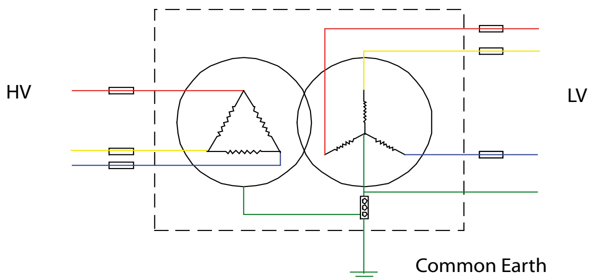
3. Common Earthing

A common earth is a distribution substation earthing arrangement employing a single common HV/LV earth.

The common HV/LV earth is bonded to:

- The transformer tank, HV surge diverters, any exposed metal parts containing or supporting the HV conductors and all metallic parts mechanically connected thereto.
- The main LV neutral, any exposed metal parts containing or supporting the LV conductors and all metallic parts mechanically connected thereto.
- Any metallic cable sheaths

Wear LV gloves when handling test leads and when disconnecting or connecting the LV earth test link.



4. SWER Substations

SWER substations use the Separate HV and LV earthing arrangement.

IMPORTANT NOTES:

The high voltage earth of Single Wire Earth Return (SWER) substations carry current (i.e. It is part of the HV circuit).

If the earth is disconnected (or broken) whilst the transformer is alive, the transformer side of the open point WILL BE ALIVE at line voltage (12.7kV).

Personnel working at the site of SWER substations shall double check the H.V. earth and its connections to ensure its continuity before energising or re-energising the transformer, or before performing any work on a live substation.

Current may flow in the earthing system.

Substation earth testing

Earth testing is required to ensure the integrity of the electrical system and ensure the effectiveness of the earth.

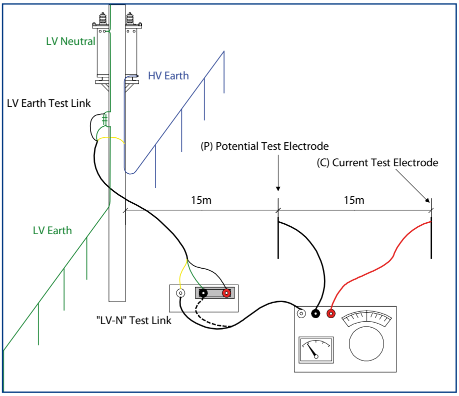
SWER substations shall be de-energised before testing of the earthing system unless specified by distribution company procedures.

Ensure all earth connections are restored to normal before leaving the job site.

'Earth testing shall be carried out at intervals specified by Distribution company procedures and the results shall not exceed the limits specified in TABLE 1 on page 21 in this Section.'

- Do not disconnect or reconnect the LV earth link unless the LV-N test link is closed.
- Open the LV-N test link for no more than 2-3 minutes while testing with the L.V earth link disconnected. The substation is operating without a proven LV earth while the test link is open.

Setup for earth resistance testing



Transformer fuse ratings

Transformer fuse ratings take into account many considerations such as the primary voltage, transient load/magnetising inrush currents, short time current withstand characteristics, cyclic overload, fuse type and the transformer type, i.e. SWER, kiosk, indoor and pole type.

Refer to Company Procedures for Transformer Fuse Ratings.

2. HV POLE TYPE CAPACITORS

General

1. Only authorised HV operators who have been instructed and trained in the switching of HV capacitor banks shall operate them.

2. HV fuses shall not be used to break capacitive currents. The Vacuum switches are to be opened prior to the HV fuses.

3. After HV isolation a minimum of 5 minutes must be allowed prior to application of earths.

4. To declare high voltage capacitors safe for the issue of an Electrical Access Permit, the neutral as well as the actives shall be earthed and, in addition, each individual capacitor shall be discharged to earth before it is touched.

3. AUTOMATIC CIRCUIT RECLOSERS (ACR'S)

When access to an ACR is given for maintenance, remote control capabilities shall be disabled.

4. SAFE TO APPROACH TEST

General

1. Any person who approaches a SWER substation with the intention of carrying out work on or in the vicinity of the pole and/or earthing system shall perform a Safe to Approach Test. This includes Isolating and Distribution type SWER substations and SWER transformers providing auxiliary supplies, e.g. ACR's.

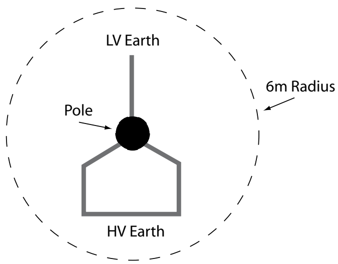
2. A safety assessment shall be undertaken taking into consideration the following:

   - Obvious broken or missing HV earthing connections on the pole and transformer
   - Signs of vegetation near the pole drying out or dying
   - Smoke or steam rising from the ground near the pole

Test procedure

1. Set Modiewark Tester at 240 volts

2. Prove tester is working by rubbing on clothing. Light should flash on and/or beeper sound. (Self test type will have an ongoing intermittent beep)



3. Take the Modiewark tester and insulating stick and stand approximately 6 metres from the pole.

4. Stand directly in line with one of the HV earth cover-strips on the pole.

5. Grasp insulated stick near the end.

6. Place the Modiewark close to ground.

7. Walk slowly towards the pole scanning immediate ground area around you.

8. If tester light goes ON and audible tone "sounds-off", do NOT proceed further and report faulty earth condition.

9. Identify fault – if possible.

10. If possible & SAFE to do so, remove hazard by isolating the substation (e.g. remotely).

11. If the tester light remains OFF continue until Modiewark is at the base of pole where earth enters the ground. Raise Modiewark tester up the pole until light goes ON (close proximity to HV conductors to test tester) then lower tester.

If there is a possible danger to the public, prohibit entry by the use of:

- Warning signs and barriers.
- A member of the work party to remain on site and issue warning.

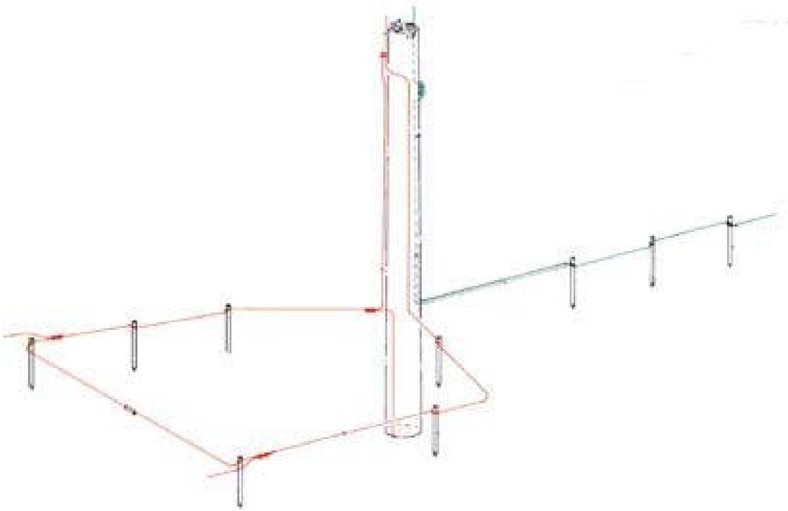
Energisation

1. When energising SWER transformers the operator must ensure:
   - Normal visual inspection of the structure, including integrity (testing/Meggering if required) of the earthing systems have been carried out.
   - Maintain clearance (6m) from HV and LV earthing systems by all personnel.
   - The load has been isolated.
   - That they use the appropriate method to avoid step & touch potentials by use of a ladder, EWP or energise remotely.
   - A Safe to Approach Test shall be completed immediately after energisation by the operator or crew.
   - Should the installation be faulty, immediately isolate the substation and take appropriate action.

5. SWER EARTHING LAYOUT

Legend — HV Earth conductor

— LV Earth conductor



6. SUBSTATION EARTH RESISTANCE VALUES

TABLE 1

EQUIPMENT	Maximum Resistance of Earth System to Ground			Maximum Resistance to Ground with Neutral Connected		Testing Requirements	
	HV	LV	Common	Common Earth System	Separate Earth System	Common Earth System	Separate Earth System
Pole/Ground/Indoor Substation	10Ω	> 50 kVA 10Ω < 50 kVA 30Ω	10Ω	1Ω*	10Ω 30Ω	Common earth Common earth with neutral connected	HV & LV earth
Kiosk Substation	5Ω	10Ω	10Ω	1Ω*	10Ω	Common earth Common earth with neutral connected	HV & LV earth
SWER Distribution Substation	10Ω	30Ω	N/A	N/A	30Ω	N/A	HV & LV earth
SWER Isolating Substation	2Ω	30Ω	N/A	N/A	30Ω	N/A	HV & LV earth
HV Switch	10Ω	N/A	N/A	N/A	N/A	N/A	HV earth
HV Fuse/Isolator/ Sectionaliser	10Ω	N/A	N/A	N/A	N/A	N/A	HV earth
HV Surge Arrester	10Ω	N/A	N/A	N/A	N/A	N/A	HV earth
HV Cable Termination	10Ω	N/A	N/A	N/A	N/A	N/A	HV earth
ACR	10Ω	N/A	N/A	N/A	N/A	N/A	HV earth
HV Concrete Pole	10Ω	N/A	N/A	N/A	N/A	N/A	HV earth
HV Line Capacitors	10Ω	N/A	N/A	N/A	N/A	N/A	HV earth

* In CMEN systems the maximum resistance to ground of the common earth (with neutral connected) is 10Ω.

SAFE APPROACH DISTANCES SECTION 8

1. GENERAL

Electrical apparatus must never be assumed to be dead, de-energised or isolated and unnecessary approach to electrical apparatus or unnecessary contact with parts regarded as alive shall be avoided. Clearances shall be maintained until the proven status of electrical apparatus and application of organisational procedures allows otherwise; e.g. Access Permit. Necessary approach shall be restricted to the period required to perform the work.

In emergency situations where there is a risk of electric shock to persons from electrical conductors or apparatus, (e.g. fallen conductors), prompt action shall be taken to ensure ordinary people are kept clear of the hazard; 6 metres for HV or 2 metres for LV conductors.

Only approved and tested equipment shall be permitted to be brought within the exclusion zone or in direct contact with live high voltage conductors. Equipment is any instrument or device designed for use in the vicinity of, or direct contact with live high voltage conductors.

Only an appropriately authorised person/s may place the insulated portion of an electrically tested EWP in contact with exposed live low voltage conductors.

To maintain Safe Approach Distances from overhead conductors, appropriate allowance shall be made for sag and sway under a variety of conditions.

Safe Approach Distances vary according to the individual and their training. Persons are classified under the following headings:

a. **Authorised Person** means a person with technical knowledge or sufficient experience who has been approved, or has the delegated authority to act on behalf of the organisation, to perform the duty concerned.

b. **Instructed Person** means a person adequately advised or supervised by an authorised person to enable them to avoid the dangers which electricity may create.

c. **Ordinary Person** means a person without sufficient training or experience to enable them to avoid the dangers which electrical apparatus may create.

NOTE: For the purpose of this section, Ordinary Person means the same as in the definitions of the 2006 Green Book, i.e. a person under the control of a Network Operator or HV Customer.

2. LIMITS OF APPROACH AND SAFE APPROACH DISTANCE PRINCIPLES

Historically 'Limits of Approach' principles have applied as personal and plant clearances in Victoria. This was defined as:

"The minimum distance beyond the reach of any part of the person's body or any conducting or unapproved object touching any part of the person's body".

'Safe Approach Distances' are based on an "exclusion zone" principle. Exclusion Zone Principles can be defined as:

"The minimum distance that shall be maintained by a person, vehicle or mobile plant (including its load, controlling ropes and any other accessories) when approaching electrical apparatus other than for work in accordance with an Access Authority".

Safe Approach Distance wording has been adopted by the VESI to align with National Electricity Network Safety Code - Guidelines for Safe approach Distances to Electrical.

Refer Figure 1 below and Figure 2 over page.

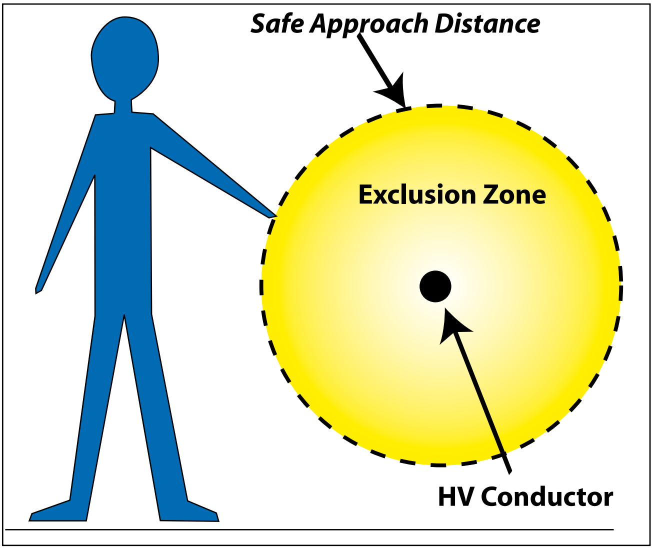
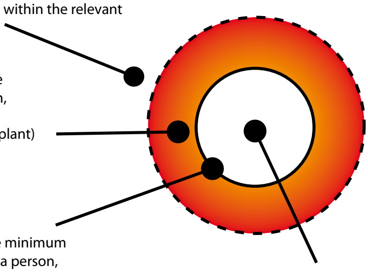


Figure 1. Safe Approach Distance Application

'Vicinity' means a situation where it is unlikely that a person will, either directly or through any conducting medium (eg: via mobile plant), come within the relevant ***safe approach distances.***

'Near' means a situation where there is a reasonable possibility of a person, either directly or through any conducting medium (eg: via mobile plant) coming within the relevant ***safe approach distances.***



'Safe Approach Distance' means the minimum distance that shall be maintained by a person, ***vehicle*** or ***mobile plant*** (including its load-controlling ropes and other accessories) when approaching ***electrical apparatus*** other than for work in accordance with an ***access authority.***

'Conductor' means a wire, cable or form of metal designed for carrying electrical current.

Figure 2. Illustration of differences between Safe Approach Distance, Near and Vicinity

Safe Approach Distance - Special

'Safe Approach Distance – Special', applies only to Authorised persons. The Safe Approach Distance has been determined using risk analysis methods.

Safe Approach Distance – Special must be used in conjunction with the following control measures:

- The Authorised Person has been specifically trained and approved to perform the work at the Safe Approach Distance - Special.
- On site risk assessments have been conducted.
- Safety observers shall be used to monitor the work activities.
- Control of inadvertent body movement by the use of insulating barriers, insulated plant and appliances and controlled body movements.
- The exposure time of the Authorised Persons working at the Safe Approach Distance - Special is minimised.
- External influences on plant and equipment, e.g. traffic, stabiliser footings are removed or controlled.
- Addressing adverse impact of weather and environmental conditions (e.g. rain, lightning, wind, light, sag or sway of conductors).

- The Safe Approach Distances - Special shall be maintained from any part of the persons body or any conducting or unapproved object touching any part of the persons body by using controlled movement.
- By considering the documented control measures the application of Safe Approach Distance - Special allows closer than "normal" approach, whilst taking into account overhead proximity, controlled upper limb movement horizontally from the worker's body and any tool being used.

If these controls cannot be applied, Access Authorities shall be issued or live work techniques shall be applied.

The Safe Approach Distance - Special principle is demonstrated in Figure 3.

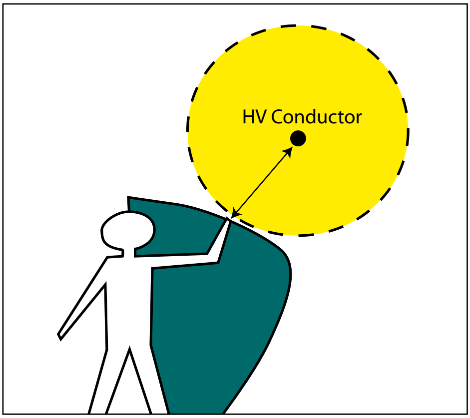


Figure 3. Safe Approach Distance – Special

As described in the 2006 Green Book, Safe Approach Distances are now the minimum clearance requirements for electrical work in Victoria. Refer to Table 1 for clearances.

SAFE APPROACH DISTANCES

Table 1 – Safe Approach Distance for Ordinary Persons, Instructed Persons or Authorised Persons

***All Safe Approach Distances* Apply to Bare Conductors Unless Otherwise Indicated**	***Ordinary Persons***	***Safe Approach Distance* for Instructed Persons & Authorised Persons**	***Safe Approach Distance* – Special for Authorised Persons Only. Refer Clause 6.2.3.**	***Authorised Live HV Electrical Workers***	
Nominal Phase to Phase AC Voltage kV	*Safe Approach Distance* Refer Notes 1 to 3 **Millimetres**	*Safe Approach Distance* (Notes 1 and 2) **Millimetres**	*Safe Approach Distance* (Notes 1 and 2) **Millimetres**	*Safe Approach Distance* (Notes 1 and 2) **Millimetres**	
LV including communications catenary connected to LV neutrals	1500	Instructed Persons – no contact Authorised Persons – Insulated contact only			
Insulated LV	100				
Earthed metallic screened HV *Insulated Conductor*	100	*Earthed* metallic screened *Conductor* – contact only Unscreened *Conductor* treat as bare *Conductor*			
Unscreened *Insulated* HV *Conductor up to and including 66*	2000				
				G&B Work Method	Live Line Stick Work Method Refer Note 5
HV up to and including 22	2000	700	300	Insulated contact	380
33	2000	700	500		680
50	2000	750	700	Refer Note 4	
66	2000	900	700		
110	3000	1000			
132	3000	1200			
220	4000	1700			
275	5000	2300			
330	6000	2700			
400	6000	3300			
500	6000	3600			
Nominal Pole to earth DC Voltage (kV)					
1.5 or less	1500	Instructed Persons – no contact Authorised Persons – Insulated contact only			
+/- 25	2000	700			
+/- 85	3000	1000			
+/- 150	3000	1200			
+/- 270	4500	1800			
+/- 350	5000	2500			
+/- 400	6000	2900			

COMMENT: Ordinary persons outside of the VESI refer to Electricity Safety (Network Asset) Regulations or "No Go Zone" Guidelines, as appropriate for "Safe Approach Distance".

NOTES

1. Deliberately avoid movements that could result in distances being infringed.

2. The distances specified are based on work from a stable surface. Appropriate allowance shall be made for conductor sag and sway.

3. These figures are the minimum Safe Approach Distance that shall be used by Ordinary Persons. For approach closer than these distances an Ordinary Person would need to become an Instructed Person.

4. When conducting G&B work up to and including 33KV, use the Safe Approach Distance of 700mm for 50 & 66KV conductors adjacent to the work area.

5. Insulated Live Line Stick (Hot Stick) work methods require the personal clearance to remain at 380 / 680 mm at all times.

3. NO GO ZONE

In 1998 and 1999 a number of fatalities, serious injuries and near misses of members of the public occurred involving contact with overhead electrical distribution or transmission assets. As a result of industry, unions and regulatory authorities working together, new "rules" were introduced in relation to working near overhead powerlines. These rules were launched in October 1999 and given the title "No Go Zone" (NGZ).

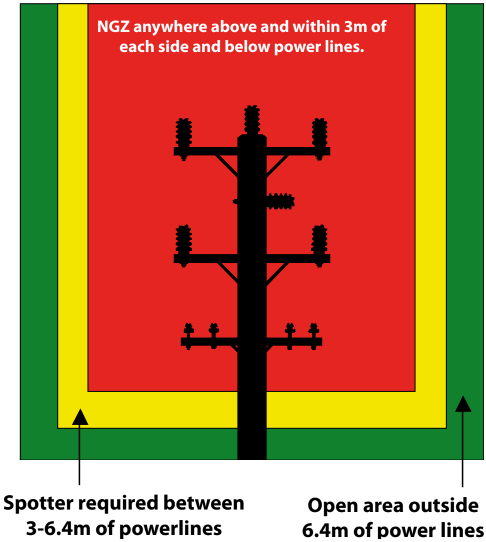
This section is provided so field workers can provide directions to non-VESI persons approaching or working in the vicinity of electricity company assets.

The NGZ rules apply only to non-VESI persons undertaking work near overhead powerlines. They provide greater clearances than those outlined in the Network Assets Regulations and are interpreted in a simplified manner.

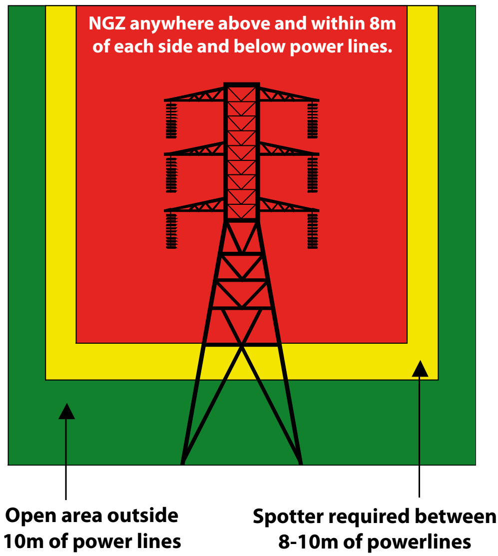
The NGZ rules define the differing requirements for 3 zones.

RED ZONE	No Go Zone. Written permission from the Network Operator required to undertake works. (Refer to VESI NGZ Guidelines).
YELLOW ZONE	Trained and registered spotter, (Safety Observer) required.
GREEN ZONE	Open area. Normal safe work practices and precautions apply.

No Go Zone for Distribution & Sub-Transmission lines



No Go Zone for Transmission



Not to Scale

4. VEGETATION CLEARING – SAFE APPROACH DISTANCES AND SAFE VEGETATION DISTANCES FOR INSTRUCTED OR AUTHORISED PERSONS

The Safe Approach Distances for Instructed or Authorised Persons are detailed in the 2006 Green Book (the Code Of Practice on Electrical Safety for the Distribution Businesses in the Victorian Electricity Supply Industry) (Section 6). Clause 6.2.5 describes Safe Approach Distance: Vegetation Clearing – General.

Safe Vegetation Distance described in this document means the minimum separation in air that should be maintained between vegetation and live electrical apparatus when performing vegetation management work.

Any safe system of work employed to undertake vegetation clearing near overhead powerlines shall result in the achievement of both the Safe Approach Distances and Safe Vegetation Distances. The preferred method of controlling risk is by the inclusion of a second level of precaution into the safe system of work. (eg. insulated workplatforms and insulated tools.)

The clearing of vegetation adjacent to overhead powerlines by Instructed or Authorised Persons using climbing or ground based methods must comply with any additional specific network operator control procedures. These procedures shall ensure that any climbing and ground based clearing methods provide at least the appropriate Safe Approach Distances for persons (and tools) as well as the minimum Safe Vegetation Distances at all times. Climbing and ground based clearing methods may require additional clearances and controls to ensure a safe system of work is maintained.

Special considerations for vegetation work near powerlines[1]

The Safe Approach Distance for persons and mobile plant are specified for ideal environmental, weather and working conditions. Allowances must be made for the effects of ambient temperature, conductor temperature, network fault current (surge), wind and other environmental influences on overhead powerline sag and sway while vegetation management work is in progress. In practice, extra safety clearance should be considered when working adjacent to powerlines towards the centre of the span to ensure that appropriate Safe Approach Distances are maintained at all times.

