Government of Western Australia
Department of Commerce
Energy*Safety*

WORKSAFE

DRAFT Code of Practice

Work On Or Near Energised Electrical Installations & In roof spaces of certain buildings

January 2017

FOREWORD

Working on or near energised electrical installations is the leading cause of serious accidents and fatalities for electrical workers. Other than certain unavoidable testing or commissioning functions, all electrical work must be carried out while de-energised. This is prescribed in Regulation 55 of the Electricity (Licensing) Regulations 1991.

The Occupational Safety and Health Regulations 1996 requires that all workers performing any work in the roof space of a building constructed or used as residential premises must turn off the main switch for the electricity supply at the main switchboard before entering any roof space. This includes electrical workers and all other workers entering roof spaces such as plumbers, pest control operators, installers of ceiling insulation, solar panels, air-conditioning systems, handyman, carpenters and builders.

This Code is a practical guide for all those to whom the Electricity (Licensing) Regulations 1991 and the Occupational Safety and Health Regulations 1996 apply. It is an approved Code under section 57 of the Occupational Safety and Health Act 1984 (the OSH Act) and is admissible as evidence in proceedings to establish what measures are practicable to control the hazards of working on or near energised electrical installations. Duty holders must comply with the applicable Act and Regulations, but may use different safe work methods to those provided in this Code if they provide equivalent or better safety outcomes.

The Code does not apply to work on the network of electricity network operators, although many of the safe work practices may have relevance to all kinds of electrical work.

If electrical accidents do occur, electricians, electrical contractors and clients have an obligation to report them immediately to the relevant network operator or the Director of Energy Safety, if there is no network operator. This requirement is prescribed in Regulation 63 of the Electricity (Licensing) Regulations 1991. The OSH Act also requires that incidents causing a fatality, or certain types of injury or disease, are reported to the WorkSafe Western Australia Commissioner.

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Director of Energy Safety

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SCOPE AND APPLICATION

This Code of Practice comprises THREE parts:

Part 1 provides uniform essential elements that constitute the minimum safety requirements when working on or near energised electrical installations. It provides high-level safety performance outcomes without being prescriptive about how to comply with these requirements.

Part 2 incorporates and elaborates on all the "high-level" requirements of Part 1 with the addition of prescribing guidance, in more detail, on how compliance can be achieved.

Parts 1 and 2 apply generally to electrical work. They apply to:

- A person who, at a workplace, is an employer, the main contractor, a self-employed person, a person having control of the workplace or a person having control of access to the workplace; and
- Designers, manufacturers, importers, suppliers, and installers of electrical equipment and installations; and
- Employers of electrical workers, electrical contractors, nominees, electrical supervisors, supervising electrical workers, officers, company directors, in-house licence holders and everyone who causes electrical installing work to be undertaken at a workplace; and
- Electrical workers, trade assistants assisting electrical workers and apprentices.

Part 3 applies to all employers of workers and workers performing work for reward in the roof space of domestic and small business premises. It applies to all types of work requiring access to the roof space such as plumbing, pest control, installation of ceiling insulation, solar panels, air-conditioning systems, handymen, carpenters, telecommunications and builders.

It also applies to electrical work.

This Code does not apply to:

- electrical work on **extra-low voltage** electrical equipment;

  work on the **network of electricity network operators**.

  This includes electrical work performed on network operator's transmission and distribution facilities, although network operators may wish to adopt those principles relevant to their operations.

  Regulation 55 of the Electricity (Licensing) Regulations 1991 **does not** apply to or in relation to electrical installing work carried out on or near a network operator's service apparatus if the work is carried out by or on behalf of the network operator.

  Regulation 55 **does** apply to electrical installations operated by network operators not associated with the network i.e. not used for the transmission and distribution of electricity.

PART 1

1. MINIMUM SAFETY REQUIREMENTS WHEN UNDERTAKING ELECTRICAL INSTALLING WORK

Electrical installing work (whether energised or de-energised) must only be carried out by appropriately licensed electrical workers.

Electrical installing work MUST NOT be carried out, on or near an energised part of an electrical installation. It is prohibited under the legislation.

Electricity (Licensing) Regulations 1991 – REG 55(2)

If the person carrying out the work could make contact, directly or indirectly (including with a thing used or controlled by the person), with an uninsulated energised part of the electrical installation, it means he/she is working near an energised part of an electrical installation.

There are some rare cases when such work can be contemplated. Refer to section 1.2 below.

The chart on page 8 provides a simple guide which should assist with complying with this Code.

1.1 Working de-energised

Before any electrical installing work is undertaken, the best risk control measure which can be applied is to de-energise the relevant part of the electrical installation and to ensure the work is not near any energised part of the installation.