[1] 2006 Green Book – Table 1 Safe Approach Distance for Ordinary Persons, Instructed Persons or Authorised Persons
2006 Green Book – Table 2 Safe Approach Distances for Vehicles (Excepting Mobile Plant when in the Working Mode)
2006 Green Book – Table 3 Safe Approach Distance for Mobile Plant when in the Working Mode
2006 Green Book – Table 4 Safe Approach Distances to Conductors for insulated Mobile Plant when operated by persons instructed or authorised to work on or near exposed conductors.

Factors regarding conductor movement to consider include:

- Positioning of plant and persons and the method of cutting of limbs.
- Sway – Conductors can move unexpectedly due to causes such as wind, fault currents or impacts. Under fault conditions movement may be sudden and extreme, in excess of the full sag at everyday temperatures.
- Sag –While tree limbs don't normally move upwards conductors may move downwards due to possible causes including, conductor temperature rise, wind, fault currents and impacts.
- The type of construction (for example suspension insulators allow more conductor movement than post insulators).

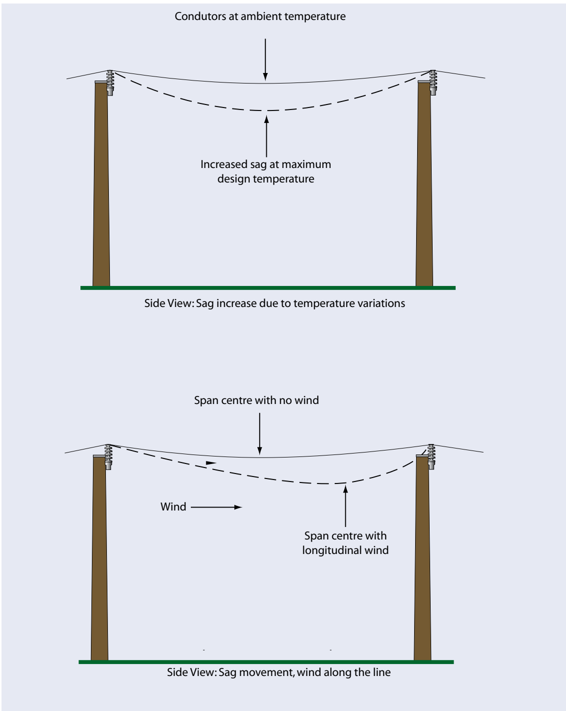


Figure 1 – Conductor Sag and Sway (Side Elevation)

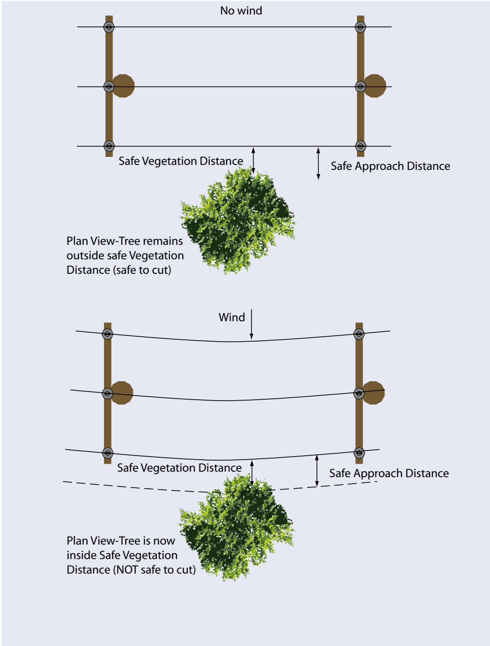


Figure 2 – Conductor Sag and Sway (Plan View)

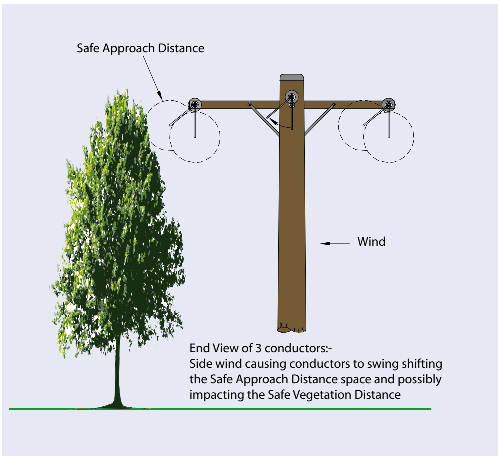


Figure 3 – Conductor Sag and Sway (Section Elevation)

Safe vegetation distances

Instructed or Authorised Persons, whilst at all times maintaining appropriate Safe Approach Distances and provided an appropriate risk assessment has been completed and deemed safe, can clear vegetation which is no closer than the distances in Table 1 – Safe Vegetation Distances.

Issues to be considered as part of a Risk Assessment prior to commencing work shall include:

- The suppression of Auto-reclose
- Positioning the 'mobile plant' and persons such that Safe Approach Distances can be maintained in all circumstances.
- The use of 'Safety Observers' and barriers and signs.
- Consideration of weather and environmental conditions;
  - rain
  - wind
  - light
  - sag or sway of conductors
- Consideration of changes in current flow in conductors
  - fault surge
  - network switching
- Movement of the tree when cut
- The use of 'insulated barriers', protective covers and 'insulated' equipment
- De-energising the electrical apparatus
- Isolating and earthing the electrical apparatus
- Using insulated tools and equipment
- A safe means and method of controlling the movement of limbs being cut

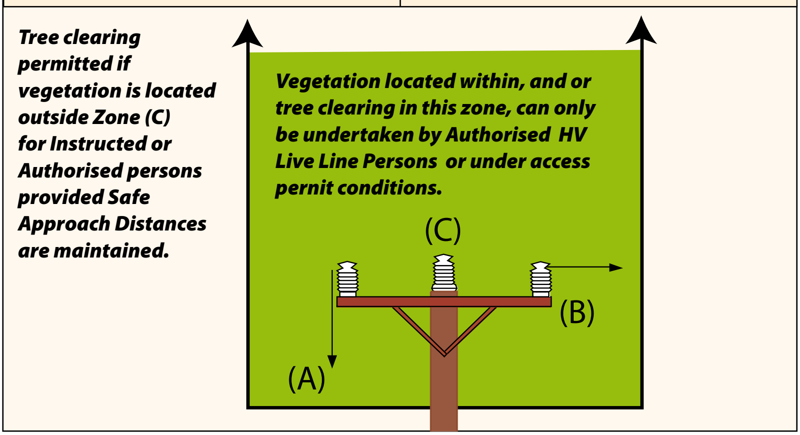
Tree limbs shall be considered as conductive (electrically unapproved) objects when in the vicinity of HV conductors.

The vegetation distances more than the minimum requirements in Table 1 – Safe Vegetation Distances (detailed below) have been assessed as providing sufficient flashover protection for Instructed or Authorised Persons working at appropriate Safe Approach Distances provided there is a safe system of work employed to undertake the task.

The Safe Vegetation Distances in Table 1 – Safe Vegetation Distances for vegetation below conductors is less than the Safe Vegetation Distance for vegetation beside conductors because a cut limb will not normally move upward. Means of controlling the movement of limbs being cut shall be made via an appropriate risk assessment undertaken prior to commencing the task and action taken as appropriate.

Table 1 – Safe Vegetation Distances

VOLTAGE	SAFE VEGETATION DISTANCE
Up to 1000V	Trees can be touching
Above 1000V and up to and including 22kV	(A) Below – 300mm (B) Beside – 700mm (C) Above/Overhanging – Not Permitted
Above 22kV and up to and including 66kV	(A) Below – 400mm (B) Beside – 900mm (C) Above /Overhanging – Not Permitted



Instructed or Authorised Persons may clear limbs above/overhanging low voltage conductors with the conductors 'alive' provided movement of limbs being cut can be controlled.

Tree clearing above/overhanging HV conductors

Only Authorised HV Live Line persons are permitted to clear tree limbs above/overhanging live HV conductors using appropriate Live Line procedures. Only Authorised HV Live Line persons are permitted to clear vegetation from an EWP positioned over the top of live HV conductors.

Information regarding Live Line Tree Cutting and Limb Removal in and around High Voltage Conductors is contained in Appendix B of the Energy Safe Victoria 'Minimum Rules for Carrying Out High Voltage Live Line Work in Victoria'.

Tree clearing can only be undertaken by Instructed or Authorised Persons above/overhanging HV conductors under appropriate access authority arrangements (ie – de-energised conditions).

UNDERGROUND DISTRIBUTION (URD) SECTION 9

1. GENERAL

1. When working on underground distribution assets, employees shall:

   - Be appropriately trained and authorised for the purpose of the work.
   - Regard any URD equipment and conductors that have been in service as energised until approved testing methods confirm that they are de-energised, and where possible earthed in accordance with Network Owners procedures.
   - Thoroughly inspect energised cables/equipment prior to working on them whilst they are energised.
   - Prior to working on a transformer, check for backfeed once it has been disconnected from the power source.

     Only expose one conductor at a time (except when testing for voltage) when undertaking any live work.
   - Adequately protect trenches required to be left open, to protect the public and employees. Warning lights and warning tape shall be used where such trenches are left open overnight.

2. Underground cables that have been in service shall be:

   - Considered energised at all times unless properly disconnected from all sources of supply, tested and earthed.
   - Proven discharged, and earthed before work is performed other than when performing live low voltage jointing.
   - Spiked prior to cutting. Whilst the cable is being spiked, all non-essential personnel shall remain outside of the manhole, vault, trench or ditch.

3. When work is to be performed on one phase of a multiphase underground distribution circuit, all phases of that circuit shall be de-energised and earthed. **NOTE:** where possible, the phases shall be bonded together.

4. When installing or removing equipment, the first conductor to be connected and the last conductor to be removed shall be the case earth/neutral.

5. Treat all cables which are energised in excess of 415 volts, and which do not have earthed conducting sheaths or screening, as bare conductors. They must be considered energised unless approved methods have been used to determine that they are de-energised.

6. Barricade or cover with protective equipment, all unscreened conductors and energised equipment that will be within reach of a person's working position.

2. LIVE JOINTING

Safety precautions

- All Personal Protective Apparel shall be worn and Personal Protective Equipment is to be set up prior to entering the hole.
- The second Live LV U/G cable jointer shall act as an assistant and as a safety observer as required.
- Approved insulating mats shall be used in the trench covering both walls and base to provide the jointer with an insulated environment.
- Approved insulating mats and covers shall be used to cover all exposed conductors/components that are within reach of the jointer, with the exception being the conductor that is being worked on. This includes other conductive assets/objects in the joint hole.
  - Tools and equipment and jointing materials shall be placed on an insulating mat adjacent to the hole within easy reach of the jointer.
  - Approved tools for live LV jointing shall be used.
  - The appropriate procedures for Live LV jointing shall be used.
  - While undertaking live work the other jointer or assistant shall not pass tools or equipment directly to the jointer in the hole. The equipment must be placed on the insulating mat where it can then be picked up from.

- Where work is required to be done in wet weather a suitable waterproof canopy shall be used. If the frame of the canopy is metal it shall be insulated. A sump shall also be dug to gather the accumulation of water seepage and be emptied out as required.
- Where the ground conditions are extremely harsh and damage of the mats may occur or the ground is wet, the insulating matting must be raised by some means to ensure they are dry and free from damage.
- The workparty shall ensure that protective equipment and apparel is in good condition.
- A rescue / entry chute shall be available at the end or on one side of the joint hole. *This chute must also be clear of the jointing position.*

NOTE: At any time where aspects of these guidelines are not met or the work crew assesses the worksite is not safe for Live LV U/G jointing, no live work shall proceed.

3. EXCAVATION

When carrying out any excavations, employees shall:

- Prior to opening an excavation, determine the location of utility assets, such as sewer, telephone, gas, electric and water lines, or any other underground assets that may reasonably be expected to be encountered during excavation work.
- When mechanical excavation operations approach the estimated location of underground assets, manual excavation shall be used to positively locate the expected assets.
- Remain outside trench/jointing hole while excavations are taking place.
- Position a ladder or other safe means of egress in trench excavations that are 1.2 metres or more in depth so as to require no more than 8 metres of lateral travel for employees.
- NOT work in an excavation in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by the water accumulation.
- Trenches shall be a max of 1.5m without shoring.
- Trenches shall be a maximum of 1.5 metres with out battering. See Fig. 1.

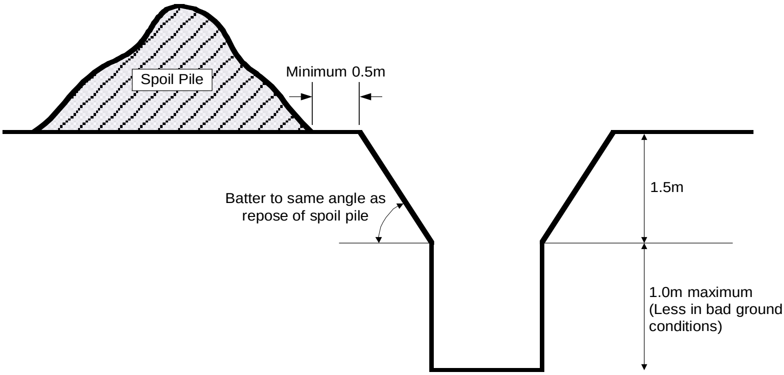


Figure 1. Battering the sides of trenches. Eg. 2.5m deep in stiff clay

When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilised such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

TOOLS AND EQUIPMENT SECTION 10

TOOLS AND EQUIPMENT

1. GENERAL

When using tools and equipment, employees shall:

- Ensure they have received appropriate instruction or training in the safe use of the tools/equipment.
- Always use the safety guards, attachments and systems that are available.
- NOT leave tools where they present hazards such as falling or contacting electric equipment.
- Tag and remove from service any defective tools and equipment until repaired or replaced.
- NOT use conductive tapes or rulers near energised conductors or assets.
- Inspect and test all tools and equipment prior to use.
- Wear appropriate PPE (eye protection, ear muffs, gloves, etc.).
- Lifting equipment shall be tested annually and colour coded per TABLE 1 of Appendix 3.

2. PORTABLE ELECTRIC TOOLS, EXTENSION CORDS AND LIGHTING

NOTE: Insulation earth leakage circuit breakers' should be used whenever a tool is being used outside of a workshop situation and in particular in combination with extension cords and/or a damp environment.

When using extension cords and portable electric tools, employees shall:

- Make a visual inspection of the item to confirm its general safe condition and check the next test date to verify that testing of the item is not overdue. All items should be tested annually.
- Keep the use of extension cords to a minimum, as they are not intended to serve as a substitute for permanent wiring. Extension cords should not be connected one to another to gain additional length.
- When using electric power tools with trailing leads, persons shall remain clear from any live high voltage apparatus.

- Cover or elevate temporary electric cords passing through work areas to protect them from damage and to eliminate tripping hazards.
- Use only leads and hand lamps which are 32 volts or less when working in a damp or confined area (e.g. inside a large tank). The transformer shall be left outside the confinement zone.
- Wear appropriate PPE (eye protection, ear muffs, gloves, etc.).
- To avoid accidental starting – don't carry a plugged in tool with a finger on the switch.
- Large electric drills have a lot of torque – beware of strains or being struck by the handle of an out of control drill.
- Don't operate power tools with loose clothing or long hair as severe injuries can result.
- Do not use electric power tools in a gaseous or explosive atmosphere.
- Secure your work; never try to hold work in your hand while using power tools.
- Disconnect tools when not in use, before servicing and before changing accessories (e.g. blades/bits).
- Remove adjusting keys (e.g. chuck key) and wrenches from the tool before turning on.
- Locate live electrical cables before drilling or cutting into walls, floors, ceilings, etc.

3. LADDERS

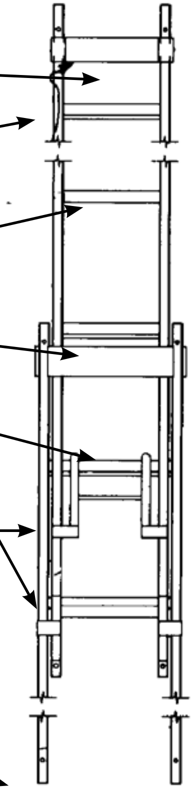
When working with ladders, employees shall:

- Select the ladder on the basis of the type of work to be performed, and the type and quality of ladder that will permit that work to be performed safely.
- Portable ladders are to have a clearly identified load rating of not less than 120kG.
- NOT use a conductive ladder in the vicinity of exposed live electrical apparatus.

- Securely place, hold or tie a ladder on even ground whenever possible to prevent slipping or falling. Ladder chocks may be used.
- Where a ladder cannot be secured or tied and the employee is working 2m or more above ground level (measured from ground to feet), the ladder **shall be footed at all times**.
- Head ropes shall be made from 12mm rope.
- Inspect the ladder at frequent, regular intervals for defects, and before each use. If defects are found, the ladder shall immediately be removed from service, labelled as defective and reported to the Team Leader.
- Carry a ladder in a horizontal position below shoulder height when in a substation or an area where energised conductors are low enough to be contacted by ladders.
- Set the base of the ladder a safe distance from the vertical - approximately 25% of the working length of the ladder (i.e. a 4:1 ratio).
- Always face the ladder when ascending or descending, using both hands.
- Undertake work from no higher than the second top rung and not stand on stiles.
- Ladders with an extended length greater than 4.87m shall be carried by two people.
- Where a ladder is used to gain access to a roof, work platform or landing, the top of the ladder shall extend above the level roof by a distance of at least 1m. The ladder shall be footed by an assistant during ascent and descent unless secured.
- Where a ladder is used near doorways, the door shall be blocked open, locked closed or a person may be used to guard the base of the ladder. Warning signs may also be displayed.
- Ladders should not be left unattended while erected in a public area.
- When using a step ladder user shall not work from the top cap or from the braces on the opposite side of the steps.
- Step ladders shall only be used when in the fully open position.

Ladder Inspection

- Leather, canvas or synthetic bucket
- Head rope, 12mm at 1.5m length
- Rungs, loose, worn, decayed, damaged rivets and cracks in fibreglass
- Loose or bent guides, top and bottom
- Operation of clutch mechanism
- Stiles not shortened, splintered, cracked or bowed
- Paint and varnish in good condition
- Feet fittings, (where fitted)



Defective Ladders

- Remove ladder from service, attach defect tag, and remove all ropes and quarantine.
- Temporary repairs to ladders are not acceptable.

4. PETROL-POWERED TOOLS

When using petrol powered equipment, employees shall:

- Be trained where appropriate.
- Turn the engine off prior to refuelling, making adjustments or repairs.
- NOT transfer petrol from one container to another within 15 metres of the equipment's fuel tank.
- Wear appropriate PPE (eye protection, ear muffs, gloves, etc.).

5. SAWS

1. When using a powered saw, employees shall:

- Ensure the correct type of saw blade is used for the material being cut.
- Ensure all guards are in place and fully functional.
- Keep the material flat on the saw table.
- Wear appropriate PPE (eye protection, ear muffs, gloves, etc.).

2. When using a chainsaw, employees shall:

- Conduct pre-operating inspection of fuel, oil, and chain inspection and tension adjustment where necessary.
- Ensure chain brakes are fitted and in working order.
- Use all appropriate PPE including, eye & ear protection and chaps.
- Only use two-stroke fuels and appropriate bar lubricating oils.
- Safety exclusion zone shall be maintained between the operator and assisting staff. The general rule of thumb is that the safety zone distance is 2½ times the length of the bar of the chainsaw.
- Not use chainsaws when working from a tree, unless trained and authorised to do so.

6. GRINDERS

When using a grinder, employees shall:

- Ensure that the spindle speed of stationary machines does not exceed the maximum operating speed indicated on the wheel.
- Ensure that grinding wheels are equipped with a safety washer or flanges, as the design requires.
- Ensure that tool rests are adjusted to a maximum of 3mm from the wheel. Adjustments shall not be made with the wheel in motion.
- NOT grind material on the side of a wheel.
- Apply work gradually to a cold wheel.
- NOT use a wheel that is out of round.
- Ensure guards are in place on all grinders.
- Wear appropriate PPE (eye protection, ear muffs, gloves, etc.).

7. COMPRESSED AIR

When working with compressed air, employees shall:

- NOT use compressed air to blow dust, dirt, or any other materials from their clothing or skin.
- NOT use conductive hoses near electrically energised equipment.
- NOT place air hoses on ladders, steps, scaffolds, or walkways so as to create a tripping hazard.
- NOT use compressed air for cleaning purposes other than for cleaning tools.
- NOT exceed the manufacturer's stated safe operating pressure for filters and other fittings.
- Wear appropriate PPE (eye protection, ear muffs, gloves, etc.).
- All compressed air hoses exceeding 10mm internal diameter shall have a safety device at the source of supply or branch line, to shut off or reduce pressure in the event of a hose failure.
- Air hose couplings shall be attached to the hose by means of crimped bands. Water hose clamps shall not be used.

8. DRILL PRESSES

When using a drill press, employees shall:

- Securely clamp or hold in a vice or jig the item, which is to be drilled.
- Remove chuck keys before starting any drill.
- Keep the drill press table free from excessive accumulation of drill cuttings and long shavings.
- Wear appropriate PPE (eye protection, ear muffs, gloves, etc.).

9. HYDRAULIC PRESSES

When using hydraulic presses/crimpers, employees shall:

- Always use them in accordance with the manufacturer's instructions.
- Not use electrically powered crimpers in the vicinity of live conductors.
- Report oil leaks or crimper damage to their Team Leader.
- Not attempt repairs or maintenance in the field.

10. SCAFFOLDING

When using scaffolding, employees shall:

- Be appropriately trained and authorised for the purpose of the work.
- Inspect the scaffolding equipment prior to erection and replace any defective equipment.
- Ensure scaffolding is placed on a firm, level surface.
- Ensure that open sides of the platform are protected by guard rails.
- Use a ladder or equivalent means of safe access to the platform.
- NOT use ladders or makeshift devices to gain added height.
- Ensure caster brakes on rolling scaffolds are locked before any employees climb them.

11. WELDING – ELECTRICAL

1. When using welding equipment, employees shall be appropriately trained and authorised for the purpose of the work.

2. The primary hazards during welding are electric shock, burns, radiant energy, toxic fumes, fires, and explosions. Adequate precautions shall be taken to guard against these hazards by observing the following:

    - Wherever practical, safety shields or barricades shall be placed around welding jobs, to protect others from the direct rays of an electric arc.
    - Before starting operations, all connections to the machine shall be checked to ensure that they are properly made and in sound condition.
    - Gauntlet gloves shall be worn when welding. Outer clothing shall be free from grease and oil. Clothing around the wrists and neck should be fastened, and pants with cuffs turned down.
    - Suitable fire extinguishing equipment shall be immediately available at all locations where welding is in progress.
    - Adequate ventilation or approved respiratory equipment shall be used while welding in poorly ventilated areas or when welding zinc, brass, bronze, galvanised or lead-coated materials.
    - All electric welding machines shall be properly earthed before being operated.
    - To protect the eyes, face, and body, employees engaged in electrical welding shall wear an approved helmet, proper protective gloves and long sleeves or welder's sleeves.
    - Employees shall wear approved eye protection when assisting with or observing electric arc welding work.
    - A welder, unless working behind a screen, shall not strike an arc with an electrode, until nearby persons, who may be exposed to the arc, have been given sufficient warning.
    - Cables with splices within 3 metres of the holder shall not be used. Operators should not coil or loop welding electrode cable around parts of their body.
    - Cables with damaged insulation or exposed bare conductors shall be replaced.

12. WELDING – GAS

1. Approved eye protection, gloves and clothing shall be worn during all welding or cutting operations.
2. Matches or cigarette lighters shall not be used to light a torch. A torch shall not be reignited from hot work. A flint lighter or stationary pilot light shall be used.
3. Hoses shall not be repaired with tape.
4. When gas welding or cutting equipment is not in use, the cylinder valves shall be closed.
5. Flashback arrestors shall be installed on all gas welding and cutting equipment to prevent the flame from entering hoses and/or regulators. The arrestors shall be placed at the regulator and at the hose ends.
6. Valve protection caps shall not be used for lifting cylinders from one vertical position to another.
7. Unless cylinders are secured on a special trolley, regulators shall be removed and valve protection caps installed prior to moving cylinders.
8. Before a regulator is removed from a cylinder valve, the valve shall be closed and the pressure released from the regulator.
9. All hose connections shall be clamped or otherwise secured in a manner that will withstand, without leakage, twice the pressure to which they are normally subjected to in service, but in no case less than a pressure of 300psi.
10. Hoses showing leaks, burns, worn areas, or other defects, which render them unfit for service shall be removed from service until they are repaired or replaced.
11. Pressure reducing regulators shall be used only for the gas and the pressure for which they are intended.
12. Gauges on oxygen regulators shall be marked "USE NO OIL."

13. An acetylene cylinder valve shall not be opened more than one and a half turns of the spindle.

14. Cylinders not having fixed hand wheels shall have keys, handles, or non-adjustable wrenches on the valve stems whilst they are in use.

15. Under no circumstances shall acetylene be generated, piped (except in approved cylinder manifolds), or utilised at a pressure in excess of 15psi. Free gaseous acetylene is potentially unstable at pressures above 15psi and could decompose with explosive violence.

16. No welding, cutting, or other hot work shall be performed on used drums, barrels, tanks or other containers until they have been thoroughly cleaned so as to absolutely ensure that there is no flammable materials present or any other materials that might produce flammable or toxic vapours.

13. WELDING – FIRE PREVENTION

The basic precautions that shall be used for fire prevention in welding or cutting work are:

- If the object to be welded or cut cannot be readily moved, all movable fire hazards in the vicinity shall be removed to a safe place.
- If the object to be welded or cut cannot be removed and if all the fire hazards cannot be removed, then guards shall be used to confine the heat, sparks and slag, and to protect the immovable fire hazards.
- If the above requirements cannot be met, then welding or cutting operations shall not proceed.

14. GENERAL HAND TOOL SAFETY

Personal protective equipment

Use the correct PPE when using tools which, for general line work, could include:

- rough working gloves – light or heavy duty
- safety eyewear – glasses, goggles or full face shield – tinted or clear
- hearing protection – ear muffs or plugs
- breathing protection – respirator or disposable mask

Don't forget your regular safety gear, including wrist to ankle clothing, safety footwear and safety helmet.

Use tools carefully

When using hand tools:

- Always consider contact with yourself your workmate or other objects due to unexpected tool movement.
- Cut in a direction away from your body.
- When handing a tool to another person, direct sharp points and cutting edges away from yourself and other persons.
- When possible, only use insulated tools (e.g. screwdriver or pliers) near electricity.
- Keep close track of tools when working at height - do not leave them on cross-arms and other structures – a falling tool can kill!
- Don't carry tools up a ladder in your hands or pockets - use a dilly bag/hand line/pole bag.
- Carry and store sharp tools such as chisels in a sheath or holster – never in your pocket.
- Don't throw tools from one location to another, from one employee to another or from ladders, scaffolds or EWP's.
- Be alert for signs of strain or repetitive stress.
- Stretch and warm up before using large tools or heavy force.
- Make sure your grip and footing is secure when using large tools.

Use the correct tool for the job

Take the time to locate the correct tool – it will make the job much easier as well as safer.

For example:

- Use a shifting spanner to fasten or undo odd sized nuts and bolts, not as a hammer.
- Use a ring or set spanner rather than a shifting spanner.
- Use a screw driver for screwing, not chiselling.

Look after your tools

Keep your tools, clean, lubricated and sharp - a dull or blunt blade can lead to injury.

Don't use broken or damaged tools – mark or tag them as unsafe to use.

Don't use impact tools such as hammers, chisels, steel pins and punches if they have a "mushroom" head – have the tool properly restored.

Store tools properly when you stop work.

Shifting spanner use

Adjust the spanner whilst placed on the nut/bolt to remove slack in the jaws.

Use the tool in such a manner that if the bolt/nut breaks or spanner slips you don't 'wear the spanner' (push away from yourself).

Use lubricant to help free up corroded/tight nuts.

Try not to work at face height.

Users should check shifting spanners prior to use for:

- Excessive wearing/damage on the jaws.
- Wear in the adjuster.
- Damaged condition (used as a hammer).
- Retaining pin.

15. LV TEMPORARY CROSSARM

The LV temporary crossarm is designed to support LV (415/240V) lines only, to enable quick replacement of a faulty LV crossarm.

- It can support LV conductors at intermediate poles with small line deviation angle;
- Hold conductor tensions at termination poles with slack-strung mains only.
- Supporting of conductors at strain poles (only where loads are not excessive and equal on each side of the crossarm).

NOTE: The newer version has PVC bearing surfaces which allow the crossarm to sustain loads under a small deviation angle in the line. Older models with heatshrink bearing surfaces shall not be used on lines with a deviation angle.

The cable support snap shackles and hooks:

- Open hooks hanging down for conductor weight only.
- Snap-shackles to be used where there is conductor uplift.
- If in doubt about possible uplift, hold the conductors (up or down) in the snap-shackles.

Working load limits

The user must determine in each case whether the loads applied in the field fall within the working load limits of the crossarm.

The working load limit of the temporary crossarm depends on the length of the crossarm and the number of conductor attachment points, and is expressed as a "working load limit per attachment point":

Working Load Limits per Attachment Point for Temporary X-Arm shown

(5-wire, equal loads all points)

Product Code	Crossarm 2.1-5	Crossarm 2.4-5	Crossarm 2.7-5
Arm length	2100mm	2400mm	2700mm
Arm weight	14kg	15kg	15.5kg
Maximum line load (conductor weight / line tension)	195kg or 1.9kN	180kg or 1.75kN	137kg or 1.35kN
Maximum deviation load (conductor pull-off force due to line angle)	1kN	1kN	1kN

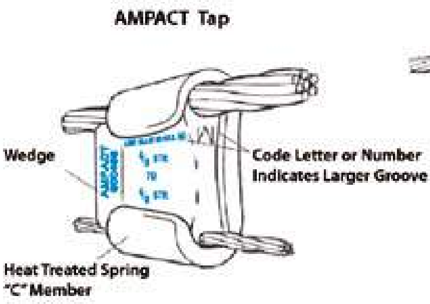
A 5-wire line with a smaller streetlight switchwire may carry heavier loads at each conductor attachment point, but care must be taken to keep the loads as balanced as possible. There will be a small load unbalance always on a 5-wire crossarm, and care should be taken when using it in a strain application to avoid gross load imbalance.

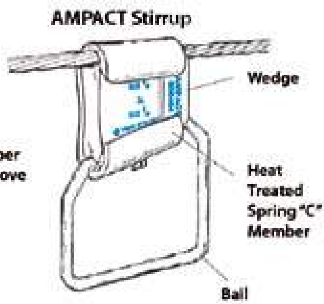
16. AMPACT TOOLS

The Ampact connections require installation by a shell fired tool.

The common Ampact connections are either conductor taps or stirrups.

When installing the Ampact connectors it is important to know the conductor sizes as this will determine which connector is used.





TOOLS AND EQUIPMENT

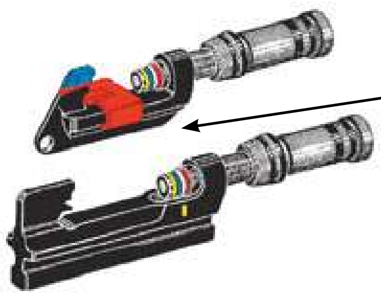
When connecting two different size conductors the wedge will have a letter or number that indicates the larger groove (see picture above)

As per any copper to aluminium connection the aluminium cable shall always be above the copper.

Installation

The Ampact connectors are supplied in colour coded packets as this determines:

- Which shell is used in the tool for the connection.
- The use of the small or large tool head.

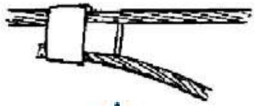


Small tool head for Red, White & Blue connectors.

NOTE: Auxiliary platform to be used when installing Red connectors.

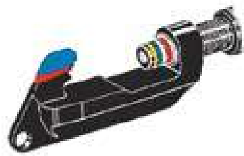
Large tool head for Yellow connectors.

Fit connector onto cables ensuring the wedge is inserted correctly (mark to largest cable).

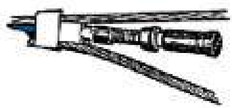


Load power unit with the appropriate shell for application.

Have the tool fully opened up to allow for correct fitting.

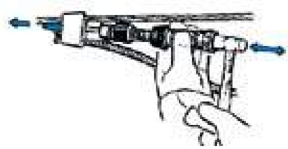


Fit the tool to the connector ensuring it is properly seated for correct application. Tighten the gas release cap ready for firing.

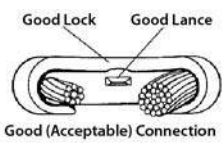


NOTE: Wedge section facing towards the tool body.

Hold the breech assembly and hit the gas release cap with a hammer to fire the wedge. Undo gas release cap then undo the breech assembly and remove the tool.



Check that the connector has been installed correctly. The wedge should have a lance that locks the wedge in place.



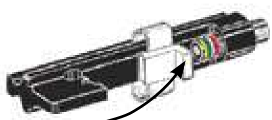
Removal

For the removal of any Ampact connector or Stirrup a take-off clip needs to be fitted. There is a clip for each colour coded connector.

When removing a connector the correct shell shall be selected:

- For Red, Blue or White connectors a Red shell is used.
- For a Yellow connector a blue shell is used.

NOTE: An incorrect selection may cause damage to the tool.

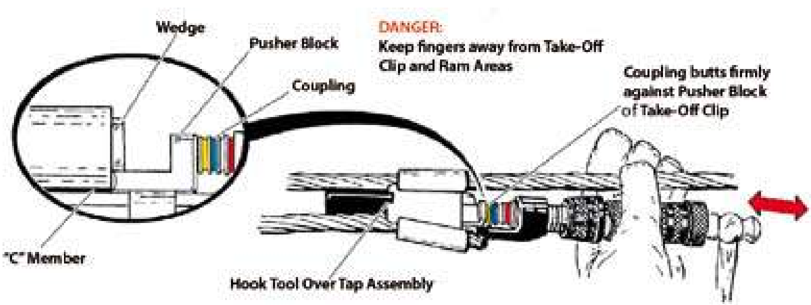


Select the appropriate take-off clip and fit to the tool head.

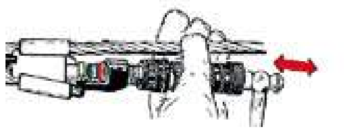
The pushing block facing the power unit.

Load the tool with the appropriate shell.

Fit the tool to the connector ensuring the wedge faces out and the bottom section of the take-off clip is against the “C” member.

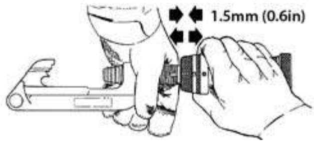


Tighten the gas release cap then hold the breech assembly and hit the gas release cap with a hammer to fire the "C" member away from the wedge. Undo gas release cap then undo the breech assembly and remove the tool.



Daily inspection

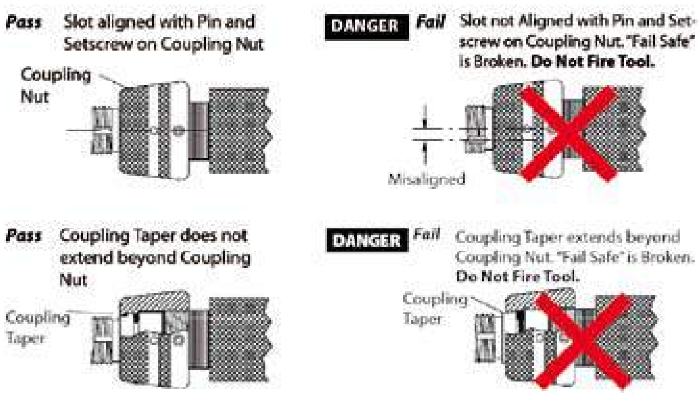
To maintain the tool in optimal working condition the unit should be cleaned regularly and inspected prior to use.



Inspection:

- **Check power unit coupling movement.** Grasp the head in one hand and the breech cap in the other. Pull out and push in as shown. There should be 1.6mm of movement for correct use.

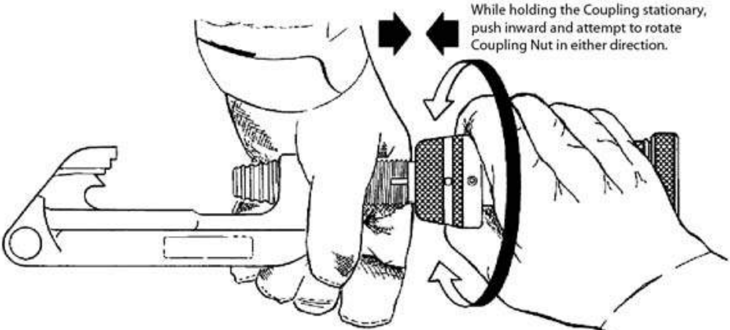
- **Visual inspection of fail safe position.**



- **Manual fail safe inspection**

Push-and-Turn Inspection

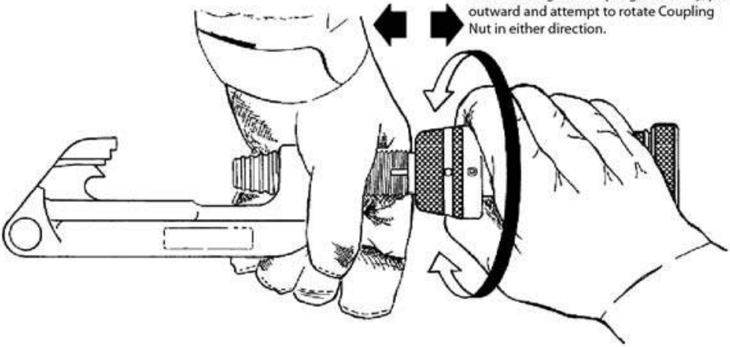
While holding the Coupling stationary, push inward and attempt to rotate Coupling Nut in either direction.



DANGER If coupling nut turns more thn 4° (about 3.2mm [1/8in]), the "Fail Safe" is broken.
DO NOT FIRE THE TOOL.

Push-and-Turn Inspection

While holding the Coupling Stationary, pull outward and attempt to rotate Coupling Nut in either direction.



DANGER If coupling nut turns more than 4' (about 3.2mm [1/8in]), the "Fail Safe" is broken.
DO NOT FIRE THE TOOL.

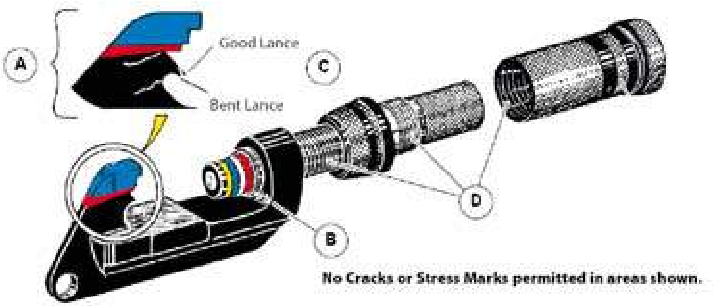
- **Inspection of stress areas**

  A. Lance area of tool head

  B. Radius at the threaded end of tool.

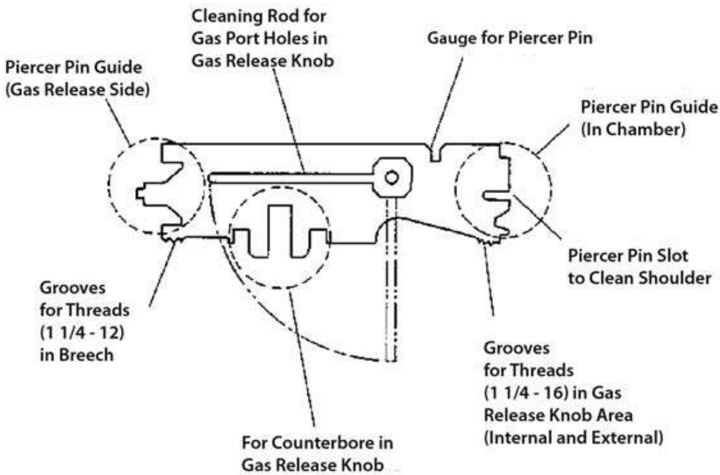
  C. Tip of the lance.

  D. The threaded areas of the power unit.

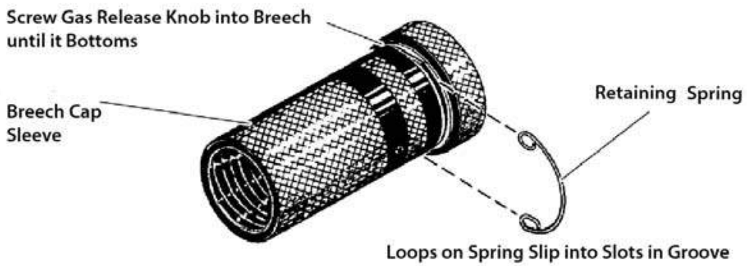


Cleaning

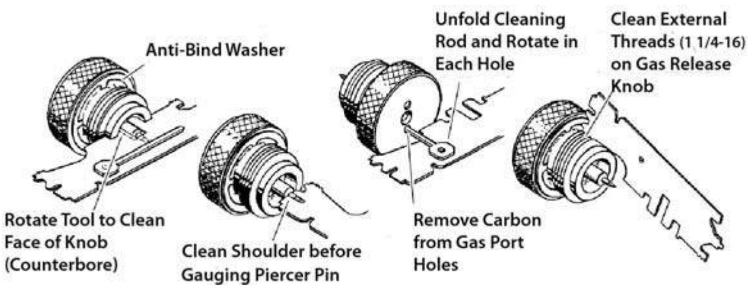
The Ampact cleaning tool is used to maintain the tool in good working condition.



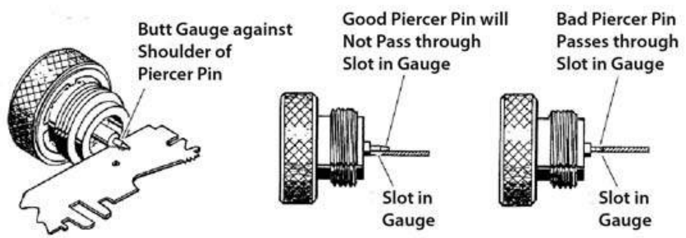
- To remove the gas release knob pry out the retaining spring from the breech cap assembly and unscrew the gas release knob.



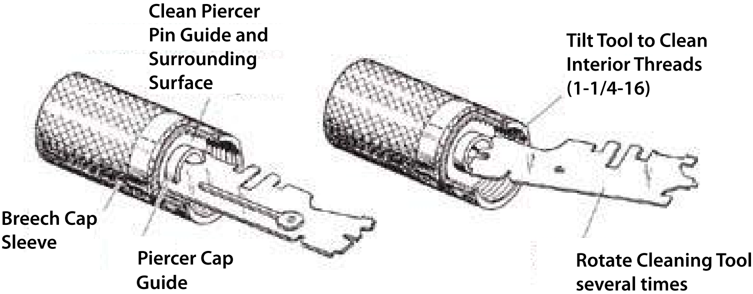
Clean the gas release knob



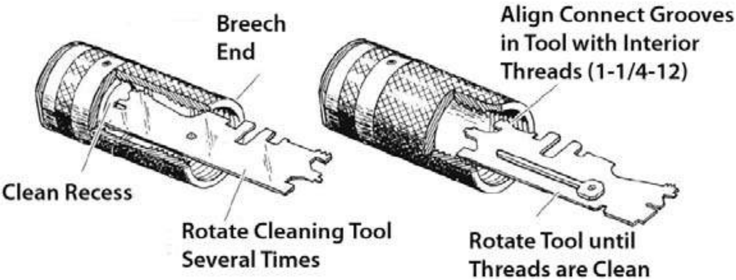
Gauge the piercer pin



Clean the gas release end of the sleeve

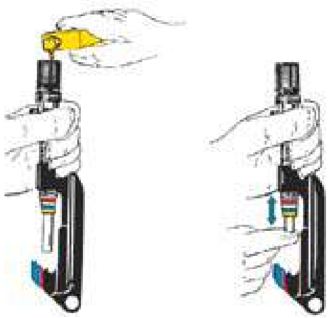


Clean the breech end of the sleeve



Cleaning the ram

Remove the breech cap and apply some lubricant/solvent and work ram up and down until movement is free.



NOTE:

Maximum travel allowed in the ram is 51mm.

For further information refer to the Ampact customers manual.

TOOLS AND EQUIPMENT

ALUMINIUM TO ALUMINIUM AMPACT SELECTION CHART

	3/12 SC/GZ	7/2.5	7/3.0	7/3.75	7/4.75	19/3.25	19/3.75	19/4.75	37/3.75	DEES
3/12 SC/GZ	602283-3	602283-1	602283-1	600456	600456					
7/2.5		602283-1	600403	600411	600411	602380-2				602586
7/3.0			600403	600411	600458	602380-4	602001	1-602031-7		275436-1
7/3.75				600411	600459	602380-4	602003			275436-1
7/4.75					600466	602046-7	602004	1-602031-5	602121-9	275435-1
19/3.25						602046-9	602007	1-602031-4	602121-7	602502
19/3.75							1-602031-4	1-602031-3	602121-6	602047
19/4.75								1-602031-2	602121-2	602174
37/3.75									602121-1	602174
Switch LUG	600456	600411	600458	600459	600466	602046-7	602004	1-602031-5	602121-9	

"White" Stirrups (DEES) have a 8mm Tinned Copper Bail.

"Blue & Yellow" Stirrups (DEES) have a 10mm Tinned Copper Bail.

ALUMINIUM TO COPPER AMPACT SELECTION CHART

	3/12 SC/GZ	7/2.5	7/3.0	7/3.75	7/4.75	19/3.25	19/3.75	19/4.75	37/3.75	DEES
7/.080"Cu	602283-3	602283-1	602283-1	600456	600456					602586
7/.104"Cu	602283-1	602283-1	600403	600411	600411	602380-2				602586
19/.083"Cu	602283-1	600403	600403	600411	600458	602380-4	602001	1-602031-7		275436-1
19/.101"Cu	600456	600411	600458	600459	600466	602046-7	602004	1-602031-5	602121-9	275435-1
37/2.52"Cu			602001	602003	602004	602007	1-602031-4	1-602031-3	602121-6	602047

NOTE: When connecting aluminium to copper, ensure that the aluminium is always on top of the connection.