Before starting work:

- Identity the circuits to be worked on (Ensure it is the correct circuit by testing i.e. do not rely on labels or other means);
- Switch off the electricity supply to installation being worked on;
- If work will be undertaken near other installations, switch off the electricity supply to these installations as well;
- Test that the correct circuit has been isolated;
- Fit appropriate tags;

Where a facility exists to lock a switch in the “OFF” position, it must be used.

Section 3 of this Code provides further guidance.

1.2 Minimum safety requirements when undertaking electrical installing work on or near energised electrical installations

Before electrical installing work is carried **on or near** an energised part of an electrical installation, the following steps must be undertaken:

a) A **risk assessment is undertaken by a competent person** who is familiar with the type of work to be carried out; and

b) The competent person (who holds an electrical worker’s licence endorsed as electrician) is satisfied that-

   i. there is **no reasonable alternative** to carrying out the work while the part of the electrical installation is energised; and

The competent person must ascertain that:

a) the work would not be able to be carried out effectively if the installation was de-energised;
b) the health or safety of one or more persons would be put in imminent and significant danger if the installation (or part of) was de-energised to do the work;
c) in order to test, measure the performance of or detect or locate faults or defects in the electrical installation or the part of the installation, the installation must be energised.

ii. the **risks identified by the risk assessment are or can be reduced to as low as reasonably practicable**; and

iii. the **work can be carried out safely**; and

c) A **safe work method statement (SWMS) for the work** has been prepared in accordance with regulation 3.143(4) of the Occupational Safety and Health Regulations 1996; and

d) **Suitable personal protective equipment and safety equipment** is used by the person carrying out the work.