RED CARTRIDGE 69338-2	WHITE CARTRIDGE 69338-5	BLUE CARTRIDGE 69338-1	YELLOW CARTRIDGE 69338-4

SWITCH LUGS	STRAIGHT	90 deg ANGLE
	279035-1	279035-2

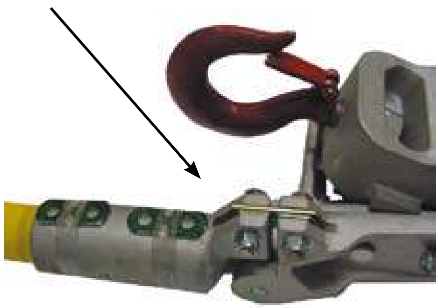
17. PORTABLE WINCHES (LUG ALLS)

For any work where straining is to be carried out on Live Conductors a webbing winch shall only be used.

The use of wire rope winches on live conductors is not acceptable.

Overstraining in the older wire rope units will be visible by the bending of the metal handle.

With the newer webbing units there is a sheer link that operates. If this has operated replace with a new link.



These items are to be used for straining only.

They must have the SWL stamped on the body of the unit.

FLEET SAFETY SECTION 11

1. GENERAL

Drivers of vehicles have a responsibility to act with care and consideration to avoid incidents.

1. When driving or operating a vehicle or item of plant, employees shall:

   - Comply with the Victorian road rules and regulations and must not drive vehicles unless authorised.
   - Without exception, all parking and traffic offences as well as any associated fines or penalties incurred while driving a vehicle are the personal responsibility of the driver.
   - Possess a current licence or authority appropriately endorsed for the category of vehicle/plant to be operated.
   - Notify Management immediately if their driver's licence is suspended or cancelled.
   - Know and obey all applicable laws and regulations in addition to company safety rules.
   - Fill in the appropriate logbook for each vehicle as required.
   - NOT smoke within any vehicle.
   - Inspect the vehicle prior to use, reporting and correcting any unsafe conditions.
   - NOT operate a hand held mobile phone, radio or TMR whilst driving a motor vehicle on a public roadway. This includes vehicles that are stationary in traffic.
   - NOT board or alight from a vehicle that is in motion.
   - Before filling the fuel tank, ensure that the engine is shut off. The hose nozzle shall be kept in contact with the fuel tank to avoid static sparks. Smoking and naked flames are prohibited. Radio and mobile phone transmissions shall be avoided whilst the vehicle is being refuelled.
   - Wherever possible, position the vehicle to avoid the necessity of reversing. When returning to a parked vehicle and prior to departing from your location, visually inspect the vehicle to ensure that it is safe to drive.

- NOT permit anyone to ride on the running boards, mudguards, or any part of the vehicle, except on seats or inside the body walls. Passengers shall not stand up in moving vehicles unless assigned to the job for the purpose of raising service wires along the route.

2. When an employee has been involved in a vehicle incident, they shall:

   - Report the incident to their Management and to the Fleet Company in accordance with documented procedures.
   - Report the incident to the police within 24 hours of the incident occurring, if the incident involved injury to the driver or a third party.

3. Wherever a vehicle or item of plant is fitted with seat belts, they shall be worn at all times by the driver and occupants. At no time shall the number of passengers exceed the number of seat belts provided.

4. In the event of an accident occurring at or near a worksite on a public roadway, employees shall undertake the following action:

   - If a traffic controller is being used, their primary responsibility is to maintain control of the traffic flow to ensure the safety of the worksite and the public.
   - Provide assistance to members of the public or employees involved.
   - Notify the appropriate emergency services.
   - Obtain the names and addresses of any witnesses as well as all relevant details.
   - Report the details of the incident to your Management.

2. ELEVATING WORK PLATFORMS

1. When operating an Elevating Work Platform (EWP), employees shall:

- Be trained and licensed to operate the EWP and be aware of its capabilities and limitations, in accordance with the manufacturer's specifications.
- Ensure that the EWP's fibreglass boom is tested at least every 6 months. The EWP shall not be used near energised assets if the test is overdue.
- Wear an approved fall protection device and lanyard whenever in an EWP and maintain at least one foot firmly on the floor of basket at all times.
- Inspect daily, all controls and areas considered critical to safe operation, including controlled descent devices, to ensure that they operate properly prior to use, as outlined in the EWP Log Book.
- Ensure that all out-riggers are in the down position on stable ground and where necessary, steel plates, timber pads or suitably prepared packing of the required strength shall be placed under the outrigger or stabilizer foot plates, that the hand brake is set and that the truck wheels are chocked, before operating the boom.
- Ensure that the EWP is set up within the 5° range of the levelling indicators.
- Earth the vehicle if it is physically possible for any portion of the EWP to contact live assets or equipment.
- Regularly clean the fibreglass surfaces, boom, basket and jib to ensure that insulating members are free of dirt, oil, or other contaminates that might degrade dielectric integrity.
- Ensure that hydraulic hoses, tools, and material cannot become entangled with any control levers.
- NOT move the EWP from one location to another (other than positioning activity) with the equipment in any position other than fully retracted.

- NOT allow material to loosely lie in the bottom of the basket.
- Observe minimum clearance distances from electrical assets.
- Be restrained to at least one point (e.g. pole or EWP) when exiting or entering an EWP basket.

2. For EWP's that are only partially insulated, the following permanent notice shall be fixed at each operator's station:

> **DANGER** **BEWARE OF POWER LINES**
>
> This appliance is not fully insulated. Do not permit any uninsulated part of this appliance to be in close proximity to live conductors.

3. FORKLIFTS

1. When operating forklifts, employees shall:
   - Be trained and authorised to operate the type of forklift.
   - Inspect the forklift at the beginning of each shift to ensure that the equipment and accessories are in safe operating condition and free from apparent damage that could cause failure whilst in use.
   - Always operate the forklift at a safe speed, dictated by the surrounding conditions.
   - Slow down and sound the horn at cross aisles and other locations where vision is obstructed.
   - Ensure that the load is carried to the rear when descending an incline and that the load is carried to the front when ascending an incline.
   - Ensure that the engine is turned off when a forklift is being refuelled.
   - NOT at anytime ride on the load or any other part, and shall not stand or pass beneath the elevated forks, whether loaded or empty.
   - Ensure only an approved platform is used for the purposes of elevating people.

- Ensure only approved attachments to the mast or forks are used.
- When moving a forklift, loaded or empty, ensure that the forks are carried as low as possible but high enough to clear uneven surfaces.
- Only carry loads, which are securely and safely loaded and are within the rated capacity of the forklift.
- Ensure that forklifts with internal combustion engines are not operated in enclosed areas for prolonged periods of time, so as not to exceed the acceptable levels of carbon monoxide.

4. MOBILE PLANT

1. Mobile plant may only be used in the vicinity of live conductors and/or electrical apparatus after precautions appropriate to the particular circumstances have been considered and approved action taken.
2. The precautions to be considered within a risk assessment shall include:
    - Check the structure to which work is to be carried out and the two adjacent structures.
    - De-energising the conductors and/or electrical apparatus.
    - Positioning the mobile plant such that limits of approach can be maintained in all circumstances.
    - The use of safety observers, barriers and notices.
    - The use of other precautions such as physical restrictions or control devices in conjunction with barriers.
    - The suppression of Auto-Reclose.
3. When working with mobile plant, employees shall:
    - Be suitably trained.
    - Give specific consideration to its use during planning of the work when mobile plant is to operate adjacent to live conductors and/or electrical apparatus.
    - Observe the minimum approach distances to electrical assets.

- Inspect the plant prior to use and complete the vehicle logbook.
- Mobile plant and, where appropriate, vehicles, shall be earthed by a trailing earth conductor.
- Take signals from only one person during operation except for emergency stop situations.
- Before operating the boom, ensure that all outriggers are in the down position on stable ground, that the hand brake is set and that the truck wheels are chocked.
- NOT stand on or ride a load or work under a suspended load or inside the angle of a winch line.
- Attach tag lines to heavy objects when possible to prevent swinging or twisting of the load.
- Not leave the controls of cranes, hoists, derricks or similar lifting equipment while the load is suspended unless the following actions, where applicable, have been taken:
    a. All loads shall be removed from the hook or dedicated lifting device.
    b. The hook shall be raised to a position where it is safely clear of other operations, or hooked back or otherwise appropriately secured.
    c. All powered motions shall be disabled. Means shall be provided and used to prevent unauthorised operation of the crane during the crane operator's absence.
- When working with an un-insulated boom near energised conductors, appoint a designated safety observer other than the operator, to observe the approach distance of the boom or load and give timely warning if approach distances are encroached.
- NOT perform work in any station or allow mobile plant to enter any station without first obtaining the permission of the person in charge of the station, and accepting all the conditions imposed by that person.
- NOT lift or push out of the way, live high voltage conductors in order to pass mobile plant below them.

- Suitably cover live low voltage conductors when lifting or pushing them out of the way to provide clearance for a vehicle or it' load.
- Control the movements of loads by means of approved non-conducting ropes of minimum length or other approved means where there is a risk of infringing the "Safe Approach Distance" to electrical conductors. No person outside the cabin of the mobile plant shall directly contact the load, mobile plant or any attached conducting objects.

4. Where no alternate route is available and the mobile plant cannot be arranged to provide the required clearance to exposed live apparatus of voltage not exceeding 66kV, arrangements shall be made with the person in charge of the high voltage conductors, to be temporarily and securely repositioned to provide the specified clearance, or alternatively, for the issue of an Access Authority to allow the conductors to be contacted and lifted or pushed out of the way.

5. The person in charge of the work shall, through all work party members, ensure compliance with the "Safe Approach Distance" for mobile plant/lifting equipment and the following general requirements for all the work situations covered in these instructions:

   - Pole structures carrying live circuits shall be checked to ensure that they are in a safe condition prior to the commencement of any work.
   - Suppression of auto-reclose.
   - A Safety Observer shall be appointed.
   - For all work, either specific work instructions shall be issued or alternatively, Organisation Procedures shall apply.

6. Pole structures may be lifted between exposed live low voltage conductors, by lineworkers, in accordance with organisational procedures and under direct supervision of the person in charge.

5. LIFTING EQUIPMENT

All lifting equipment shall be inspected and tested annually and shall show paint markings consistent with those in Table 1. Appendix III - Rigging.

MANUAL HANDLING SECTION 12

MANUAL HANDLING

1. MATERIAL HANDLING AND STORAGE

1. When employees are required to move, store or handle materials, whether by hand, manually operated equipment or by power operated equipment, it shall be performed in a manner which minimises the risk of personal injury or damage to equipment and property.

2. When objects are being handled manually or by mechanical equipment, care shall be exercised to prevent the objects or the mechanical equipment from infringing limits of approach.

3. For mechanical handling where there is a risk of infringing the limits of approach to electrical conductors, the movement of loads shall be controlled by means of approved non-conducting ropes or other approved means, and no person outside the cabin of the mobile plant shall directly contact the load, mobile plant or any attached conducting objects.

4. Permanent aisles and passageways shall be appropriately marked.

5. Storage of materials shall not create a hazard. All stored materials that constitute a hazard shall be stacked, blocked, interlocked, and limited in height so that they are secure against sliding or collapse.

6. Employees shall report situations where they consider that manual handling is likely to be a risk to the health and safety of themselves or others.

2. HOUSEKEEPING

1. Storage areas shall be kept free from accumulation of materials that constitute hazards such as tripping, fire, explosion, or pest harbourage. Vegetation control shall be exercised when necessary.

2. Materials stored in quantity should be arranged so that the weight is evenly distributed and is not top heavy. Maximum safe floor loads shall not be exceeded.

3. Poles, pipes, timber and similar material shall be stored on suitable racks and blocked to prevent them from moving.

4. Salvaged poles should be stripped of all hardware prior to storage.

5. Poles stored in the road reserve should not be left in areas where there is a high pedestrian traffic load, such as outside shopping areas and near bus stops or taxi ranks.

   Where poles are left in the road reserve they should:

   - Always be placed as far as possible from vehicular traffic.
   - Be chocked to prevent rolling.
   - Have the butt face oncoming traffic to reduce the incidence of vehicles contacting head high portions of the pole.
   - Have the cross-arms rotated to be in line with pole rather than at right angles to reduce the overall profile of the pole.

6. Barrels and drums, etc. shall be stored on end or securely blocked to prevent rolling.

7. Materials or equipment should not be stored near or under energised equipment, if it is practical to store them elsewhere.

8. When storage under or near energised equipment is necessary, proper clearances shall be maintained and care shall be taken when moving materials into and out of such storage.

3. LIFTING AND CARRYING

1. Manual handling related incidents account for many injuries. These injuries can be easily avoided by using correct lifting techniques. Lift with your leg muscles – bend your legs and keep your back straight. Lift only what you can manage comfortably and avoid bearing weight in awkward positions.

2. Pipes, conduit, reinforcing rods and other conducting material shall not be carried on the shoulders in the vicinity of exposed live electrical equipment or conductors.

3. Hand lines or hoists shall be used for raising or lowering tools and material to another level which is beyond your reach.

4. Do not jump from platforms, scaffolds, loading docks or other elevated places. Always use steps, stairs, ladders, etc., to descend from higher elevations.

5. Poles shall not be moved from a pile when a worker is still standing on the stack or if they are between the hoist and the stack. Workers other than those assigned to guide the ends of the poles shall stand clear.

6. When objects are being handled manually or by mechanical equipment, care shall be exercised to prevent the objects or the mechanical equipment from infringing the limits of approach.

HAZARDOUS GOODS SECTION 13

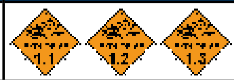
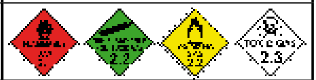
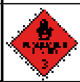
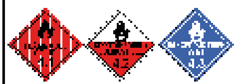
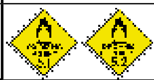
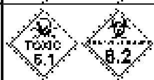
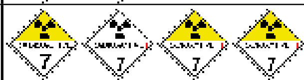
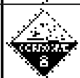
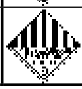
This section contains general procedures for the management of common workplace substances.

Detailed information relating to any substance (including first aid treatment) is available from the product's Material Safety Data Sheet (MSDS).

This information should be referred to prior to the use of any potentially hazardous substance.

1. DANGEROUS GOODS

Dangerous goods are segregated into nine major classes:

CLASS	DEFINITION	SYMBOLS
1	Explosives.	
2	Gasses: compressed, liquefied or dissolved under pressure.	
3	Flammable Liquid.	
4	Flammable solids, substances liable to spontaneously combust, and substances, which in contact with water, emit flammable gasses.	
5	Oxidising agents and organic peroxides.	
6	Poisonous (toxic) and infectious substances	
7	Radioactive substances.	
8	Corrosive substances.	
9	Miscellaneous dangerous goods.	

Spills and leaks of oil and other chemicals can cause serious environmental damage. Following the correct procedure for dealing with oil filled equipment, and using simple common sense, will reduce the probability of a spill or leak occurring. However, if one does occur, ensure that the appropriate clean-up and reporting procedures are followed.

When working with any dangerous goods, employees shall:

- Familiarise themselves with the product's Material Safety Data Sheet (MSDS).
- Wear all appropriate Personal Protective Equipment (PPE) as required by the MSDS.
- Use the product in accordance with the manufacturer's recommendations.
- Ensure that dangerous goods are labelled and stored only in containers that are specifically designed for the product.
- Familiarise themselves with the location of first aid equipment (including the eyewash facilities) and fire extinguishers.
- Shield other employees from unnecessary exposure to the dangerous goods.
- Refer immediately to the MSDS for proper medical attention should accidental contact with a chemical occur.
- Dispose of containers that once held dangerous goods according to accepted and approved methods.

2. PROTECTIVE APPAREL FOR SPILLS

Employees shall utilise the following PPE as required:

- PVC (dark green) gloves – single use only.
- PVC knee length safety boots – single use only.
- PVC yellow coveralls – single use only.
- Safety glasses – must be washed thoroughly after each use.
- Respiratory protection – after heavy usage, canisters are to be appropriately disposed of.

For PCB's, employees shall utilise the following PPE as required:

- Unsupported nitrile (light green) gloves - single use only.
- PVC knee length safety boots – single use only.
- PVC yellow coveralls – single use only.

- Safety glasses – must be washed thoroughly after each use.
- Respiratory protection – after heavy usage, canisters are to be appropriately disposed of.

For solvents, employees shall utilise the following PPE as required:

- PVC (red) gloves - must be washed thoroughly each after use.
- PVC knee length safety boots – single use only.
- PVC yellow coveralls – single use only.
- Safety glasses – must be washed thoroughly after each use.
- Respiratory protection – after heavy usage, canisters are to be appropriately disposed of.

For oils, employees shall utilise the following PPE as required:

- Barrier (white) gloves - single use only.
- PVC knee length safety boots – single use only.
- PVC yellow coveralls – single use only.
- Safety glasses – must be washed thoroughly after each use.

3. ASBESTOS

It is important to note that asbestos is not hazardous to health unless it is in free form and capable of being inhaled. Asbestos becomes a health hazard if the fibres become airborne and are inhaled.

If at any stage the employee is unsure regarding the presence of asbestos, then the appropriate protective apparel shall be worn.

It is recommended that the appropriate dust masks be worn while working in the vicinity of asbestos products. The effectiveness of these masks may be reduced by facial hair or by poor fitting.

If it is necessary to provide a hole through asbestos cement (AC) sheeting or millboard, then it is preferable to carefully punch the hole through, as this will minimise the disturbance of particles.

If it is necessary to drill AC sheeting, use only a low speed hand operated drill to minimise particle disturbance. The use of power tools is not permitted because of the inherent possibility of releasing asbestos fibres into the air.

During the drilling operation and subsequent clean up, the operator, or any persons in the immediate vicinity, should wear an appropriate dust mask. Under no circumstances should accumulated dust particles be removed by brushing or blowing.

The dust should be removed with a damp throw away cloth and then placed in an asbestos bag marked "asbestos material", sealed and returned to the asbestos disposal container at the depot.

Do not drill millboard. Holes are to be carefully punched through.

If it is necessary for employees to remove pieces of AC sheeting, then it is essential that such broken pieces of sheet be placed in the asbestos bag provided, marked "asbestos material" and returned to the asbestos disposal container at the depot.

If an employee believes that they have been exposed to airborne asbestos particles, the employee should notify the dispatch officer who shall record the details in the Asbestos Register.

4. COMPRESSED GAS CYLINDERS

Designated cylinder storage areas shall be clearly posted with the name of the gases stored.

Adequate portable fire extinguishers or fire hose stations shall be available for fire emergencies at storage areas.

Signs which read "NO SMOKING - NO OPEN FLAMES OR IGNITION SOURCES" shall be posted around the storage areas.

When storing compressed gas cylinders, employees shall:

- Secure cylinders in an upright position.
- Tag defective compressed gas cylinders or valves with a "Danger Do Not Operate" tag.
- Label empty cylinders and store separately from the full cylinders.
- Ensure cylinder valves are closed at all times when the cylinder is not in use.
- NOT store cylinders near exits, stairways or locations where heavy moving objects may strike or fall against them.

- NOT store cylinders near readily ignitable substances or near corrosive chemicals.
- Ensure acetylene cylinders are stored valve end upwards. If the cylinder is on its side, acetylene may leak out and create a dangerous condition.

When transporting compressed gas cylinders, employees shall:

- Ensure cylinders are transported preferably in the upright position or in suitable racks and properly secured.
- NOT lift cylinders with choke slings. If they must be lifted by mechanical means, they must be lifted in a cradle made for that specific purpose.
- Ensure protective valve caps are properly installed during transport.

When using compressed gas cylinders, employees shall:

- Secure the cylinder in an upright position.
- Ensure that the cylinder valve is closed and that all pressure is released from the regulator, before the regulator is removed from the cylinder.
- Keep valves, regulators, hoses and other apparatus free from oil or grease.
- NOT use a leaking cylinder.
- Ensure excessive heat does not come into contact with any part of a compressed gas cylinder.
- Ensure cylinders are not dropped or permitted to strike violently against each other or any other surfaces.
- NOT use a cylinder that does not have a legible label or marking identifying its contents.
- NOT use a flame to detect flammable gas leaks.
- NOT use the top of cylinders as a place for tools.

5. OILS AND PCB'S

When working with oil and PCB spills, employees shall:

- Avoid contact with the material.
- Make the site safe and cordon off the area if necessary.
- Contain any spills or leaks as best you can.
- Ensure that the material does not enter drains or waterways (do not flush it away).
- Contact the Control Room and your Supervisor as soon as possible.

6. COPPER CHROMIUM ARSENATE POLES

Copper Chromium Arsenate, or CCA is comprised of a mixture of chemicals. In the treatment process, the CCA chemicals react in the timber to form water insoluble compounds that are permanently fixed in the timber (unless released by burning the timber). CCA treated timber is often recognised by its green colouration. However, weathering, timber species and formulation differences can potentially make identification difficult.

Employees and contractors shall:

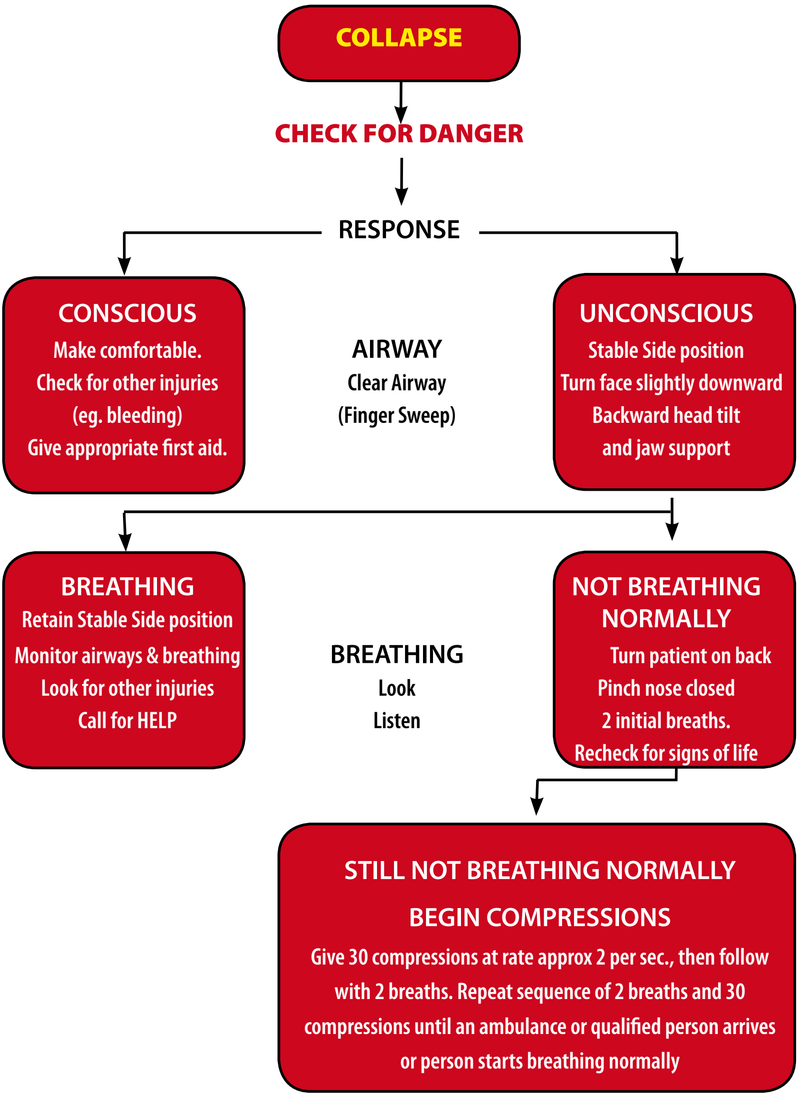
- Avoid burning CCA treated timbers and breathing the fumes.
- Avoid skin contact whenever handling CCA treated timbers, through wearing impervious (leather) gloves (which will also minimise the occurrence of splinters); and
- Wash skin after handling CCA treated timbers and prior to eating, drinking and going to the toilet.

Sawing treated timber

- Sawing treated timber creates heat at the cutting face and wood vapour is produced. Hand sawing produces less vapour and dust than power sawing.
- Employees and contractors shall wear the following PPE when sawing CCA treated timber:
  - Impervious (leather) gloves,
  - Safety glasses, and
  - P1 or P2 respiratory protection.

FIRST AID SECTION 14

Basic Life Support Flowchart



CALL 000 or 112 for an ambulance

1. GENERAL GUIDELINES

All employees should exercise sound judgement and practices and not exceed their level of training when rendering first aid. First aid kits shall be maintained and should be readily available for use. They shall be inspected at regular intervals to ensure that expended items are replaced.

No employee is permitted to intentionally use a needle to give injections to workers, use scalpels or knives to open the skin of a co-worker or any other medical procedure that results in the release of blood. (Exceptions: the removal of splinters, emergency injections (Epipen) for an allergic reaction and using protective equipment in first aid treatment.

Employees shall not intentionally handle needles or other sharp objects that are known or thought to be contaminated with blood or other body fluids such as those that might be present following an emergency medical response.

Employees shall not intentionally place their hands in waste receptacles where blood or other body fluids are known to be present without first donning protective gloves.

Broken glass that has been contaminated with blood shall not be picked up with the hands. A mechanical device, such as a dust pan, tongs or forceps, shall be used to retrieve the glass.

2. INFECTION CONTROL FOR THE FIRST AIDER

When administering first aid, employees shall:

- Treat every person as a potential source of infection.
- Wash their hands before treating the casualty.
- Use fresh disposable gloves for each casualty.
- Use disposable masks for resuscitation.

If significant exposure to bodily fluid occurs:

- For a puncture or penetrating injury.
- Wash the area well with soap and water.
- Gently squeeze the injury and encourage it to bleed, but do not traumatise the wound.
- Splashes to broken skin and open wounds.

- Wash the area well with soap and water.
- Splashes to the eyes and/or mouth:
- Irrigate with copious quantities of water.

Report the contact to your Doctor and Team Leader as soon as practicable.

Used gloves, swabs, etc. should be placed in a sealed plastic bag and disposed of appropriately. If in doubt, contact you local hospital or medical centre.

3. BANDAGING WOUNDS

A bandage may comprise of any material used to wrap or cover an injured body part. Bandages are used to:

- Hold dressings in place.
- Apply pressure to control bleeding.
- Protect a wound from contamination or infection.
- Prevent swelling.
- Restrict movement.
- Provide support to an injured limb or body part.

General principles when applying bandages:

- With the casualty in a comfortable position, support the injured part in the position in which it will be bandaged.
- Always use a reef knot to tie bandages (refer to Appendix I). For pressure bandages to control bleeding, apply a dressing and firm bandage to hold the pad in place. For bandages used for immobilisation, tie the knot on the opposite side of the wound.
- Apply the bandage securely and firmly enough to hold the dressing in place and apply the needed pressure or immobilisation, but no so tightly that it restricts circulation. When bandaging extremities, leave the fingernails or toenails exposed so as to give a visual check that the circulation is not impaired.

The two primary types of commercially available bandages, which are used for most wounds, are the Roller Bandage (which can be wrapped around a body part) and the Triangular Bandage (which can be folded, wrapped and tied in various ways for differing injuries).

4. BLEEDING CONTROL

For bites, cuts, wounds, punctures and fractures:

- If an arm or leg wound, raise the limb above heart level.
- Using a clean cloth, apply direct hand pressure to the wound.
- If the bleeding stops, bandage the wound normally.
- Apply pressure bandage if required.

5. BURNS

The aim of first aid in burn injuries is to:

- Remove the casualty from the heat source.
- Cool the affected area.
- Protect the injured area from infection and further damage, and obtained medical aid.

Immediate action:

- Remove the casualty from danger.
- Extinguish burning clothing (smother with a blanket, jacket or similar, or use water).
- Remove hot clothing.
- Hold the burnt area under cold, gently running water until the affected area has returned to normal body temperature (usually 10 minutes).

General management:

- **Do not** apply any lotions, ointments or oily dressings.
- **Do not prick** or break blisters - this increases the risk of infection.

- If the casualty is thirsty or there is a long delay, give frequent small amounts of water. **Do not give alcohol.**
- Seek medical aid urgently.
- Extreme pain can be alleviated by gently pouring water over the dressing, however ensure that this does not over-cool the area, particularly if the burnt area is extensive.

Management of deep burns:

- Remove or cut away clothing from the burnt area but leave clothing that is stuck.
- If possible, remove constricting rings, bracelets etc. before any swelling starts.
- Wash with gently running cold water to reduce the swelling and pain, and until the temperature returns to normal - this usually takes at least ten minutes.
- Cover the burnt area with a sterile or clean non-stick dressing, and bandage lightly to minimise fluid loss and pain.

Chemical and corrosive burns:

- Wash off immediately with a large volume of flowing water for approximately twenty minutes.
- Remove contaminated clothing and footwear, but avoid contaminating yourself.
- Do not attempt to pick off contaminants that stick to the skin.
- Cover the area with a sterile or clean non-stick dressing.
- Seek medical assistance urgently.

Electrical burns:

- Wash and cool the burnt area under gently running water, well away from live assets.
- Apply a clean, dry dressing.
- Seek medical attention urgently for all electrical burns, as the surface skin may show little evidence of burning, even though deep tissue may be seriously burnt.
- Seek medical attention urgently.

6. THE DRABC ACTION PLAN

Whenever you approach the scene of an accident or emergency, follow the DRABC Action Plan to ensure the safety of all concerned and to optimise the casualty's path to recovery.

D – check for Danger:

- To yourself.
- To bystanders.
- To the casualty.
- Take all precautions necessary to ensure that nobody else can be injured – you will not be able to effectively render assistance if you become a casualty yourself.

R – check for Response:

Is the casualty conscious? Gently shake the casualty and ask if they can hear you.

- If the casualty is conscious, check for other injuries and manage any bleeding.
- If the casualty is unconscious, turn them onto their side. This should be done by kneeling beside the casualty and placing their furthest arm at right angles to their body. Their nearest arm is then laid across their chest. With the casualty's near knee raised, roll the casualty away from you. Continue to support the casualty in this position until the airway and breathing have been checked.

A – clear and open the Airway:

- Whilst still supporting the casualty on their side, tilt their head back and down slightly. Open their mouth and with two fingers, gently clear any foreign objects. Dentures should only be removed if they are loose or broken.
- To open the airway, place one hand on the casualty's forehead and support the chin with the other hand. Tilt the head back gently and lift the jaw forward, opening the casualty's mouth slightly.

B – check for Breathing:

- Look for the rising and falling of the chest.
- Listen for the sound of breathing.
- Feel with your cheek close to the casualty's mouth.

If the casualty is breathing, ensure that they are in the stable side position. To do this, adjust the upper knee so that the thigh is at right angles to the hip, and place the hand of the upper arm under the casualty's cheek to maintain head tilt. Now check for other injuries and manage as required.

If the casualty is not breathing, turn them onto their back and commence EAR (expired air resuscitation), giving two full breaths. Remember to keep the casualty's head tilted, pinch their nostrils or seal them with your cheek, and to lift their jaw forward/upward with your other hand.

C – Compressions:

With CPR, the correct placement of your hands is important.

- Locate the lower end of the breastbone by feeling along the lowest rib on each side from the outside inwards.
- Locate the upper end of the breastbone by placing a finger in the groove between the collarbones.
- Extend the thumbs of each hand equal distances to meet in the middle.
- Keep the thumb of one hand in position and place the heel of the other hand below it.

For an adult, the breastbone should be depressed about 5cm.

Give 30 compressions at the rate of approximately 2 per second, followed by 2 breaths. Maintain this cycle until an ambulance or qualified person arrives or the person starts breathing normally.

The cycle of compressions and breaths is the same whether there are 1 or 2 first-aiders.

7. CONVULSIONS

- Clear the area around the casualty to keep them from injuring themselves.
- Do not force anything into the casualty's mouth.
- Do not attempt to restrain the casualty.
- When the convulsions are over, start CPR if required, otherwise keep the casualty quiet and calm.
- Seek immediate medical attention.

8. ELECTRIC SHOCK

- Protect yourself. If the casualty can be safely removed from the electricity source, do so.
- After the casualty is safely removed from live assets:
- If they are not breathing:
  - Commence CPR
- If they are breathing:
  - Treat for shock
  - Treat the burns as heat burns
  - Maintain body temperature
  - Keep the casualty quiet and laying down

FIRST AID

9. HEART ATTACK

Chest symptoms:

- Uncomfortable pressure.
- Crushing pains.
- Fullness or tightness.

NOTE: Pain can be at the centre of the chest behind the breast bone and may spread to either shoulder, neck, lower jaw or either arm.

Other symptoms may include:

- Sweating, nausea, shortness of breath and/or weakness.
- Discomfort will usually last longer than two minutes. Pain may come and go at intervals.

Expect a denial from the casualty:

- Examples: "It's indigestion", "I'm too healthy", and "It can't happen to me".

If the casualty is conscious:

- Have the casualty rest - quietly and calmly. Allow the casualty to assume a position that provides the most comfort and ease of breathing.
- Ask if the casualty is taking any medication.
  - If YES: assist in administering medicine according to the casualty's instructions.
  - If NO: keep the casualty quiet and calm.
- Call for medical assistance.
- Be prepared to administer CPR if required.

If the casualty is unconscious:

- Check for a pulse.
- If there is NO pulse, commence CPR.
- If there is a pulse, then keep the casualty under observation and maintain the airway as required.
- Call for medical assistance.

10. THERMAL STRESS

Heat Cramps

- **Symptoms:**
- Painful spasms. These can be in fingers, large leg muscles, and the abdominal wall or in all of them.
- Heavy sweating, cold and clammy skin.
- Intermittent cramps.
- **Treatment:**
- Apply firm pressure (no kneading) to cramped muscle.
- Applying warm/wet towels also gives relief.
- Do not give large quantities of water, instead, give half a glass of water at 15 minute intervals, as tolerated by the casualty.

Heat Exhaustion

- **Symptoms:**
- Profuse sweating, weakness, dizziness, sometimes cramps.
- The skin is cold and pale, clammy with sweat.
- The pulse is rapid and weak.
- Body temperature is normal or below normal.
- Vomiting may occur.
- **Treatment:**
- Quickly move the casualty to a cooler place.
- Turn the casualty on their side if vomiting occurs.
- Make the casualty rest.
- If conscious, give half a glass of water at 15 minute intervals, as tolerated by the casualty.
- Provide additional fluids after the rest period.
- If untreated, exhaustion may lead to heat stroke.

FIRST AID

11. HEAT STROKE

- **Symptoms:**
- Weakness, dizziness, nausea, cramps.
- Although sweating stops, clothes are sweat soaked.
- The skin is hot and dry.
- High body temperature.
- Rapid and strong pulse.
- Armpit and groin areas are dry.
- **Treatment:**
- Loosen or remove clothing.
- Move the casualty to a cooler place and make every effort to lower body temperature.
- Wrap the casualty in cool wet sheets if possible.
- Make the casualty rest.

12. SHOCK

- **Signs and symptoms:**
- Pale, clammy skin, sweating, chills.
- Weakness, faintness, drowsiness, confusion.
- Weak rapid pulse (over 100 beats per minute).
- Short, rapid and shallow breathing.
- Nausea.
- Unconsciousness.
- **Treatment:**
- If the casualty is not breathing, commence CPR.
- Elevate the casualty's feet by 300mm.
- Keep the casualty warm and lying flat.

- Stop any severe bleeding with direct hand pressure.
- Do not move the casualty unless there is no alternative.
- Do not give the casualty any alcoholic beverages.

13. SPRAINS

A sprain occurs when a joint is forced beyond its normal range of movement, stretching or tearing the ligaments that support the bones in the joint. Symptoms may include:

- Pain, which may be quite intense and increase if the joint is moved.
- Swelling (normal joint contours are altered when compared with the opposite limb).
- Bruising.

Management of sprains:

- Rest - the injured limb.
- Ice - apply cold packs to the affected area.
- Compression - apply a firm bandage to the injured joint.
- Elevate - the injured part.

14. STRAINS

A strain is the result of overstretching a muscle or tendon. Symptoms may include:

- Pain in the region, usually sharp and of sudden onset.
- Loss of power and additional pain on movement.
- Tenderness over the muscle.

Management of strains:

- Control any bleeding within the tissue by applying a cold pack over the injured area.
- Advise the casualty not to over-stretch the muscle any further.
- Support the injured muscle with a pressure bandage.
- Encourage gentle exercise to reduce painful spasm.

TERMINAL STATIONS & ZONE SUBSTATIONS SECTION 15

1. GENERAL

Terminal Stations in Victoria are owned by the Transmission Company and serve the primary purpose of converting incoming transmission voltages to voltages suitable for distribution networks.

Zone Substations in Victoria are owned by the electricity distribution companies and are used to transform sub-transmission voltages to high voltage distribution voltages and to act as controlling points between differing high voltage networks.

2. ENTRY

Terminal & Zone substations are classified as HV Enclosures, therefore un-supervised access can only be gained by those persons authorised by the relevant asset owner. (See *Green Book* definitions).

Entry to stations is available to non-authorised persons where they are under the supervision of an authorised person.

When entering and/or working in a Terminal or Zone Substation, employees shall:

- Wear Personal Protective Equipment as provided.
- Notify the Control Room as to the reason for being there and the planned length of stay.
- Familiarise themselves with the status of equipment and the surrounding area, noting those parts which are energised, establish the location and placement of barriers and signs defining the limits of the working space(s), and observe which switches or breakers disconnect the equipment from the source of supply.
- Ensure all Terminal and Zone Substation and switchyard gates are kept locked or barricaded to prevent public entrance when work is being performed inside the substation.
- Ensure unauthorised persons do not enter substations or switchyards.
- In switchyards and switch rooms, erect temporary barricades and/or signage between the equipment being worked upon and the nearest energised equipment.

3. PERSONAL PROTECTIVE EQUIPMENT

The Green Book outlines the PPE requirements for entry to stations in Section 3.

General PPE requirements

1. Working on, near or in the vicinity electrical apparatus:
   - Headwear
   - Natural fibre clothing from wrist to ankle
   - Fully enclosed footwear

2. Operating electrical apparatus
   - Headwear
   - Natural fibre clothing from wrist to ankle
   - Fully enclosed footwear
   - Hand protection
   - Face/eye protection

3. Visits to a work site with no involvement in any work at that site and movements confined to normal access ways:
   - Headwear
   - Jacket or dustcoat
   - Leg covering to ankle length
   - Fully enclosed footwear

4. TERMINAL AND ZONE SUBSTATION SINGLE LINE DIAGRAMS

Terminal stations and Zone substations are drawn schematically. Schematic drawings represent the elements of a system using symbols and generally straight lines. They usually omit all details that are not relevant to the information being portrayed.

For Terminal and Zone substations, these schematic drawings are known as single line diagrams. An example is shown in Figure 1 on the following page

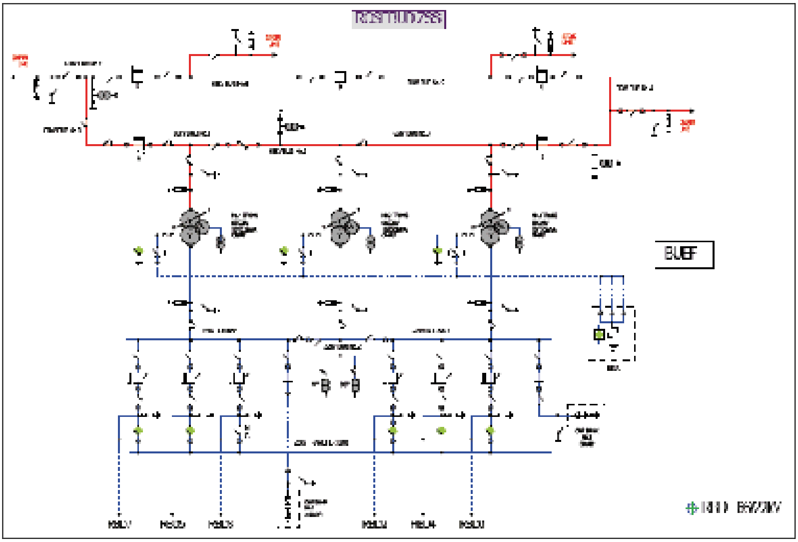


Figure 1

5. EQUIPMENT TYPES

Transformers

A 66/22kV transformer with separate oil cooling arrangement

The transformer is the fundamental part of a Zone or Terminal Station. It transforms the input (primary) to the output (secondary) voltage. In a typical Zone Substation the primary voltage is 66kV from the subtransmission network and the secondary voltage is 22kV for supply to the distribution network. A typical Zone Substation transformer in an urban station is rated at 20/33MVA. The 20 MVA rating applies with natural cooling and the 33MVA rating is achieved using forced cooling which can include oil pumps and fans. A transformer of this type will contain approximately 18,000 litres of transformer oil to facilitate cooling and insulation of the transformer windings and weigh approximately 45 tonne. Transformers are located within bunded areas to prevent environmental damage should an oil spill occur.

Most transformers are also fitted with on-load tap changers to maintain the secondary voltage at a constant level with varying loads on the transformer.

Circuit breakers (CBs)

Circuit breakers are used in Zone and Terminal Substations to control and manage the supply of electricity to and from the station. They are located on both the primary and secondary sides of the transformers. They are used to divide the Zone Substation into discrete protection zones so that if a fault should occur in a particular zone then only that zone will be isolated by the automatic operation of the circuit breakers. These zones may include the 66KV lines, the transformers and the individual distribution feeders. Circuit breakers are designed to carry load currents continuously and interrupt fault currents. Many different technologies have been used over the years in the design of Circuit breakers. Older circuit breakers use transformer oil as the interrupting medium. Today distribution circuit breakers commonly use vacuum interrupters and at high voltages (66kV and above) SF6 gas is the most common technology used in the design of circuit breakers.

A 66kV CB

Modern distribution circuit breakers are commonly installed indoors. Older designs and high voltage circuit breakers are general designed for outdoor installation.

Voltage transformers (VTs)

Voltage transformers (VT's) are used in Terminal and Zone substations to transformer the very high voltages to representative values for use in protection, control and metering systems. For this reason they are known as measurement or instrument transformers. VT's are rated in VA and typically are rated at 100VA in a Zone Substation. The primary voltage may typically be 22,000, 66,000 or 220,000 volts. The secondary or output voltage is typically 110 volts. Voltage transformers can be either magnetic type or capacitive type. They can be oil filled and used outdoors or of cast epoxy design for use in indoor switchboards.

A 66kV VT

Current transformers (CT's)

Current transformers (CT's) are also measurement transformers and are used in Terminal and Zone Substations to transform large load currents and fault currents to representative values for use in protection, control and measurement systems. CT's can be stand-alone units as found in outdoor high voltage switchyards or they can be incorporated in the design of circuit breakers either in switchboards or in outdoor circuit breakers. Typically CT's may have multiple primary ratings or taps such as 1200/900/600/400 ampere. The secondary rating is typically 5 amps and this is used as the input to the protection or metering systems.

Capacitor banks

Capacitor banks are primarily used to correct the power factor in Zone Substations. As most customer loads are inductive the capacitors are used to compensate for these loads and thus achieve a power factor closer to unity. This means better utilisation of the primary plant in the stations can be achieved. Capacitor banks are also used to support voltage in Terminal Stations.

Capacitor banks are often switched on and off according to the time of day or the MVAR load on the station. Modern capacitor banks are comprised of small individual capacitor cans of approximately 300 kVAR each. These are connected together in series and parallel combinations to make capacitor banks of up to 12 MVAR rating in Zone Substations.

A 22kV Capacitor Bank

Substation capacitor banks, cases and support structures shall be considered energised at full potential until Isolated. A minimum delay of five minutes must be observed before earthing. Before individual units are handled they shall be short-circuited between all terminals and the case. If the cases of capacitors are in earthed substation racks, the racks shall be bonded to earth. Any line to which capacitors are connected shall be short-circuited before it is considered safe for access.

Station services transformers

The Station Service Transformer provides the 415/240V supplies at a Terminal Station or a Zone Substation used to power all auxiliary equipment on the station. This includes the light and power to all buildings, the supply to the tap changers on the transformers, the cooling fans and pumps on the transformers and the battery chargers that maintain the DC supplies for the station. In Zone Substations the Station Services Transformer is typically rated at 50 or 100 kVA. They may be pole or platform mounted transformers or kiosk types. In Zone Substations they are often supplied at the distribution voltage from one of the feeder circuit breakers or directly from a distribution bus.

A 22kV Station Service Transformer

Neutral Earth Resistors (NERs)

NER's are used in Zone Substations to limit the magnitude of any fault currents that may flow should an earth fault occur on the distribution network. They are connected between the transformer neutral/s and earth on the secondary side of Zone Substation transformers. NER's improve supply quality and network safety. A NER for a 22kV network will typically have a resistance of 8 ohms and be rated at 1500 ampere.

A 22kV Neutral Earth Resistor

Isolators

Isolators are used to isolate sections of the network or individual items of plant such as circuit breakers. An isolator provides a physical break in a circuit that is appropriate for the operating voltage. Isolators are not rated for interruption of load current; they are able to de-energise plant. Isolators are rated to carry fault current and specified in ampere.

66kV Duoroll

Isolators can be gang operated three phase or single phase units. Gang operated isolators can be operated from an operating handle. Single-phase isolators are normally stick operated (insulated operating stick).

22kV Single phase isolator

66kV ganged rotary isolator

Earth switches

66kV Earth Switch

Earth switches or earthing facilities are normally installed in conjunction with isolators. They are used to apply earths to plant in preparation for the issue of Electrical Access Permits. Earth switches are generally gang operated via an operating handle. They are incorporated in modern distribution switchboards and in these circumstances they are fully fault rated.

Batteries

All protection, control and communications equipment is powered using DC supplies. All Terminal Stations and Zone Substations use DC supplies for all critical functions. This ensures the safe operation of all equipment even under abnormal conditions including complete loss of all AC supply. Batteries are arranged in banks to deliver a range of different control voltages. These include 24volt, 50 volt, 110 volt and 240 volt DC. Battery condition is monitored constantly to ensure the safe operation of the stations.