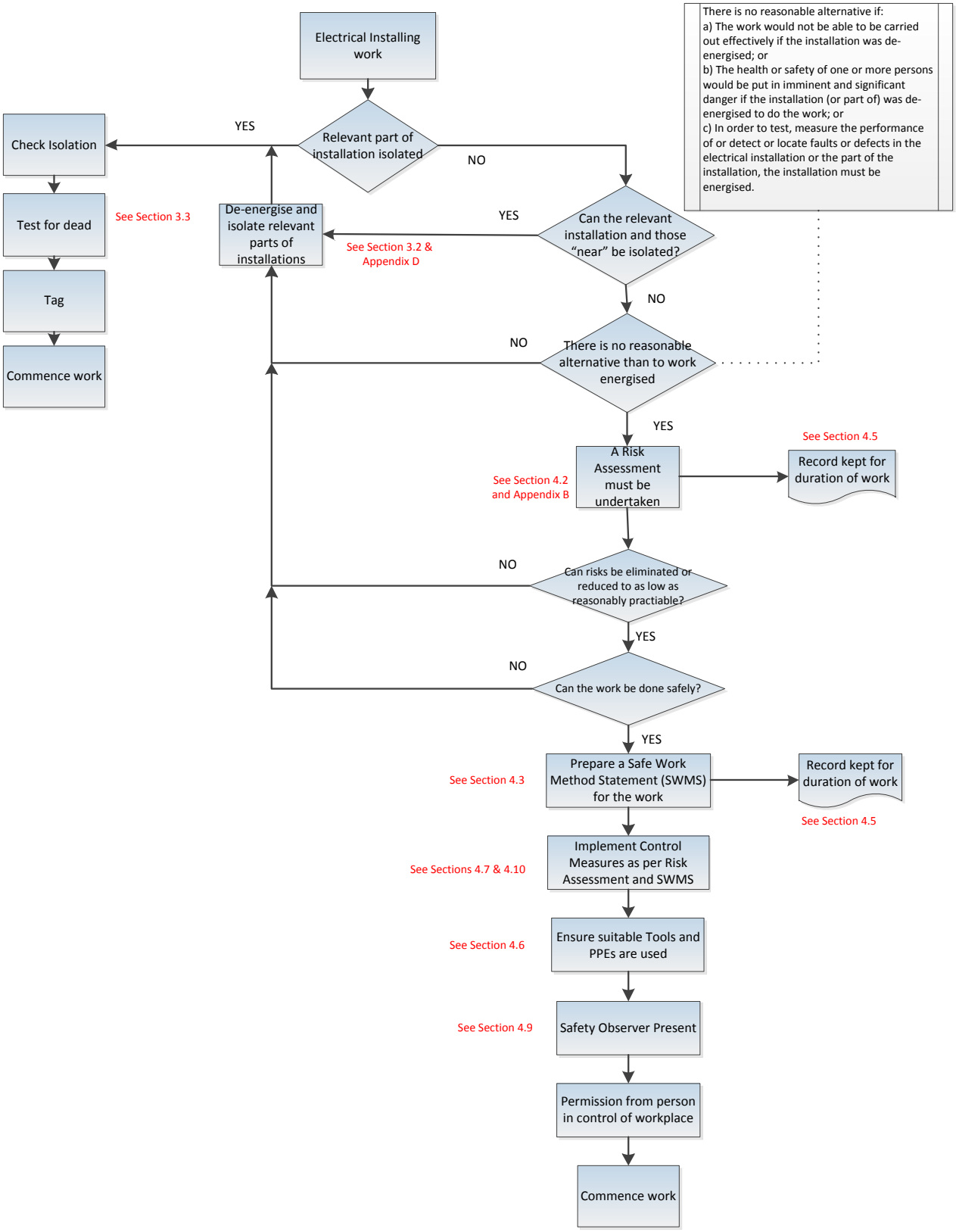


Figure 1: Work on or near energised electrical installations - Decision-matrix

PART 2

2. ELECTRICAL INSTALLING WORK – RISKS & RESPONSIBILITIES

The risks of working on electrical installations must be adequately managed. To ensure this, the legislation requires that electrical installing work is only undertaken by licensed operatives, trained to do such work.

Electrical installing work (whether energised or de-energised) must only be carried out by appropriately licensed electrical workers.

Subject to Regulation 19 of the Electricity (Licensing) Regulations 1991 (ELR), a person who carries out any electrical work commits an offence unless the carrying out of that work by that person is authorised by a licence or permit. Several exemptions apply. Please refer to the ELR for more details.

Electricity (Licensing) Regulations 1991 – REG 19

A person who carries out any electrical work commits an offence unless the carrying out of that work by that person is authorised by a licence or permit.

2.1 What is electrical installing work?

Electrical installing work means assembling and fixing in place, altering or adding to any electrical installation or maintaining, removing or connecting to fixed wiring, any electrical equipment.

It involves work on electrical machines or instruments or on an electrical installation or on electrical appliances or equipment, to which electricity is supplied or intended to be supplied at a nominal pressure exceeding 50 volts alternating current or 120 volts ripple free direct current.

It also includes work comprising an assessment of an electrical installation to ensure the installation and any work done on the installation comply with the requirements of the Electricity (Licensing) Regulations 1991.

An electrical installation includes all wiring, wiring enclosures, switch gear, control and protective gear, appliances and any other components permanently connected to or associated with the wiring and that is on premises to which electricity is or is intended to be supplied through distribution works. Where electricity is supplied from a private generating plant, it includes that plant.

Electrical equipment includes any component or part of an electrical installation.

2.2 What are the hazards?

Even the briefest contact with electricity at 50 volts for alternating current (V a.c.) or 120 volts for direct current (V d.c.) can have serious consequences to a person's health and safety. High voltage shocks involving more than 1000 V a.c. or 1500 V d.c. can cause contact burns and damage to internal organs.

Electrocution or flash burns can easily occur. Flash burns can occur where the available energy under fault conditions is high. Electricity flashovers produce very high temperature gases, causing disfigurement and severe internal burns when inhaled.

It only requires a very small failure of work practice, such as a slip with a screwdriver or a dropped tool, for such accidents to occur.

2.3 Who must manage electrical risks?

Employers, persons having control of the workplace or a person having control of access to the workplace

Employers have a general duty of care under the OSH Act to provide and maintain a working environment that does not expose workers to hazards, so far as is reasonably practicable, including the hazards posed by energised electrical installations.

The OSH Regulations provide specific duties in relation to electrical work for employers, main contractors, self-employed persons, a person having control of a workplace, or a person having control of access to a workplace.

Workers also have a duty to ensure their own safety and health at work, and to avoid adversely affecting the health and safety of others. This includes following instructions for conducting work safely provided by their employers.

Hazards that should be considered by an employer in conducting a risk assessment for electrical work include electrical shock, falls from height, heat stress, fatigue and musculoskeletal stress.

Safe systems of work should ensure workers have the required training and supervision, are provided with the appropriate tools and equipment (including testing instruments and personal protective equipment) and document the procedures and practices that should be followed when conducting the work.

When work is conducted in residential premises, it is considered to be a workplace for the purpose of the OSH Act. However, a homeowner or tenant does not have duties in relation to control of access to the workplace except to the extent the control is in connection with the carrying on by that person of a trade, business or undertaking (whether for profit or not).

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.1

3.1. Identification of hazards, and assessment and reduction of risks, duties of employer etc. as to

A person who, at a workplace, is an employer, the main contractor, a self-employed person, a person having control of the workplace or a person having control of access to the workplace must, as far as practicable —

(a) identify each hazard to which a person at the workplace is likely to be exposed; and

(b) assess the risk of injury or harm to a person resulting from each hazard, if any, identified under paragraph (a); and

(c) consider the means by which the risk may be reduced.

This duty requires electrical risks to be eliminated or, if this is not reasonably practicable, the risks must be minimised by implementing control measures.