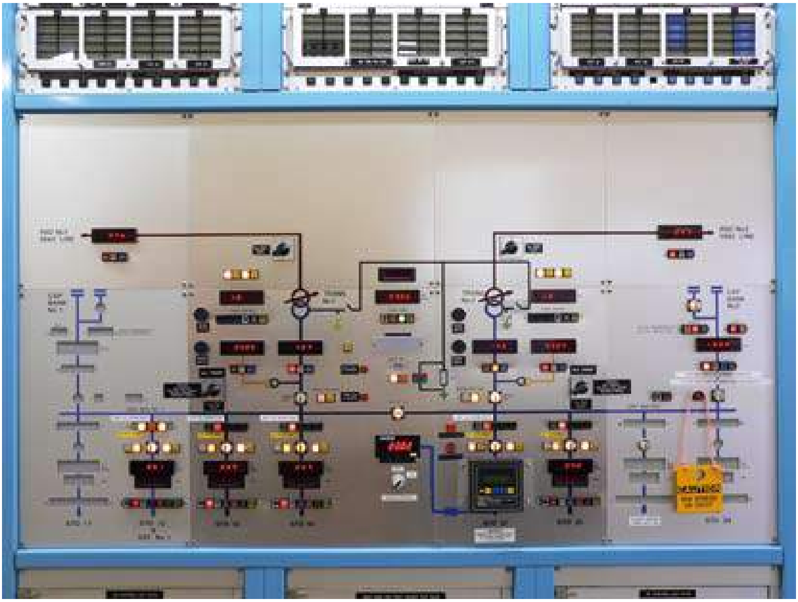
When working with or on batteries, employees shall:

- Be suitably trained.
- Wear appropriate personal protective clothing (eg, goggles/face shield, chemical resistant overalls or splash apron and chemical resistant gloves).
- Avoid the use of non-insulated tools in the immediate area.

- Remove contaminated clothing and wash the skin with water immediately, should electrolyte be spilled.
- NOT smoke or use naked flames.
- Use ventilation where provided.

Control/protection panels

Control panels are used to mount protection, control and communications equipment. In modern substations this is generally done using rack mounting type panels. In older substations the equipment was mounted on a variety of panel types.



6. PROTECTION SYSTEMS

Protection equipment is necessary to detect and isolate faults from the system. Protection relays detect faults by comparing the quantity (and angles in some cases) of the primary circuit current or voltage to a pre-determined setting. This comparison is done electromechanically for induction-type relays and digitally or electronically for digital or static relays.

If a fault is detected, the relay will issue a command to trip the circuit breaker after a predetermined time setting. Measurement of the primary circuit uses instrument transformers (ie CT's and VT's) to allow indirect, safer and more manageable connections to high voltage and/or high current equipment.

The main protection functions for distribution and subtransmission circuits are:

Overcurrent

The relay starts to operate (pick up) when current magnitude exceeds the preset current setting. Overcurrent can be detected in phase conductors, neutral conductors and/or the earth return path:

- Phase-overcurrent or "overcurrent" protection is where current in a phase conductor is measured.
- Ground-overcurrent or "earth fault" protection is used to detect earth faults whereby:
  (a) the current in a specific neutral or earth conductor is measured and/or
  (b) the residual current of the phase conductors of a 3 phase system is measured. This is achieved by measuring the "summed" current of the parallel connection of all phase CT's, or is calculated within the relay itself, (applicable only to digital relays).

The residual current in a typical distribution HV network is zero during normal conditions, even with extreme load unbalance. This is due to distribution transformer primary winding and earthing configuration. Sensitive settings can therefore be applied to earth fault relay, typically, a setting of 10>20% of the nominal CT secondary current is used. It is possible for a residually connected relay to operate when a high-resistance joints is present in one phase of a multiple parallel circuit

Overcurrent relays invariable contain in-built timers to enable time-graded coordination with other related relays. An inverse-time characteristic provides a time delay that is inversely proportional to the current detected, (ie the higher the current, the shorter the operating time).

Ground-overcurrent (earth fault) relays often use a definite-time characteristic only, as the earth fault current magnitude does not vary so greatly between two relaying points on a given network.

Directional overcurrent

Same as previous, with the addition that the direction of a fault can be known by comparison of the primary circuit voltage and current. Directional overcurrent is widely used in protection of ring or parallel feeders, where fault current can flow in either direction depending on the location of the fault and supply source. Directional relays that look back directly into a source can be set sensitively, as current flowing in this direction will be abnormal, and thus considered a fault.

Differential protection

Compares the current entering the protected circuit (or zone) to the current leaving the zone. A zone is bounded by measuring CT's at the terminals of the protected circuit. Where the terminals are some appreciable distance apart, then a communications channel or pilot wire is required between ends for differential comparison, logic and inter-tripping facilities. There are many various patented techniques available to perform differential comparison and intertripping.

As differential protection only operates for faults within a zone of protection, there is no requirement to consider the operation times of protection outside the zone; instantaneous operation is therefore often applied to differential protection.

Distance protection

Distance relaying principles are based in impedance measurement and so require the values of primary circuit voltage and current for any instant time. The impedance of any given circuit is a fixed quality; if the impedance measured by the relay has decreased to some value below a predetermined setting, then a fault is assumed on the circuit and tripping can be initiated.

NOTE – On overhead line HV systems, many faults, particularly earth faults may be transient ones, hence earth fault and overcurrent protection systems may be associated with auto reclose relays. These relays automatically re-close the circuit breakers after a short pre-determined time and these usually lock out after a set number of unsuccessful attempts.

For HV Live Line work, auto-reclose shall be suppressed, or Live Line Sequence (LLS) enabled. LLS gives instantaneous trip and sensitive earth fault protection.

7. COMMUNICATION SYSTEMS

Remote control and indications of substations and field equipment are vital in ensuring safe, efficient and effective operation of an electrical distribution network. This was the primary objective for the development of SCADA systems, (Supervisory Control And Data Acquisition). As the name implies, the SCADA systems main functions are to provide remote control of remote devices and to return the status, alarm and system operating data from remote devices. Remote control is generally required from one or more strategically located control centres. The main control point is often known as the Network Control Centre, (NCC).

The SCADA master station which generally resides at the NCC, communicates to Remote Terminal Units (RTU's) located at substations and on field equipment such as pole mount Auto-Reclosers. The SCADA master interrogates the RTU's over a communications network. The medium for the communications networks can take many different forms; the most widely used are radio, pilot or supervisory wire and fibre-optic.

The substation RTU is generally equipped with digital and analogue Input/Output (I/O) to interface with substation devices. The main function of digital I/O is to provide for the display of the operating status of field equipment (eg indicating a breaker in either the open or closed position) and for operational control of field equipment (eg operating to open or close a breaker). Analogue I/O is generally used to provide for the display of real-time values of the electrical quantities seen by a particular device, (eg the load current through a breaker, or the voltage on a busbar).

Control centre communications can also be achieved with Intelligent Electronic Devices (IED's) such as digital relays via serial communications linked to the RTU or to the SCADA master itself. The main benefit of this is that event data, indication and control points available within the IED can be accessed remotely via SCADA.

8. EARTH GRIDS

The earth grids installed in Terminal Stations and Zone Substations serve the following purposes:

As a Voltage Reference Point for the Network Supplied

The secondary windings of the transformers in Terminal Stations and Zone Substations are connected to the earth grid so that the voltages on the network are maintained at the specified values with respect to earth. That is the distribution network voltage (e.g. 22kV) is held constant by the connection to the earth grid.

For the Management of Fault Current

The earth grid in Terminal Stations and Zone Substations is designed to facilitate the return of earth fault current from faults on the network it supplies to the source of the fault current, the Zone Substation transformer. This then ensures that enough fault current flows to operate protective devices such as fuses and circuit breakers. Any earth fault on a distribution feeder, such as a possum strike on a concrete high voltage pole, results in fault current flowing into the pole and the ground and then returning to the zone substation transformer via the earth grid at the Zone Substation. Consequently the earth grid has to be designed and built to carry the large currents that may be associated with network earth faults. Earth conductor sizes and the integrity of all connections are critical to the safe operation of the earth grid. All plant within a substation such as transformers, circuit breakers, surge diverters and bus support structures etc. are all bonded to the earth grid in the station so that in the event of a failure the fault current can be safely managed.

Safety

The earth grid in Terminal Stations and Zone Substations also ensures the safety of all people working in the substation by limiting the step and touch voltages that can occur under fault conditions. When fault current flows into and earth grid dangerous voltage rises can occur on the earth grid. The design of the earth grid is intended to manage these voltage rises, should they occur, so that people within and outside the substation are not exposed to dangerous voltages.

Work on earth grids

Special precautions must be taken when working on in service earth grids to prevent exposure to hazardous voltages should a network earth fault occur at the time the works are being undertaken. These precautions may include the use of bonders and insulating gloves.

Station earths

Earthing receptacles and facilities are provided in Zone Substation to permit the effecting bonding to earth of plant and lines using portable earthing equipment. This then permits the safe issue of Electrical Access Permits for the maintenance of this substation equipment by ensuring that the equipment remains at earth potential.

9. MOBILE PLANT & EXCAVATING WITHIN STATIONS

A person shall not perform work in any station or allow mobile plant to enter any station without first obtaining the permission of the person in charge of the station and, accepting all the conditions imposed by that person.

An Access Authority shall be issued in a Terminal and Zone Substation where:

- Mobile plant or other large vehicles will be used.
- The work involves excavation or the use of explosives.
- Where Ordinary Persons are involved.

Mobile plant when in the travelling mode within Zone substations or Terminal stations shall have a trailing earth lowered. When in a stationary working mode the mobile plant shall be connected to the station earth grid.

The work party shall ensure that work does not require the earthed portions of the mobile plant to move outside the perimeter of the station earth grid;

Before starting an excavation in any energised station, the crew leader shall obtain all available information on existing subsurface structures such as power and control cables, pipes, ground wires, etc. Work in the vicinity of all such assets shall be done with great care. The crew leader in conjunction with the operating authority shall designate the limits of the excavation and the employees shall keep within these limits.

Any accidental opening in the earthing system shall be repaired using high voltage rubber gloves or by bridging out the opening. Caution must be observed, as this is possibly an energised open circuit. If a section of the substation fence is extended or removed, earthing and bonding continuity shall be maintained at all times.

10. ELECTRICAL TESTING AND TEST FACILITIES

NOTE: This section applies to fixed and temporary test sites using high voltage and/or high power, but does not include routine work such as phasing or checking for voltage on a de-energised line.

When carrying out electrical testing involving secondary Isolations in a Zone Substation, employees shall:

- Be trained and authorised.
- Protect the test areas using appropriate barriers with danger signs attached.
- Ensure test trailers and vehicles are earthed, and employees are protected against step and touch potential with bonding, insulation or isolation techniques.

11. GAS INSULATED EQUIPMENT

Employees shall wear company approved protective clothing to avoid skin contact with powder residue that may be found inside the SF6 gas containment system.

Manufacturer's cautions shall be followed when performing maintenance on breakers or buses. This includes product bulletins, safety bulletins, and manufacturer's warnings.

When working on SF6 equipment, special precautions should be taken not to breathe the SF6 gas or its by-product.

Employees shall use a regulator, gauge, and hose for proper PSI rating when filling or adding SF6 gas.

12. ZONE SUBSTATION SWITCHING

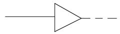
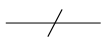
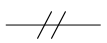
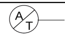
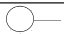
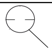
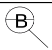
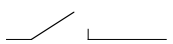
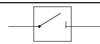
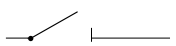
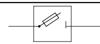
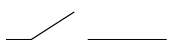
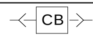
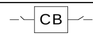
Before switching is performed in a substation where work is in progress, the employee performing the switching shall notify all personnel working within the substation.

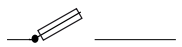
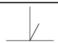
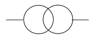
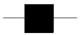
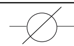
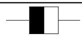
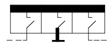
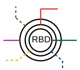
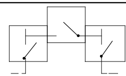
All other personnel shall be clear of the work area during the time any circuit breaker is being racked in or out. The circuit breaker shall be in the open position and the control circuit rendered inoperative by activating the operator safety switch, if the design so permits.

The application of earthing devices to isolated contacts within the spouts of metal-clad switchgear shall be supervised by an Authorised Person.

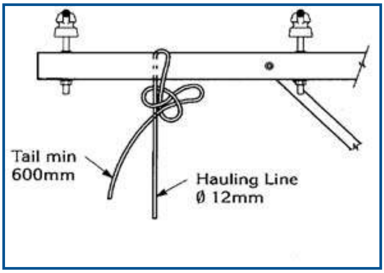
Any employee who has carried out switching or maintenance in a Zone Substation shall record the details of their work in the Substation logbook.

13. SYMBOLS AND DEFINITIONS

	Lines crossing & connected together		Cable head
	Lines crossing but not connected together		Fused transformer
	SWER overhead conductors		Unfused transformer (thinner stem)
	Single phase overhead conductors		Auto transformer
	Open point		Two pole type transformer
	Open bridges		Indoor type substation
	Bay break		Ground type substation
	Mid-span break		SWER Isolating
	Single operated arc switch		SF6 Gas switch
	Gang operated arc chute FB switch		SF6 Gas switch with fuses on same pole
	Single operated isolator		Circuit breaker – Indoor type
	Rotary arc chute switch		Circuit breaker – Outdoor type

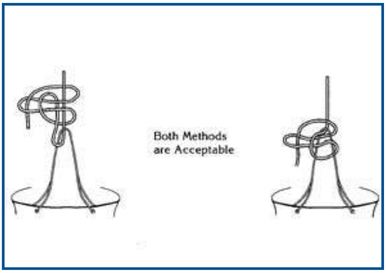
	Rotary isolators	AS	Automatic sectionaliser
	Gang operated arc chute fuse combination	AR	Automatic circuit recloser
	Single operated fused isolator		On load tap changing transformer
	Live line clamp (shown at 30° to line it controls)		Transformer
	Over current fault indicator - Manual		Line voltage regulator
	Over current fault indicator – Automatic		Capacitor
	Over current fault indicator – Electronic		Kiosk substation with transformer switch & switched 'through feed'
	Zone substation distribution feeder buses		Bus tie switch
EL	Earth leakage	BUEL	Back up earth leakage
MEL	Master earth leakage	GTH	Gas thermal
BA	Boric Acid	EDO	Expulsion drop-out
PFF	Powder filled fuse	O.O.S	Out of service
WP	Water pump	AB	Air break
HD	Horn deflector	FB	Flicker blade

KNOTS AND HITCHES



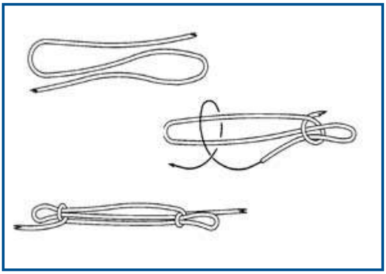
Quick Release Knot

Used as a safety handline in case of an emergency in Pole Top Rescue (PTR).



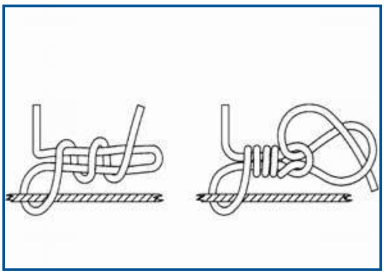
Pole Bag Quick Release Knot

Used to secure a pole bag when it is being raised or lowered from pole or cross-arm.



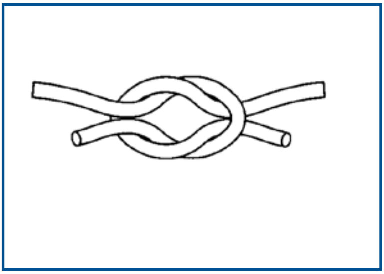
Sheep Shank

This knot is used for securing loads on trailers and vehicles. It may also be used to shorten a section of rope.



Cable Stringing Knot

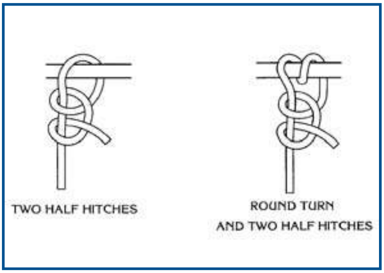
Used to secure a conductor when it is being raised or lowered from a cross-arm.



Reef Knot

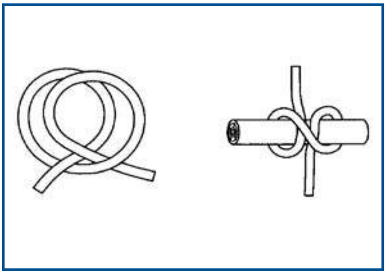
Used for tying lashing to a cross-arm being erected and for tying the lashing around the handline or tackle being used to raise a cross-arm.

Used for tying bandages.



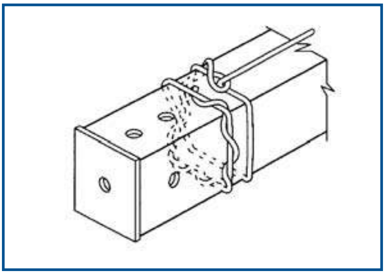
Two Half Hitches

Used in PTR to secure the dead end of the hauling line to an anchor point, after having passed it through the waist section of the harness.



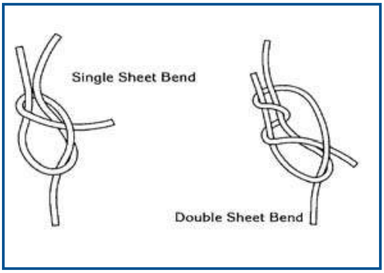
Clove Hitch

Used to commence rope lashings. For all other purposes it must be secured with half hitches.



Round Turn and Timber Hitch

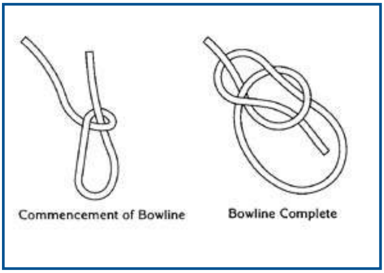
Used when raising and lowering cross-arms.



Single / Double Sheet Bend

Used to join rope together, and for making endless handlines.

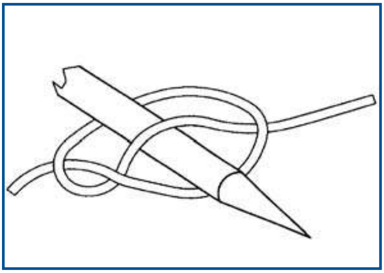
It is safer when the double sheet bend is used, particularly when rope sizes differ.



Bowline

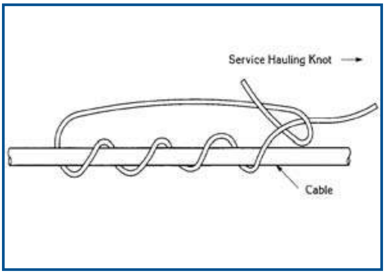
Used to make a loop in a rope, to enable tackles and other lifting or straining devices to be attached.

Used extensively during pole erection and live line.



Lever Hitch

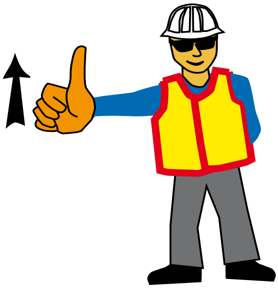
Used to raise and lower mats, preformed tubing, tools and equipment. The greater the weight, the tighter it grips (provided it is not tied upside down).



Service Hauling Knot

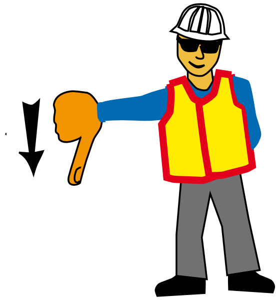
Used to raise, lower and strain cable.

CRANE SIGNALS



BOOM UP

● ● ●



BOOM DOWN

● ● ● ●

BOOM OUT

▬ ● ● ●

BOOM IN

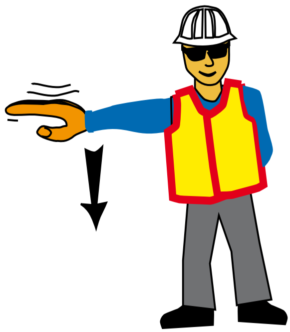
▬ ● ● ● ●

more over page

SWING

STOP

HOIST RAISE



HOIST LOWER

RIGGING

RIGGING

1. INTRODUCTION

This Section covers the safe use and care of chain lifting slings, wire role slings, synthetic flat we slings, synthetic round endless slings and associated tackle used for taking loads. For information regarding conductor load calculations see Section 4

2. NATURAL FIBRE ROPES

Although natural fibre ropes are frequently called "hemp" ropes, they are made from manila and/or sisal fibres. First grade rope is made with manila fibre, second grade with a blend of manila/sisal and third grade with sisal only. A sisal rope is whiter and does not have the gloss and smoothness of a manila rope as sisal fibres are stiffer and tend to split. Manila and sisal each have approximately the same mass for equal lengths of rope.

The most common type of natural fibre rope consists of three strands twisted together and this construction is known as plain or hawser laid.

Manila fibre rope

Sisal fibre rope

3. SYNTHETIC FIBRE ROPES

Most ropes used in the Electricity Supply Industry are now made from synthetic fibres. Synthetic ropes generally have greater strength, flexibility and resistance to abrasion with less weight. As they do not absorb water, they handle better when wet. They have a much higher resistance to mildew, rot and chemical attack and deteriorate less due to heat, cold water, age and general exposure.

Their main disadvantage is a smoother, more slippery surface which decreases the reliability of knots and splices. Knots in synthetic ropes should be made in the same way as for natural fibre ropes however where possible extra turns should be taken. When splicing synthetic rope, use at least two extra tucks per strand when compared to the same size natural fibre rope.

Polypropylene rope

Synthetic fibre ropes can be spun from long threads (filaments) or made up from shredded fibres similar to natural fibre ropes. Filament types are stronger while the shredded fibre type is cheaper and more akin to natural fibre in feel and appearance.

Safe Working Load (SWL) for Ropes

Generally, the safe working load (SWL) of a rope is determined by squaring the diameter of the rope.

eg: SWL for natural fibre12mm rope is 12 x 12 = 144kg

New specialised high strength ropes may have a greater SWL. Refer to manufacturer's specifications.

4. STEEL WIRE ROPES

The manufacture of the strands in wire rope is in some ways similar to the method of making stranded copper or aluminium conductor.

The steel is drawn into wire sizes, the wires are helically laid into strands and the strands (usually six) are laid over a core to form the finished rope. The main core can either be fibre or steel. A fibre core is impregnated with lubricant prior to the manufacture of the rope. The steel core can be either a steel wire strand or an independent wire rope, the latter being usually made of seven strands each of seven wires, one central strand forming the support for the other six.

A rope of "ordinary lay" has the wires laid in one direction and the strand in the opposite direction. A rope of "Langs lay" has the wires and the strands laid in the same direction. Langs lay rope stands greater frictional wear than ordinary lay rope, owing to the greater surface area of wires exposed to friction by the load. But Langs lay rope should never be used where one end of the rope is free to turn.

Safe Working Load (SWL) for Steel Wire Rope

The working load of a steel wire rope is determined by applying a factor of safety or load factor to the minimum breaking load. As there are many different constructions and types of steel wire rope, it is not possible to give a simple formula for calculating the working SWL. Always refer to the manufacturers specifications for the wire rope.

Flexibility of Steel Wire Rope

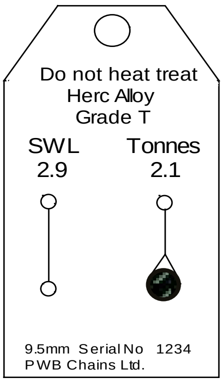
Generally the greater number of wires in a rope, the greater the flexibility. For instance a 6 x 7 rope, (that is a rope made up of 6 strand of 7 wires in each strand), would not have sufficient flexibility for use as a winch rope; however ropes from 6 x 19 up to 6 x 41 could be typically used depending on the application.

5. LIFTING CHAINS

Chain is heavier than steel wire rope of the same lifting capacity but is more durable. It can withstand rougher handling and can be stored without deterioration.

Most chain manufactured today for lifting is Grade (T) short-link lifting chain or 80 alloy steel. It is stamped (T), 80, 800 HA, CM a Polar Bear or various combinations of them.

Each chain sling must have a tag attached showing its manufacturer, grade, SWL, serial №, link size and different applications and uses.



Safe Working Load Chains

The SWL for chains is stamped onto the mandatory tag. Never exceed the manufacturers SWL.

6. SYNTHETIC FIBRE SLINGS

Synthetic slings are made from nylon, polyester, polypropylene or aramid polyamide.

7. SLINGING AND TYPICAL SLING APPLICATIONS

Slings are normally made from natural or synthetic fibre rope, chain, steel wire rope or synthetic webbing. Very few slings actually wear out; the principle abuse, apart from overload is to pass them around too sharp a radius when under load. This can be avoided by packing corners with soft wood or tyres. A wire rope sling that refuses to lie flat has been overstrained or bent around too small a radius.

The most positive and safest connection of a sling to a load is by hooking or shackling direct to eye bolts or specially prepared connections; this is invariably a feature of all transformers, from the smallest to the largest.

Chain Slings

These are for general use, where applications require versatility, flexibility and resistance to abrasion and cutting.

Wire Rope Slings

The use of wire rope slings for lifting provides several advantages over other types of slings. While not as strong as chain, wire rope has good flexibility with minimum weight; this is an advantage, particularly when long and large capacity slings are required for heavy lifts.

Synthetic Flat Web Slings

Synthetic flat web slings offer a number of advantages for rigging purposes. Their relative softness and width create much less tendency to mark or scratch finely machined, highly polished or painted surfaces and have less tendency to crush fragile objects than wire or chain slings. Because of their flexibility, they tend to mould themselves to the shape of the load.

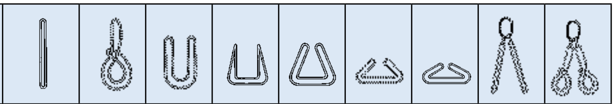
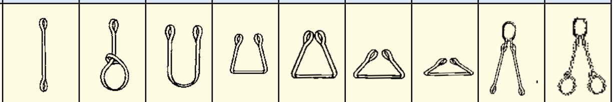
Synthetic Endless Round Slings

Light and extremely easy to handle, they are ideal for difficult loads where surface damage is a concern. Because load contact points can be changed with every lift, wear is evenly distributed prolonging the life of the sling.

Safe Working Load (SWL) for Slings

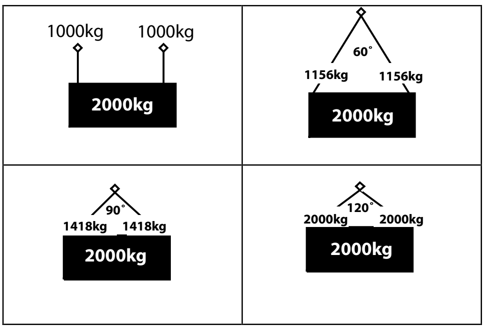
The SWL for slings is established by the manufacturer and must not be exceeded under any circumstances.

Slingtech round and Flat Slings – Working Load Limits

ROUND SLINGS										
FLAT SLINGS										
L = LOAD FACTOR		L = 1.0	L = 0.8	L = 2.0	L = 1.9	L = 1.7	L = 1.4	L = 1.0	L = 1.7	L = 1.38
COLOUR CODE	W.L.L. Tonnes	VERTICAL W.L.L Tonnes	CHOKE S.W.L. Tonnes	BASKET S.W.L. Tonnes	30° S.W.L. Tonnes	60° S.W.L. Tonnes	90° S.W.L. Tonnes	120° S.W.L. Tonnes	60° S.W.L. Tonnes	60° CHOKE S.W.L. Tonnes
VIOLET	1.0	1.0	0.8	2.0	1.9	1.7	1.4	1.0	1.7	1.3
GREEN	2.0	2.0	1.6	4.0	3.8	3.4	2.8	2.0	3.4	2.7
YELLOW	3.0	3.0	2.4	6.0	5.7	5.1	4.2	3.0	5.1	4.1
GREY	4.0	4.0	3.2	8.0	7.6	6.9	5.6	4.0	6.9	5.5
RED	5.0	5.0	4.0	10.0	9.5	8.6	7.0	5.0	8.6	6.9
BROWN	6.0	6.0	4.8	12.0	11.4	10.3	8.4	6.0	10.3	8.2
BLUE	8.0	8.0	6.4	16.0	15.2	13.8	11.2	8.0	13.8	11.0
ORANGE	10.0	10.0	8.0	20.0	19.0	17.3	14.1	10.0	17.3	13.8

8. LIFTING OF EQUIPMENT

Sling Angles



If a load is lifted by a pair of equal length sling legs inclined to each other, there is an increasing load in each of the sling legs as the angle between them increases. It is vital that this is understood and that the necessary allowance is always made to the SWL of each sling.

For example, if a load weights 2000kg the weight carried by two vertical slings of the same length is equal, ie 1000kg on each leg.

However, if the same load is lifted with the slings not vertical but at an angle to the load, the load in each sling increases as the angle between the slings increases:

a) At 120° the load on each sling doubles;

b) At 140° the load on each sling trebles.

These load increases are described as the loading factor and demonstrate how critical sling angles are. The loading factors for common sling angles are as follows:

Angle	30°	45°	60°	90°	120°
Loading factor	1.93	1.85	1.73	1.41	1.0

To establish the load on a sling leg, divide the weight of the load by the loading factor for that particular angle, eg:

a) Load weight = 3500kg, sling angle is 60°

3500 ÷ 1.73 = 2023kg on each sling leg

b) Load weight = 7300kg, sling angle is 45°

7300 ÷ 1.85 = 3946kg on each sling leg

Use of Spreaders

When lifting a load which is fitted with lifting lugs, it is essential that care be taken that the lugs are not bent inwards by the pull of the sling. To prevent this, a "spreader" can be fitted between the two legs of the sling so that the direction of the pull of the sling on the lugs is vertical and not sideways. When using a spreader it is important that it is fitted as close as possible to the lugs so that the angle between the legs is as small as possible.

9. ROPE TACKLES

A tackle (or block and tackle) is a system of two or more pulleys with a rope or cable threaded between them, usually used to lift or pull heavy loads; they are however also commonly used as a temporary stay during construction work.

To determine the mechanical advantage of a set of tackle blocks, the number of rope parts coming from the moving (running) block is counted.

3:1 6:1

Like all machines, blocks are not 100% efficient due to the effects of friction and this needs to be accounted for when determining the overall mechanical advantage and SWL of the block and tackle. For practical purposes, the sheave friction losses on well maintained sheaves are approximately 10% of the load to be lifted for each sheave.

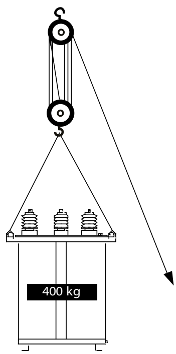
Example

To use a set of three sheave blocks to raise a 400kg transformer how much weight must be applied to the fall of line to begin the move?

Weight of transformer	400kg
Friction loss (6 x 10% of 400kg)	240kg
Total weight	640kg

Mechanical advantage of blocks 6:1

Pull on fall line 640 ÷ 6 = 107kg



APPENDICES

10. CARE AND HANDLING OF RIGGING EQUIPMENT

General

Care and maintenance:

a) Storage should be under and off the ground, in a cool, dry building where temperatures are reasonably constant to avoid condensation. The rope and its wrappings should not touch the floor. The rope should be clear of dust, acid fumes, salt and other corrosive factors;

b) The care and preservation of synthetic ropes is very much the same as for natural fibre ropes except it is not recommended to scrub synthetic ropes to free them from mud and dirt. Hang the ropes up to dry thoroughly and then work the fibres to allow the dirt to fall out;

c) When under load, ropes in use must not rub together or cross sharp edges or corners; falling objects can cur and bruise them internally as well as externally;

d) Ropes must not be subjected to shock loading; loads should be applied gently and braking equally gently. Shock loading not only damages ropes, it can hazardous to people nearby;

e) Every sling and rope should be thoroughly examined at regular intervals by a competent person and such examination should also be made at any time there is doubt about the condition.

Safety Points:

a) Never handle running ropes;

b) Use leather gloves when handling wire ropes;

c) Use a few recognised knots rather than large numbers of uncertain knots;

d) Too high a safety factor for steel ropes is unadvisable because of the heavier sheaves, drums etc required.

Natural and Synthetic Fibre Ropes

a) Never use metal clamps or splices on fibre ropes that are under load; such devices will damage the rope and can also be extremely dangerous if the rope breaks;

b) When using synthetic rope for winch work around a capstan, take extra turns round the drum to counteract slipping; on no account let synthetic ropes surge off the drum or the resultant heat will melt and weaken the rope;

c) New fibre ropes are usually supplied in coils wrapped in hessian or other suitable material. To uncoil the rope, lay the coil on end with the inner end on top; cut the holding bands of the coil but do not remove the hessian or cover, as they help to hold the coil in shape; uncoil the inner end of the rope upwards from the coil in an anti-clockwise direction.

Steel Wire Rope

Wire rope can deteriorate due to many factors including; abrasion, corrosion, stretching or mechanical damage. When inspecting check the construction of the rope, for signs of stretching and damage and broken wires.

When wire rope is manufactured it is filled with lubricant to minimise frictional wear and to keep moisture out. Therefore wire ropes should never be exposed to heat which will melt the lubricant.

Points to remember:

- Never overload
- Do not shock load
- Protect the rope from sharp corners
- Avoid dragging the rope from under loads
- Don’t roll loads with wire ropes
- Don’t store ropes in wet areas
- Keep wire ropes lubricated

Annual Inspection and Colour Codes

- All lifting tackle, i.e. slings, pulleys, chains hoists etc, shall be subject to annual inspection.
- Where the equipment passes inspection it shall be colour coded for the year of inspection per TABLE 1.
- Where equipment fails inspection it shall be immediately removed from service.
- Where tackle is found to be out of inspection date, or where tackle is not in use and not inspected it shall be clearly identified as such and shall not be used.

TABLE 1

BLUE	GREEN	WHITE	BRONZE
2000	2001	2002	2003
2004	2005	2006	2007
2008	2009	2010	2011
2012	2013	2014	2015
2016	2017	2018	2019
2020	2021	2022	2023

Rope Tackles

a) Keep as clean and dry as possible;

b) Keep sheave bearings lubricated with appropriate grease. Do not use oil;

c) When not in use, blocks should be hung up in the truck or store room;

d) Do not leave blocks where heavy material can be placed on them, which may damage the blocks or rope;

e) Do not drag block on the ground as dirt may get in around the sheave bearing or other moving parts.

The block components should be inspected periodically for the following defects:

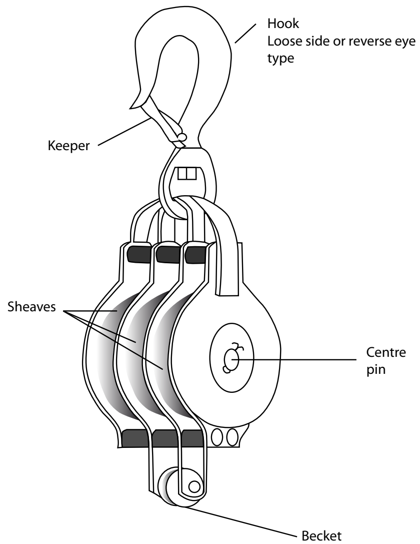
Hook Broken, bent out of shape, safety catch in working order.

Shell Broken, bent out of shape, sharp edges that will damage the rope.

Sheaves Broken, sharp edges that will damage the rope, worn bearings, sheave not turning freely in the shell.

Centre Pin Cotter key or split pin missing or excessive movement due to wear.

Becket Out of shape or worn condition of bolt or pin and thimble for the rope.



11. ERECTING ELECTRICAL EQUIPMENT

General

A common task in line construction and maintenance activities is the erection of electrical equipment such as transformers, capacitor banks, and gas switches etc.

When such equipment is being installed manually or by mechanical equipment, care shall be exercised to prevent personnel, the object or lifting equipment infringing the Safe Approach Distances.

For mechanical handling where there is a risk of infringing the Safe Approach Distances to electrical conductors, the movement of loads shall be controlled by means of non-conducting ropes or other approved means. No person shall contact the load, mobile plant or any attached conducting objects.

Lifting devices used as pole mounted lifting equipment, e.g. rope tackles and handlines shall be attached to pole structures by lineworkers or other suitably trained personnel.

For these tasks, suitable work methods and an appropriate number of persons shall be used to maintain Safe Approach Distances and these controls shall be recorded in the risk assessment completed by the work party.

Control measures to be considered within a risk assessment should include:

- Isolating and earthing electrical apparatus.
- Positioning the mobile plant such that the Safe Approach Distance can be maintained in all circumstances.
- The use of Safety Observers and barriers and signs.
- The use of other precautions such as physical restrictions or control devices in conjunction with barriers.
- The suppression of auto-reclose.
- The alteration of protection and control settings.
- De-energising the electrical apparatus.
- The use of non-conductive ropes.

When mobile plant may come near live electrical apparatus, the mobile plant shall be earthed.

When mobile plant is operated from outside the mobile plant, precautions such as the use of equipotential mats shall be taken to protect the operator from hazardous step and touch potentials.

Erecting equipment using a truck mounted winch

Due to environmental conditions or access restrictions, it is common in rural situations for a work party to have to erect equipment by the use of a truck mounted winch.

Figure 1 shows the proper set-up to use an approved truck mounted winch for this task.

- Always remember to maintain Safe Approach Distances
- Secure covers in place on LV conductors before rigging to raise or lower equipment
- Use guide ropes or tackle to guide equipment into place
- Do not attached guide ropes to bushings
- Pad HV & LV bushings to prevent damage when necessary
- Chock wheels of vehicle
- Make initial lift approximately 100mm and check all of the attachments and anchorages and proceed with the lift only after you are satisfied that it can be safely completed.

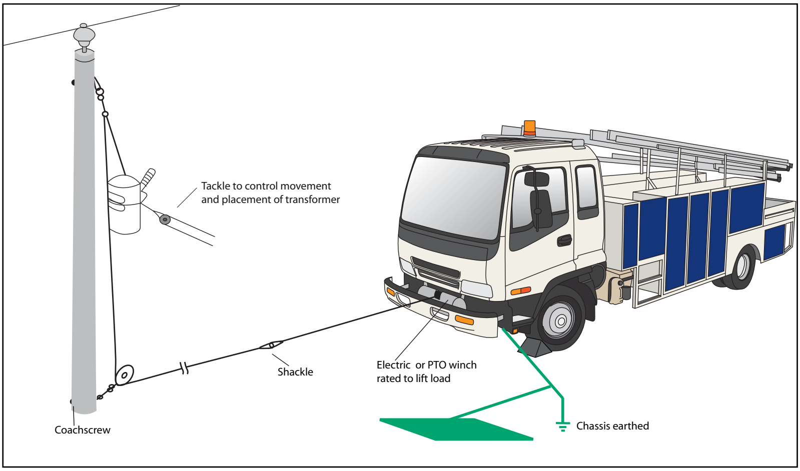


Figure 1. Proper set-up to use an approved truck mounted winch.

TENSION JOINTS

1. COMPRESSION SLEEVE SCHEDULE (HEXAGONAL)

CONDUCTOR		SLEEVE			HEXAGONAL COMPRESSION JOINTS				
							DIE DIMENSIONS		
STRANDING	TYPE	TYPE OR DRAWING No.	O.D.	MIN. LENGTH	AF DIE MARKING	EXTENSION	A.C.	A.F.	L
3/2.75 3/2.75 3/4/2.5	SC/GZ SC/AC ACSR	HELICAL MIDSPAN SPLICES ONLY							
6/1/2.5 7/2.5	ACSR AAC	ALUMINIUM 36R	16.5	350	14.4	5	16.6	14.4	31.8
6/1/3.0 7/3.0	ACSR AAC	ALUMINIUM 44R	20.6	380	17.3	15	19.1	16.6	25.4
6/1/3.75 7/3.75	ACSR AAC	ALUMINIUM 50R	20.6	470	18	10 25	20.6	17.9	25.4
6/4.75 7/1.60 7/4.75	ACSR AAC	ALUMINIUM 61R	25.4	500	22	10 25	25.4	22.0	22.2
19/3.25	AAC	ALUMINIUM 68A	25.4	280	22	15	25.4	22.0	22.2
19/3.75	AAC	ALUMINIUM 80A	30.2	320	26.2	15	30.2	26.2	22.2
19/4.75 #	AAC	ALUMINIUM T1/250/90	39.7	660	30.3	80	38.1	33.7	50.8
37/3.75 •	AAC	ALUMINIUM T1/250/217	50.0	710	43.2	30	51.0	44.2	

\# There are two different sleeves on the market for 19/4.75 AAC. Only use the smaller diameter sleeve requiring the 30.3 A/F die and 12 tonne press.

• 60 tonne hexagonal press required.

FOR FURTHER INFORMATION ON ABBREVIATIONS AND SLEEVE MARKINGS SEE NOTES ON PAGE Apx4 - 4

2. COMPRESSION SLEEVE SCHEDULE (VERSACRIMP)

CONDUCTOR		SLEEVE			VERSACRIMP COMPRESSION JOINTS	
STRANDING	TYPE	TYPE OR DRAWING No.	O.D.	MIN. LENGTH	CRIMPS PER END	EXTENSION
3/2.75 3/2.75 3/4/2.5	SC/GZ SC/AC ACSR	HELICAL MIDSPAN SPLICES ONLY				
6/1/2.5 7/2.5	ACSR AAC	ALUMINIUM 36R	16.5	350	8	35
6/1/3.0 7/3.0	ACSR AAC	ALUMINIUM 50R	20.6	470	11	15
6/1/3.75 7/3.75	ACSR AAC	ALUMINIUM 44R	20.6	470	11	10
6/4.75 7/1.60 7/4.75	ACSR AAC	ALUMINIUM 61R	25.4	500	OVERLAP	10 15
19/3.25	AAC	ALUMINIUM 68A	25.4	280	6	5
19/3.75	AAC	ALUMINIUM 80A	30.2	320	7	10
19/4.75	AAC	**NOTE:** VERSACRIMP **NOT** USED. SEE HEXAGONAL COMPRESSION SLEEVE SCHEDULE ON PAGE 2				
37/3.75	AAC					

FOR FURTHER INFORMATION ON ABBREVIATIONS AND SLEEVE MARKINGS SEE NOTES ON PAGE Apx4 - 4

APPENDICES

3. COMPRESSION SLEEVE NOTES

Abbreviations

AC = Across Corners

AF = Across Flats

L = Length

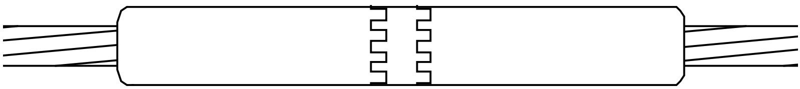
OD = Outside Diameter

4. SLEEVE IDENTIFICATION

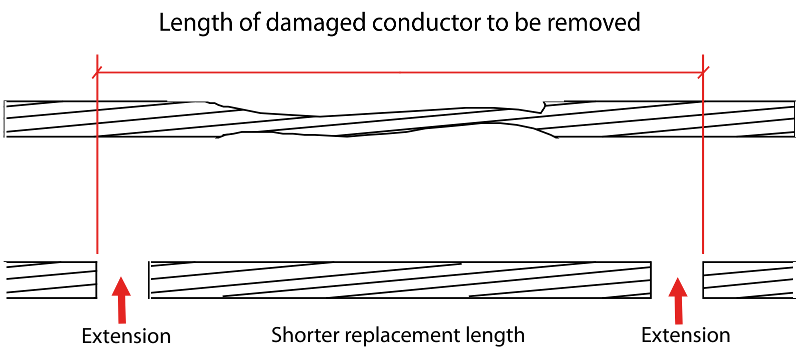
Prefix	–	Manufacturers Identification
Figures	–	Sleeve bore, e.g. 80A has a 0.80" bore
Suffix R	–	Sleeve is suitable for conductors as strong as ACSR
Suffix A	–	Sleeve has only sufficient strength for AAC

Press from centre outwards

Keep the last crimp inside the marked finish line or on the un-tapered portion of the sleeve



NOTE: Compression joints EXTEND during compression.



DEDUCT the scheduled EXTENSION amount shown in the Tables to maintain existing sag after repair is completed.

5. OTHER

- Clean conductors before jointing
- Use jointing compound only when sleeves are not pre-filled
- Hexagonal dies must fully close at each compression
- Inspect, straighten and clean completed joints

DEFINITIONS

For the purpose of this Fieldworkers Handbook, the following definitions shall apply:

1. Access Authority

Any form of authorisation which allows access to, and work upon, electrical apparatus, work in the vicinity of electrical apparatus or plant, and testing of electrical apparatus.

2. Alive (also Energised, Live)

Having a potential difference between conductors, or to earth, or to non-electrical parts.

3. Approved

Equipment, person or procedure, having an Organisation's endorsement for a specified function.

4. Approved Examiner

A person who has the permission of Alinta Asset Management, as appropriate for the duty concerned.

5. Approved Training Course

A course of instruction and assessment by an authorised trainer that meets the requirements of the 'Training Standards of Electrical Safety in the Distribution Businesses' and as approved by the individual organisation.

6. Authorised

A person with technical knowledge or sufficient experience who has the permission in writing of an appropriate officer, or has the delegated authority to act on behalf of an organisation, for the duty concerned.

7. Authorised Applicant

A person tested against an approved training standard, who holds an Authority To Make Application for specified types of work authorities.

8. Authorised Recipient

A person trained against an approved training standard, who has passed a test conducted by an authorised officer, and has signed onto the Authority To Receive Electrical Access Permit.

9. Authorised Tester

A person tested against an approved training standard, who is an Authorised Recipient, and has also been authorised to receive Sanction For Testing.

10. Bonded

Connected together in such a manner as to ensure that all bonded parts are maintained at the same potential.