The OSH Regulations include more specific requirements for managing electrical risks at the workplace. For example, all persons conducting a business or undertaking have duties to ensure, so far as is reasonably practicable, electrical equipment and installations at the workplace are without risks to health and safety

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.59

3.59. Electrical installation etc., duties of employer etc. as to

A person who, at a workplace, is an employer, the main contractor, a self-employed person or a person having control of the workplace must ensure that —

(a) all electrical installations at the workplace are designed, constructed, installed, protected, maintained and tested so as to minimise the risk of electrical shock or fire; and

(b) each connection on a flexible cord that is installed or renewed at the workplace after 1 October 1996 is of either the moulded one-part non-rewireable or transparent type.

Designers, manufacturers, importers, suppliers, and installers of electrical equipment and installations that could be used for work must ensure, so far as is reasonably practicable, they are without risks to health and safety. Designers and manufacturers of electrical equipment or installations must ensure they are designed and manufactured so that electrical risks are eliminated or, if this not reasonably practicable, minimised.

Electrical contractors, Nominees, Electrical supervisors, Supervising electrical worker, officers, company directors, **in-house licence holders** have a duty to exercise due diligence to ensure that the business or undertaking complies with the OHS Act and Regulations. This includes taking reasonable steps to ensure that the business or undertaking has and uses appropriate resources and processes to eliminate or minimise electrical risks at the workplace.

Electrical workers must take reasonable care for their own health and safety and not adversely affect the health and safety of other persons. Workers must comply with any reasonable instruction and cooperate with any reasonable policy or procedure relating to health and safety at the workplace. This means that if electrical equipment is provided by the person conducting the business or undertaking, the worker must use it in accordance with the information, instruction and training provided on its use.

Workers need to be responsible for their own safety and the safety of others and to follow instructions, use personal protective equipment and advise the employer if they believe that they are being asked to do anything unsafe or beyond their competencies.

Employers and self-employed persons should ensure electrical installation work is carried out by competent persons.

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 1.3

Competent person, in relation to the doing of anything, means a person who has acquired through training, qualification or experience, or a combination of those things, the knowledge and skills required to do that thing competently.

Electricity (Licensing) Regulations 1991 – REG 19

A person who carries out any electrical work commits an offence unless the carrying out of that work by that person is authorised by a licence or permit.

Formal or on-the-job training may be appropriate depending on the circumstances. Examples of training include:

- induction training—to ensure new starters or workers new to a job are trained on safe systems of work and other relevant health and safety matters;
- supervisor and management training—to ensure that safety issues are appropriately managed at the workplace;

- work-specific training—to ensure that workers carrying out particular work are trained on any electrical and other risks specific to the work, as appropriate;
- ongoing or refresher training—to ensure that any training on work health and safety matters is repeated as appropriate on a periodic basis;
- emergency procedure training—to ensure workers know what to do in the event of an emergency, for example procedures to follow if a person receives an electric shock;
- first aid training—to ensure appropriate procedures are followed for administering first aid, for example proper treatment for electric shock;
- electrical rescue and resuscitation training for safety observers.

The special needs of workers should be taken into account in deciding the structure, content and delivery of training, including literacy levels, work experience and specific skills required to carry out the work.

The level of supervision provided to workers should be appropriate for the type of work, as determined by the risk assessment. Regulation 50 of the Electricity (Licensing) Regulations 1991 identifies supervision as a key factor in performing electrical work safely and provides guidance on when direct supervision of workers is appropriate (Refer to Safety Guidelines for Electrical Workers).

3. WORK ON DE-ENERGISED ELECTRICAL INSTALLATIONS

3.1 Prohibition on electrical work on or near energised electrical installations

The person with control of the workplace or a person having control of access to the workplace must ensure that work is not undertaken on an electrical installation or part of an electrical installation at the workplace unless the installation has been confirmed as de-energised, by a competent person. Certain exemptions apply (see section 6).

A person commits an offence if the person carries out or causes electrical installing work to be carried out, on or near an energised part of an electrical installation.

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.59A

3.59A. Electrical installing work

(1) A person who, at a workplace, is an employer, the main contractor, a self-employed person, a person having control of the workplace or a person having control of access to the workplace must ensure that, before electrical installing work is carried out on an electrical installation or part of an electrical installation at the workplace, the electrical installation or part of the electrical installation:

(a) is tested by a competent person to ascertain whether or not it is energised; and

(b) if it is found to be energised, is de-energised and isolated by a competent person.

(2) Sub-regulation (1)(b) does not apply in relation to electrical installing work carried out under the Electricity (Licensing) Regulations 1991 regulation 55(4).

Electricity (Licensing) Regulations 1991 – REG 55 (3)

A person who carries out electrical installing work, or causes electrical installing work to be carried out, on or near an energised part of an electrical installation commits an offence unless the person carries out the work or causes the work to be carried out under sub-regulation (4).