11. Conductors

Those parts of electrical apparatus normally alive and also the neutral connections of such electrical apparatus.

12. Dead

Isolated and at earth potential.

13. De-energised

Disconnected from all sources of supply, but not necessarily isolated, earthed or out of commission.

14. Discharged

Having been connected to the general mass of earth in such a manner as to remove any residual electrical energy in a conductor or conducting object.

15. Earthed

Connected to the general mass of earth in such a manner to ensure and maintain an effective dissipation of electrical energy.

16. Earthing Device

An approved device used for the earthing of conductors.

17. Electrical Access Permit

A form of authorisation which allows access to, and work upon, electrical apparatus.

18. Electrical Apparatus

Any electrical equipment, including overhead lines and underground cables, the conductors of which are alive or can be made alive.

19. Electrical Operator

A person tested against an approved training standard who has written authorisation to carry out switching operations on high voltage electrical apparatus.

20. Glove and Barrier Work

Glove and Barrier Work is work at high voltage, up to and including 33kV, using established practices in which an Authorised Person is fully insulated from earth and other phases using Approved and tested personal protective equipment and insulating devices.

21. High Voltage Customer

Any consumer of electricity directly connected at high voltage to the transmission or distribution networks.

22. High Voltage Electrical Apparatus

Electrical apparatus which is required to operate at more than 1000 volts alternating current nominal or 1500 volts direct current nominal. This definition shall not include the secondary wiring of instrument transformers or control devices, which may operate on occasions above 1000 volts.

23. Instructed

Persons adequately advised or supervised by Authorised Persons to enable them to avoid the dangers which electricity may cause.

24. Isolated

The state of electrical apparatus when disconnected from all sources of supply by breaks of a length appropriate to the voltage and the insulating medium.

25. Isolator

A device which, for reasons of safety, provides in the open position, breaks of a length appropriate to the voltage and the insulating medium.

26. Limits of Approach

The minimum distances which shall apply to persons, vehicles, mobile plant and elevating work platforms approaching exposed live conductors.

27. Live Line Stick

A stick specifically designed, approved and tested for work on live high voltage electrical apparatus.

28. Live Line Work

All work involving access to high voltage components of electrical apparatus capable of being energised, without implementing the established practice of isolating, proving de-energised, and earthing at the worksite.

29. Low Voltage

All voltages not exceeding 1000 volts alternating current or 1500 volts direct current.

30. Mechanical Plant

Equipment and plant of a non-electrical nature which may be a separate unit or coupled with electrical apparatus. Throughout this Code of Practice, the term 'plant' shall mean 'mechanical plant'.

31. Mobile Plant

Cranes, elevating work platforms, tip trucks or similar plant, any equipment fitted with a jib or boom and any device capable of raising or lowering a load.

Mobile plant can only be considered as a vehicle when in the normal travelling mode and not in the working mode when determining limits of approach.

32. On Site Earth

An approved earthing device which is attached to the structure that a work party is working upon and to electrical apparatus under access permit.

33. Operating Authority

An appropriate representative of an organisation, who is responsible for the control of the high voltage electrical apparatus concerned.

34. Operating Stick

A stick specifically designed, approved and tested for carrying out operations on live electrical apparatus.

35. Operational Earth

An approved earthing device attached by or under the direction of an electrical operator to high voltage or low voltage apparatus.

36. Ordinary (Persons)

Persons having inadequate training or experience to enable them to avoid the dangers which electricity may cause.

37. Recipient

A person who has signed onto an Electrical Access Permit.

38. Recipient in Charge

An Authorised Recipient to whom an Electrical Access Authority has been issued and who is in charge of all Recipients signed onto that authority.

39. Safe Approach Distances

Means the minimum distance that shall be maintained by a person, vehicle or mobile plant (including its load, controlling ropes and any other accessories) when approaching electrical apparatus other than for work in accordance with an access authority.

40. Safety Observer

A person competent for the task they are observing and warning against unsafe approach to electrical apparatus.

41. Sanction for Testing

A form of authorisation to allow energisation of electrical apparatus for testing purposes.

42. Shall

Throughout this manual the word 'shall' is to be interpreted as mandatory.

43. Should

Throughout this manual the word 'should' is used in an advisory or discretionary sense.

44. Station

Any location, in which high voltage supply is generated, converted, controlled or transformed, or in which any similar electrical apparatus or plant is installed.

45. Switch

A device capable of making, carrying and breaking currents under normal circuit conditions. It is also capable, in the open position, of satisfying the isolating requirement for an isolator.

46. Vehicle

A truck (non-tipping), car, utility, or other general purpose conveyance used for the carriage of persons or goods (see also Mobile Plant).

FUSING TABLES

22kV Pole Mounted & Ground Type Substations *(see notes on page 3)*

Trans. kVA	HV Fuse Size			HV Fuse Max. Safe Load (kVA)	Trans. Rated LV Current. (A)	Single LV Circuit (Standard Arrangement)		Multiple LV Circuits (Bus Arrangement)	
	PF	EDO	BA			Max. HRC Fuse Size	Cct. Capacity (% rated current)	Max. HRC Fuse Size	Cct. Capacity (% rated current)
10 - 1 Ø	5	5	-	80	42	50	119%	-	-
15 - 1 Ø	5	5	-	80	62	100	161%	-	-
25 - 1 Ø	5	5	-	80	104	125	120%	-	-
50 - 1 Ø	5	5	-	80	208	250	120%	-	-
25	5	5	--	140	35	100	142%	-	-
50	5	5	-	140	70	100	143%	-	-
100	10	10 #	15 *	285 460	139	250	180%	125	90%
200	10	16	15 *	285 460	278	315	113%	250	90%
300	16	16	15 *	460	417	315	76%	315	76%
500	31.5	25	25 *	900 715	696	400	57%	400	57%
750	40	40	40	1150	1043	500	48%	500	48%
1000	50	63 *	50	1430 1800	1391	630	45%	630	45%
1500	90	63 *	65	1800 2580	2087	630	30%	630	30%
2000	90	-	65	1800 2580	2782	630	23%	630	23%

22kV Pole Mounted & Ground Type Substations. (Cont.)

- HV Fuse sizes are selected to allow for:
  - (a) Transformer transient load/magnetising inrush currents
  - (b) Transformer short time current withstand characteristics
  - (c) 150% cyclic overload, (note for larger kVA ratings the maximum available HV fuse size may limit this criteria)
  - (d) maximum ambient air temperature of 40° C
- In the case of single LV circuits only, LV fuses shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used.
- In the case of multiple LV circuits, LV fuse sizes are generally one fuse size rating lower than that of the standard single circuit LV arrangement.
- The combined fuse rating of multiple circuits should not greatly exceed 150% of the transformer rated current

- 22kV Powder Filled, (PF), fuses have a 13.1 kA fault current interrupting capability
- 22kV Boric Acid, (BA), fuses are all type E (slow), and have a 10kA fault current interrupting capability
- 22kV Expulsion Drop Out, (EDO), fuses are all type K, (quick), and have a 2kA fault current interrupting capability

\# Maximum LV fuse size of 200A to be used with 10A EDO HV fuse.

* Not to be used for new construction

22kV RMU & KIOSK Type Substations (non switchgear specific)

Trans kVA	Trans. Rated HV Current (A)	HV Fuse Size * (A)	Trans. Rated LV Current (A)	Single LV Circuit Details	
				Max. HRC Fuse Size (A)	Circuit Capacity (% rated current)
300	7.9	16	417	315	58%
500	13.1	25	696	400	43%
750	19.7	31.5	1043	400	29%
1000	26.2	40	1391	400	22%
1500	39.4	CB	2087	400	15%
2000	52.5	CB	2782	400	11%

- HV Fuse sizes are selected to allow for:
  - (a) Transformer transient load/magnetising inrush currents
  - (b) Transformer short time current withstand characteristics
  - (c) Allow loading of transformer up to at least 100% of nominal rating
  - (d) 15% fuse de-rating factor to account for additional heating of fuse element due to:
    - i) limited ventilation of enclosed switchgear (+15º C above ambient air temperature), and
    - ii) proximity of fuse element to kiosk transformer (+5º C)
- LV fuse sizes shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used, having regard to the number of circuits. For operational load breaking requirements, the maximum LV fuse size is limited to 400A
- After fuse operation only the faulted or damaged phase(s) shall be replaced.

* All HV fuses are of the powder filled full range DIN type. Circuit breakers are used for transformers above 1000 kVA

22kV RMU & KIOSK Type Substations (Switchgear Specific)

Wilson / Sola Basic Switch Link & Loop Through Pad Mount Switchgear [1]						
Trans kVA	Trans. Rated HV Current (A)	McGraw-Edison Type NX Fuse (A)	Trans. Rated LV Current (A)	Single LV Circuit Details		
				Max. HRC Fuse Size (A)	De-rated Current Carrying Capacity (A)	Circuit Capacity (% rated current)
300	7.9	18	417	400	300	58%
500	13.1	25	696	400	300	43%

[1] For Wilson Pad Mount with Cooper RTE Switchgear see page 6

FUSING TABLES – UNITED ENERGY NETWORK

Wilson Pad Mount with Cooper RTE Switchgear							
Trans kVA	Trans. Rated HV Current (A)	Bayonet Fuse Type Cooper Bay-o-net Fuse Link	Backup Fuse Type Efen 'HH' Current Limiting (A)	Trans. Rated LV Current (A)	Single LV Circuit Details		
					Max. HRC Fuse Size (A)	De-rated Current Carrying Capacity (A)	Circuit Capacity (% rated current)
100	2.6	15	31.5	139	200	150	108
200	5.2	25	31.5	278	400	300	108
315	8.3	25	40	438	400	300	69
500	13.1	40	80	696	400	300	43
750	19.7	40	80	1043	400	300	29
1000	26.2	65	100	1391	400	300	22
1500	39.4	100	160	2087	400	300	15
2000	52.5	100	160	2782	400	300	11

- LV fuse sizes shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used, having regard to the number of circuits. For operational load breaking requirements, the maximum LV fuse size is limited to 400A
- After fuse operation only the faulted or damaged phase(s) shall be replaced.

22kV Indoor Substation using Pole Mounted Switchgear

Trans kVA	Trans. Rated HV Current (A)	HV Fuse Size * (A)	HV Fuse Maximum Safe Load (kVA)	Trans. Rated LV Current (A)	Single LV Circuit Details	
					Max. HRC Fuse Size (A)	Circuit Capacity (% rated current)
300	7.9	16	415	417	315	76%
500	13.1	25	645	696	400	57%
750	19.7	31.5	815	1043	400	38%
1000	26.2	40	1030	1391	400	29%
1500	39.4	63	1625	2087	400	19%
2000	52.5	80	2065	2782	400	14%

- Fuse sizes are selected to allow for:
  - a) Transformer transient load/magnetising inrush currents
  - b) Transformer short time current withstand characteristics
  - c) Allow loading of transformer up to at least 100% of nominal rating
  - (e) 10% fuse de-rating factor to account for additional heating of fuse element due to limited ventilation of enclosed switchgear (+15° C above ambient air temperature)
- LV fuse sizes shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used, having regard to the number of circuits. For operational load breaking requirements, the maximum LV fuse size is limited to 400A
- All HV fuses are PF type. Ratings up to and including 31.5A are of the full range type with a 2 inch barrell diameter. Fuse ratings 40A and above are of the backup type with a 3 inch barrell diameter.
- After fuse operation only the faulted or damaged phase(s) shall be replaced.

11kV Pole Mounted & Ground Type Substations *(see notes on page 9)*

Trans. kVA	HV Fuse Size			HV Fuse Max. Safe Load (kVA)	Trans. Rated LV Current. (A)	Single LV Circuit (Standard Arrangement)		Multiple LV Circuits (Bus Arrangement)	
	PF	EDO	BA			Max. HRC Fuse Size	Cct. Capacity (% rated current)	Max. HRC Fuse Size	Cct. Capacity (% rated current)
200	35.5	25	25	510 360	278	315	113%	250	90%
300	35.5	40	40	510 570	417	400	96%	315	76%
500	56	63	50*	800 900 715	696	630	91%	500	72%
750	90	63	65	1290 900	1043	630	60%	630	60%
1000	100	-	-	1430	1391	630	45%	630	45%
1500	125	-	-	1790	2087	630	30%	630	30%
2000	CB	-	-	-	2782	630	23%	630	23%

11kV Pole Mounted & Ground Type Substations. (Cont.)

- HV Fuse sizes are selected to allow for:
  - (a) Transformer transient load/magnetising inrush currents
  - (b) Transformer short time current withstand characteristics
  - (c) 150% cyclic overload, (note for larger kVA ratings the maximum available HV fuse size may limit this criteria)
  - (d) maximum ambient air temperature of 40° C
- In the case of single LV circuits only, LV fuses shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used.
- In the case of multiple LV circuits, LV fuse sizes are generally one fuse size rating lower than that of the standard single circuit LV arrangement.
- The combined fuse rating of multiple circuits should not greatly exceed 150% of the transformer rated current
- For operational load breaking requirements, the maximum LV fuse size is limited to 630A
- 11kV PF fuses are of the backup type only. Ratings up to and including 35.5A have a 2 inch barrell diameter. Fuse ratings 35.5A have a 3 inch barrell diameter

BA and EDO fuses are not to be used for new construction!

FUSING TABLES – UNITED ENERGY NETWORK

11kV RMU & KIOSK Type Substations (non- switchgear specific)

Trans kVA	Trans. Rated HV Current (A)	HV Fuse Size * (A)	Trans. Rated LV Current (A)	Single LV Circuit Details	
				Max. HRC Fuse Size (A)	Circuit Capacity (% rated current)
300	15.7	31.5	417	400	72%
500	26.2	40	696	400	43%
750	39.4	63	1043	400	29%
1000	52.5	80	1391	400	22%
1500	78.7	CB	2087	400	15%
2000	105.0	CB	2782	400	11%

- HV Fuse sizes are selected to allow for:
  - (a) Transformer transient load/magnetising inrush currents
  - (b) Transformer short time current withstand characteristics
  - (c) Allow loading of transformer up to at least 100% of nominal rating
  - (d) 15% fuse de-rating factor to account for additional heating of fuse element due to:
    - iii) limited ventilation of enclosed switchgear (+15° C above ambient air temperature), and
    - iv) proximity of fuse element to kiosk transformer (+5° C)
- LV fuse sizes shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used, having regard to the number of circuits. For operational load breaking requirements, the maximum LV fuse size is limited to 400A
- After fuse operation only the faulted or damaged phase(s) shall be replaced.
- All HV fuses are of the powder filled full range DIN type. Circuit breakers are used for transformers above 1000 kVA. (see page 16).

11kV RMU & KIOSK Type Substations (switchgear specific)

Yorkshire TYKE Switchgear					
Trans kVA	Trans. Rated HV Current (A)	OEFMA LEL PF Fuse (oil immersed)	Trans. Rated LV Current (A)	Single LV Circuit Details	
				Max. HRC Fuse Size (A)	Circuit Capacity (% rated current)
300	15.7	30	417	250	46%
500	26.2	50	696	315	35%
750	39.4	60	1043	400	29%
1000	52.5	75	1391	400	22%

Reyrolle OKSS Switchgear					
Trans kVA	Trans. Rated HV Current (A)	Reyrolle PF Fuse (oil immersed)	Trans. Rated LV Current (A)	Single LV Circuit Details	
				Max. HRC Fuse Size (A)	Circuit Capacity (% rated current)
300	15.7	60	417	315	58%
500	26.2	75	696	400	43%
750	39.4	75	1043	400	29%
1000	52.5	75	1391	400	22%

For Wilson Pad Mount with Cooper RTE Switchgear see page 12

Wilson Pad Mount with Cooper RTE Switchgear							
Trans kVA	Trans. Rated HV Current (A)	Bayonet Fuse Type Cooper Bay-o-net Fuse Link	Backup Fuse Type Efen 'HH' Current Limiting (A)	Trans. Rated LV Current (A)	Single LV Circuit Details		
					Max. HRC Fuse Size (A)	De-rated Current Carrying Capacity (A)	Circuit Capacity (% rated current)
100	7.9	25	50	209	315	240	115
300	15.7	40	100	417	400	300	72
500	26.2	65	100	696	400	300	43
750	39.4	100	160	1043	400	300	29
1000	52.5	100	160	1391	400	300	22
1500	78.7	125	200	2087	400	300	15
2000	105.0	125	200	2782	400	300	11

- HV Fuse sizes are selected to allow for:
  - (a) Transformer transient load/magnetising inrush currents
  - (b) Transformer short time current withstand characteristics
  - (c) Allow loading of transformer up to at least 100% of nominal rating
- LV fuse sizes shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used, having regard to the number of circuits. For operational load breaking requirements, the maximum LV fuse size is limited to 400A

11kV Indoor Substation using Pole Mounted Type Switchgear

Trans kVA	Trans. Rated HV Current (A)	HV Fuse Size * (A)	HV Fuse Maximum Safe Load (kVA)	Trans. Rated LV Current (A)	Single LV Circuit Details	
					Max. HRC Fuse Size (A)	Circuit Capacity (% rated current)
200	10.5	35.5	460	278	315	113%
300	15.7	35.5	460	417	400	96%
500	26.2	56	720	696	400	57%
750	39.4	56	720	1043	400	38%
1000	52.5	90	1160	1391	400	29%
1500	78.7	125	1600	2087	400	19%
2000	105.0	CB	-	2782	400	14%

- HV Fuse sizes are selected to allow for:
  - (a) Transformer transient load/magnetising inrush currents
  - (b) Transformer short time current withstand characteristics
  - (c) Allow loading of transformer up to at least 100% of nominal rating
  - (d) 10% fuse de-rating factor to account for additional heating of fuse element due to limited ventilation of enclosed switchgear (+15º C above ambient air temperature)
- LV fuse sizes shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used, having regard to the number of circuits. For operational load breaking requirements, the maximum LV fuse size is limited to 400A
- 11kV PF fuses are of the backup type only. Ratings up to and including 35.5A have a 2 inch barrell diameter. Fuse ratings 35.5A have a 3 inch barrell diameter

6.6kV Pole Mounted & Ground Type Substations. *(see notes on page 15)*

Trans. kVA	HV Fuse Size			HV Fuse Max. Safe Load (kVA)	Trans. Rated LV Current. (A)	Single LV Circuit (Standard Arrangement)	
	PF	EDO	BA			Max. HRC Fuse Size	Cct. Capacity (% rated current)
100	35.5	16	15	305 130	139	250	180%
200	35.5	40	40	305 340	278	250	90%
300	56	63	50	480 540 430	417	400	96%
500	90	63	65	770 450	696	630	91%
750	125	-	-	1074	1043	630	60%
1000	125	-	-	1074	1391	630	45%

6.6kV Pole Mounted & Ground Type Substations. *(Cont.)*

- HV Fuse sizes are selected to allow for:
  - (a) Transformer transient load/magnetising inrush currents
  - (b) Transformer short time current withstand characteristics
  - (c) 150% cyclic overload, (note for larger kVA ratings the maximum available HV fuse size may limit this criteria)
  - (d) maximum ambient air temperature of 40^{o} C
- LV fuse sizes shown are the maximum sizes which will discriminate satisfactorily with the selected HV fuse size. Any fuse size up to that size may be used, having regard to the number of circuits. For operational load breaking requirements, the maximum LV fuse size is limited to 630
- 6.6kV fuses are actually 11kV powder filled fuses of the backup type operating at 6.6kV. Ratings up to and including 35.5A have a 2 inch barrell diameter. Fuse ratings 35.5A have a 3 inch barrell diameter

BA and EDO fuses are not to be used for new construction!

22kV & 11kV RMU & KIOSK Type Substations with CB Protection

Voltage (kV)	Trans kVA	Trans. Rated HV Current (A)	CB Relay Setting		
			M&G RM6 VIP11R	M&G RM6 VIP30	ABB CTC
22	1000	26.2	45	36	Refer Protection Engineer
"	1500	39.4	60	55	
"	2000	52.5	75	68	
11	1000	52.5	75	68	
"	1500	78.7	125	140	
"	2000	105.0	160	140	

- HV Circuit Breaker settings have been selected to allow for:

  (a) Transformer transient load/magnetising inrush currents

  (b) Transformer short time current withstand characteristics

  (c) Allow loading loading of transformer up to 100% of normal rating

Pole Mounted & Ground Type Substations LV Fuse Emergency Ratings

Trans. kVA	Trans. Rated LV Current. (A)	Single LV Circuit (Standard Arrangement)		Multiple LV Circuits (Bus Arrangement)	
		Standard LV HRC Fuse Size	Emergency LV HRC Fuse Size	Standard LV HRC Fuse Size	Emergency LV HRC Fuse Size
22kV					
100	139	250	315	125	250
200	278	315	400	250	315
300	417	315	400	315	400
500	696	400	500	400	500
11kV					
200	278	315	400	250	315
300	417	400	500	315	400
500	696	630	630	500	630

- For operational load breaking requirements, the maximum LV fuse size is limited to 630
- Since the standard LV fuse size for single LV circuits is the maximum fuse size which will discriminate satisfactorily with the HV fuse, application of an emergency LV fuse with a higher rating may result in a loss of protection discrimination with the HV fuse. As a result, a fault of the LV circuit is likely to cause the HV fuse to operate before the LV fuse. Therefore it is critical the standard LV fuse is reinstated immediately after the emergency period has passed.

FUSING TABLES – UNITED ENERGY NETWORK

Distribution Line Capacitor Bank Fusing Table

Voltage (kV)	Line Capacitor Rating (kVAr)	Capacitor Rated HV Current (A)	HV Fuse Size (A)
22	450	11.8	10
	600	15.7	15
	900	23.6	25
11	450	23.6	20
	600	31.5	25
	900	47.2	50

12.7kV SWER Fusing Table

SWER Isolating Transformer (ISO)			SWER Distribution Transformer
Primary 22kV Fuse Rating	Secondary 12.7kV Protection Device		Primary 12.7kV Fuse Rating (A)
	Recloser	Fuse	
15E BA	Refer Protection Engineer	10K EDO	5K EDO

11 & 22kV Overhead Distribution Spur Fusing Table

Voltage (kV)	Spur Fuse Size (A)	Application Criteria	
		Max. Loading on Spur (kVA)	Largest Downstream Fuse (A)
22	65 BA	1980	Less than or equal to 31.5PF, 40A BA or 40A EDO
11	125 PF	1905	Less than or equal to 90 PF

Spur fuse sizes have been selected to allow for :-

(a) transient load/magnetising inrush currents on spur
(b) no cyclic overloading above 100% rated load
(c) maximum ambient air temperature of 40°C

11kV applications shall be 125A powder filled fuses only.

22kV applications shall be 65A boric acid fuses only. In those cases where boric acid (BA) or expulsion dropout (EDO) fuses are used on the spur as transformer fuses, it is likely that fault currents of >1.5 kA occurring beyond the transformer fuse may result in the 65A BA spur fuse operating.

- when spur fusing steel overhead conductor, maximum fault level at spur fuse must not exceed 4kA

Where the spur line supplies only a single transformer, the spur fuse can also be used to protect the transformer ie. avoiding the need to install fuses at the transformer. However, where the transformer rating is less than 750kVA the standard 65A BA spur fuse cannot be applied. Refer to Protection Engineer.