These provisions do not apply to work carried out by or on behalf of a network operator on the electrical equipment, including line-associated equipment, controlled or operated by the operator to generate, transform, transmit or supply electricity. They do not apply to or in relation to electrical installing work carried out on or near a network operator's service apparatus if the work is carried out by or on behalf of the network operator.

Before any work is undertaken on or near energised electrical installations, the most effective control measure that can be applied is to de-energise the relevant part of the electrical installation.

3.2 Isolation and tagging

Before commencing any electrical work, the electrical circuits or equipment to be worked on must be disconnected from all sources of electricity supply. The circuits must be proven to be de-energised by testing and adequate precautions must be taken to prevent inadvertent re-energisation.

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.58

3.58. Terms used

De-energised and isolated

For the purposes of this Division, an electrical installation or a part of an electrical installation is de-energised and isolated if —

(a) it is electrically separated from the or each supply of electricity; and

(b) measures are taken to ensure that it cannot be energised inadvertently.

Before starting work:

- Identity the circuits to be worked on (Ensure it is the correct circuit by testing i.e. do not rely on labels or other means);
- Switch off the supply to installation being worked on;
- If work will be undertake near other installations, switch off the supply to these installations as well;
- Test that the correct circuit has been isolated;
- Fit appropriate tags;

Where a facility exists to lock a switch in the "OFF" position, it must be used.

Locks are for the **safety of personnel** and:

- They must be **uniquely keyed** so that they can be fitted and removed only by the person owning the lock;
- **All persons involved in carrying out the work must fit their own lock** at the same isolation point(s). This may require the use of a multi-lock security device;
- They must be **clearly labelled** (with a personal identification tag or Danger tag) to identify the person who attached the tag and the nature of the electrical work being undertaken; and
- Tags must be removed upon completion of work or at the end of the shift (if the work will be continued by others, who must fit their own locks).

Danger tags are for the **safety of personnel** and:

- They **must be fitted and removed only by the person who signed the tag;**
- **All persons involved in carrying out the work must fit their own Danger tag** at the same isolation point(s); and
- They must be removed upon completion of the work or at the end of the shift (if the work will be continued by others, who must fit their own Danger tags).

Refer to Appendix D for further guidance on isolation and tagging.

Refer to Appendix F for guidance on some of the risks to be considered whenever conducting "Isolation and tagging".

3.3 Test for dead

The safe work principle 'TEST FOR 'DEAD' BEFORE YOU TOUCH' must be applied at all times.

Even if the electricity supply is believed to have been isolated, it must be assumed that all conductors and electrical components are energised until they have been proven de-energised.

Testing for 'dead' must be undertaken as appropriate for the duration of the electrical work. Testing is undertaken prior to touching, taking into account all relevant factors including the

nature of the conductor, nature of the isolation, nature of work, if there has been a change or the area has been left idle (unattended) for a period.

The testing method (including the testing equipment used) must be safe and effective. The electrical worker carrying out the testing must understand testing procedures and be competent in the use of the testing equipment.

Equipment-mounted voltmeters should not be used as the only method of determining whether an electrical part is de-energised.

Refer to Appendix D for further guidance on testing.

If voltage testers are used they should be tested for correct operation immediately before use and again after use to confirm that the instrument is still working. This check should be considered to be part of the ‘TEST FOR ‘DEAD’ BEFORE YOU TOUCH’ safe work principle.

Refer to Appendix E for further guidance on tools and equipment.

If there are any exposed conductors in the immediate work area they should be separated by design or segregated and protected with insulated barricades, insulated shrouding or insulated material to prevent against inadvertent or direct contact.

4. WORK ON OR NEAR ENERGISED ELECTRICAL INSTALLATIONS

Energised electrical work is electrical work carried out in circumstances where the part of electrical installation or equipment being worked on is not electrically separated from a supply of electricity.

Electricity (Licensing) Regulations 1991 – REG 55 (2)

Electrical installing work is carried out near an energised part of an electrical installation if the person carrying out the work could make contact, directly or indirectly (including with a thing used or controlled by the person), with an uninsulated energised part of the electrical installation.

Electrical work must not be carried out on or near electrical installations while energised only because it is merely more convenient for the electrical installation to stay energised while the work is being carried out.

Energised electrical work must not be carried out unless the risk to persons directly affected by a supply interruption is higher than the risk to the licensed electrical workers who will carry out the energised electrical work. Only in rare circumstances would it be possible to justify that it is not practicable to have a short break in supply. Most electrical installations suffer no harm through unplanned interruptions of this kind to the network supply. In some cases a short break may allow for the insertion (and removal) of insulated barriers.

Requiring electrical work to be carried out while the installation is energised could constitute a breach of the general duty of care in the OSH Act, or specific duties in the OSH Regulations.

Electricity (Licensing) Regulations 1991 – REG 55 (5)

A person may carry out electrical installing work, or cause electrical installing work to be carried out, on or near an energised part of an electrical installation if, a competent person is satisfied, among other things (see Reg 55(4)), there is no reasonable alternative to carrying out the work while the part of the electrical installation is energised.

It can be deemed there is no reasonable alternative if one of the following apply —

(a) it is necessary that the part of the installation be energised for the work to be carried out effectively;

(b) it is necessary that the part of the installation be energised because carrying out the work by alternative means would put the health or safety of one or more persons in imminent and significant danger;

(c) it is necessary that the part of the installation be energised in order to test, measure the performance of or detect or locate faults or defects in the electrical installation or the part of the installation.

Electrical work on or near any installation, equipment, machinery, plant or appliance may pose a risk of direct or indirect contact with nearby exposed energised electrical parts (e.g. installing or testing circuits on a switchboard adjacent to exposed energised electrical parts).

In some circumstances the risks associated with undertaking electrical work near exposed energised parts can be equivalent to those associated with work on energised electrical installations. Risks to be considered, but not limited to, are those arising from:

- energised parts;
- exposed high temperature parts;
- moisture entering the electrical equipment.

If a hazard cannot be eliminated, the risk must be reduced by implementing effective control measures. Control measures include elimination, substitution, isolation, engineering or administrative controls. These controls generally eliminate, reduce or minimise risk in a more reliable manner than personal protective equipment (PPE) and may be used in combination.

Further information on the risk management approach to minimising risks may be found Appendix B of this Code and in the Commission for Occupational Safety and Health's *Guidance note: General duty of care in Western Australian workplaces*.

4.1 Planning and preparation

Workers carrying out the electrical work must have or be provided with suitable and adequate information, instruction and training in:

- planning and preparation requirements for the carrying out of energised electrical work;
- safe work procedures, particularly those documented in safe work method statements;
- proper use of the relevant tools, testing equipment and PPE;

First aid facilities must be provided at the workplace and they must be readily accessible

Emergency contact numbers should be made available at the workplace

Fire-fighting equipment that is suitable for electrical fires should be accessible.

Energised conductors should be insulated where necessary to prevent inadvertent contact or flashovers.

Unauthorised persons should be prevented from entering the work area, for example through the use of barriers and signage.

Many of these requirements require consultation, cooperation and coordination between multiple duty holders at the workplace. In some cases, the person with management or control of the workplace may not be the person with control of access to the workplace.

Safe work method statements prepared for energised electrical work must describe consultation arrangements with the person with management or control of the workplace, including any authorisation procedures and position descriptions.

4.2 Risk Assessment

Under Regulation 55(4)(a) of the Electricity (Licensing) Regulations 1991, a risk assessment must be undertaken prior to electrical installing work being undertaken on or near an energised part of an electrical installation.

Electricity (Licensing) Regulations 1991 – REG 55 (4)

A person may carry out electrical installing work, or cause electrical installing work to be carried out, on or near an energised part of an electrical installation if

(a) a risk assessment has been undertaken by a competent person who is familiar with the type of work to be carried out; and

(b) the competent person is satisfied that-

(i) there is no reasonable alternative to carrying out the work while the part of the electrical installation is energised; and

(ii) the risks identified by the risk assessment are or can be reduced to as low as reasonably practicable; and

(iii) the work can be carried out safely; and

(c) where the Occupational Safety and Health Regulations 1996 regulation 3.143 does not apply to the work, a safe work method statement for the work has been prepared in accordance with regulation 3.143(4) of those regulations (as if the work were high-risk construction work and the place where the work is to be carried out were a construction site); and

(d) suitable personal protective equipment and safety equipment is used by the person carrying out the work.

The risk assessment must identify the electrical hazards to which a person doing the work is likely to be exposed and assess the risk of injury or harm, resulting from those hazards, to the person who will carry out the work.

The assessment should be designed to check compliance with the legislative requirements described above.

For energised electrical work, any significant findings should be recorded, reviewed from time to time and revised if necessary.

The **written risk assessment** must determine the risk level and assist with a decision on appropriate risk control measures.

Risks include:

- electric shock if exposed energised parts are touched;
- explosion, for example if a metal tool is dropped onto busbars causing a short circuit;
- exposed high-temperature parts causing burns to bare skin; and
- electrical fires caused, for example, by allowing moisture or dust to enter electrical equipment.

The following factors should be taken into account in assessing risks:

- type of work carried out and tools or equipment used;
- proximity of the work to energised parts;
- the types of tools and equipment used in the work, for example the conductive properties of tools;
- environmental conditions such as confined space, wet surfaces or unfavourable weather; and
- assessing the need to repair equipment while it remains energised.

Refer to Appendix B for further guidance on the Risk Assessment Process.

Hazards indirectly caused by electricity—conductive materials

Persons can be exposed to electrical risks, including risks of electric shock, arcing and explosion, without directly contacting exposed energised parts of electrical installations. Other conductive materials can provide current paths for the electric shock, fault current or both.

All materials should be regarded as conductive unless proved otherwise. Gases and liquids should be regarded as conductive. Particular care should be taken when exposed energised parts are near earthed situations.

The electric shock path to earth can be via conductive materials, such as concrete, timber with a high moisture content or water. For example, ladders that are damp or dirty may become conductive and create a potential hazard.

When working near exposed energised parts or working energised, the tools and equipment used should be non-conductive or insulated. Examples include:

- torches;
- telescopic devices;
- rulers and tape measures;
- insulated hand tools, for example screwdrivers, pliers, cable cutters, spanners and crimpers; and
- powered tools.

Metallic personal items including watches and watchbands should not be worn by workers carrying out work near exposed energised parts. Metal objects worn on or close to the body increase the risk of electric shock. Additionally, electrical burns can be more serious because these objects retain heat and provide contact points for current to flow.

Examples of metallic personal items include jewellery, body piercings and metal spectacle frames.

Refer to Appendix F for guidance on some of the hazards involved in doing electrical work.

4.3 Safe Work Method Statement (SWMS)

Regulation 3.143 of the Occupational Safety and Health Regulations 1996 requires preparation of a safe work method statement (SWMS) in accordance with regulation 3.143(4) of those regulations.

Before any electrical installing work is undertaken on or near an energised part of an electrical installation, a safe work method statement, in accordance with regulation 3.143(4) of those regulations, has to be prepared. This is irrespective of whether the work is deemed as high-risk construction work and the place where the work is to be carried out is a construction site. Please refer to Regulation 55(4)(c) of ELR.

Safe work method statements document a process for identifying and controlling health and safety hazards and risks. They may also incorporate a risk assessment.

SWMS must be developed in consultation with relevant workers. If the workers are represented by a health and safety representative, the consultation must involve that representative.

Safe work method statements must:

- identify the electrical work;
- specify the hazards associated with that electrical work and risks associated with those hazards;
- describe the measures to be implemented to control the risks; and
- describe how the risk control measures are to be implemented, monitored and reviewed, and may include the risk assessment prepared for the relevant work.

OSH Regulation 3.143(4) requires that the SWMS is in writing. They should be written in a way that makes them readily understandable by the workers who are to use them.

OSH Regulation 3.143(5) requires that the SWMS is kept up to date and work is carried out in accordance with the SWMS as an alternative to specifying the retention period. They must, for example, be revised if a decision is made to change relevant safe work procedures at the workplace.

A copy of the SWMS must be readily accessible to any worker who is to carry out the electrical work covered by the statement.

4.4 Consultation between duty holders

All persons with duties under the legislation, including persons with control of the workplace or control of access to the workplace must manage electrical risks at the workplace while electrical work is being carried out, not just those carrying out the electrical work.

Electrical work will often be carried out at a place that is not under the management or control of the person carrying out the electrical work. For example, the place where work is carried out may be under the management or control of:

- if the place is a permanent workplace—the person conducting a business or undertaking from that workplace
- if the place is a public place—the relevant local or state authority.

These persons will also have duties in relation to the health and safety of the electrical worker(s) and other persons at the place where the electrical work is being carried out.

All duty holders must, so far as is reasonably practicable, consult, cooperate and coordinate activities with each other to ensure compliance with their work, health and safety duties.

In addition to the general duty to consult, the person conducting a business or undertaking carrying out the electrical work must ensure the electrical work is only authorised (among other things) after consulting with the person with management or control of the workplace.

Consultation should ensure that all relevant persons are aware of any scheduled electrical work to be carried out and also any relevant risks to health and safety arising from that work.

Arrangements should also be put in place to ensure, so far as is reasonably practicable, that all persons at the place receive suitable and adequate information and instruction, for example about the need to comply with warning or safety signs and stay out of any no-go zones.

4.5 Record keeping requirements

If a person to whom the regulations apply prepares a risk assessment or a safe work method statement (SWMS), that person must:

a) keep a copy of the risk assessment and the SWMS until all the work to which it relates is completed;
b) for the period for which the assessment must be kept, ensure a copy is readily accessible to any worker engaged by the person to carry out electrical work to which the assessment or statement relates; and
c) for the period for which the assessment or statement must be kept, ensure a copy is available for inspection under the Act.

4.6 Tools and equipment

All workers should be competent in the safe use of their tools and equipment (including PPE). For more information about maintaining and inspecting tools and equipment, including testing and fault finding instruments, see Appendix E of this Code.

4.7 Work position

Electrical work should be carried out from a position that minimises the risk of inadvertent contact with uninsulated exposed energised parts and also the risk of an electric shock path being created. For example, safe work method statements should require, so far as is reasonably practicable, that electrical workers position themselves so that:

- an involuntary action like sneezing would not cause them to touch exposed energised parts;
- no electric shock path can be created due to working in an awkward position, for example testing components towards the rear of a washing machine via the front panel; and
- no electric shock path can be created when carrying out phase sequencing or rotation testing on overhead mains or at an underground pillar.

4.8 Supervision of workers

The level of supervision provided to workers should be appropriate for the type of work, as determined by the risk assessment.

Regulation 50 of the Electricity (Licensing) Regulations 1991 identifies supervision as a key factor in performing electrical work safely and provides guidance on when direct supervision of workers is appropriate.

Whether you are an employer, supervisor or an electrical worker under supervision, it is important to understand your obligations under the Electricity (Licensing) Regulations 1991.

Refer to EnergySafety's "Safe Working Guidelines" for further guidance.

4.9 Safety observers

A competent safety observer must be present when work is carried out on an energised electrical installation, unless the work consists only of testing and a risk assessment shows that there is no serious risk associated with the proposed work.

The role of the safety observer should be clearly communicated to all workers and understood.

The safety observer must:

- be competent to undertake the electrical work being observed;
- be competent to implement control measures in an emergency; and
- be competent to rescue the worker who is carrying out the work if necessary, and must have been assessed in the previous 12 months as competent to rescue and resuscitate a person.

The safety observer should:

- not carry out any other work or function that compromises their role, for example they should not be required to observe more than one task at a time;

- not be situated in the work basket of the elevating work platform from which the electrical work is being carried out;
- be able to communicate quickly and effectively with the electrical worker(s) carrying out the work. Specialist equipment may be necessary if there is a barrier to communication;
- not have any known temporary or permanent disabilities that would adversely affect their role and performance.

4.10 Safety barriers and signs

Barriers and signs may be designed, erected or installed to:

- protect electrical workers from inadvertently contacting energised exposed (uninsulated) parts;
- ensure that access to and egress from the work location of energised work allows for clear, unobstructed passage; and
- warn others and direct people away from dangerous work areas.

Different kinds of safety barriers may be required for different purposes. For example:

- to protect electrical workers from inadvertently contacting energised exposed parts—a physical safety barrier should consist of a non-conductive material such as wood or plastic or, alternatively, correctly earthed steel and be strong enough to withstand the impact from falling objects or loose material;
- to exclude persons generally from a work area where there is a risk of energised exposed parts—secure housings, enclosures, doors and walls may provide appropriate safety barriers.

A risk assessment should be carried out by a competent person to advise whether a barrier is appropriate to address the relevant risks.

The barrier must be erected safely. This may require switching off and isolating the electricity supply while the barrier is installed.

A barrier may be temporary or permanent and, if applicable, should clearly designate the safe work area by defining the approach path to the relevant piece of equipment/installation.

4.11 Emergency planning and accident reporting

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.10

Evacuation procedure, duties of employer etc. as to

A person who, at a workplace, is an employer, the main contractor, a self-employed person or a person having control of the workplace must ensure that —

(a) there is an evacuation procedure to be followed in the event of fire or other emergency at the workplace; and

(b) where practicable, the evacuation procedure is clearly and prominently displayed at the workplace; and

(c) where practicable, a diagram showing the location of exits and the position of the diagram in relation to the exits is clearly and prominently displayed at the workplace; and

(d) where practicable, the evacuation procedure is practised at the workplace at reasonable intervals; and

(e) persons at the workplace who would be required to help control or extinguish a fire at the workplace are appropriately trained and provided with appropriate protective clothing and equipment.

Quick action after an electrical incident that causes injury can save a life or significantly reduce the severity of the injury. Even if an electrical incident does not appear to have caused injury at the time, there may be some delayed effects.

Any person who is involved in an electrical incident involving an electric shock should receive medical attention.

A well-prepared emergency response assists in managing the severity of the injury where an incident has occurred and takes into account the health and safety of those required to respond to the incident. For example, in an exposed energised high voltage situation, the electricity supply should be isolated and proved de-energised before carrying out a rescue.

Special consideration must also be given in relation to other higher-risk workplaces including confined spaces, working at heights (e.g. elevating work platforms), workplaces with hazardous atmospheres which present a risk to health or safety from fire or explosion, and trenches, shafts and tunnels.

If electrical accidents do occur, electricians, contractors and clients have an obligation to report them immediately to the relevant network operator or the Director. This requirement is prescribed in Regulation 63 of the Electricity (Licensing) Regulations 1991. Fatalities and specific types of injury and disease must also be reported to the WorkSafe Western Australia Commissioner.

4.12 Leaving unfinished work

Refer to Appendix D of this Code.

5. PARTICULAR ENERGISED ELECTRICAL WORK – TESTING AND FAULT-FINDING

Electricity (Licensing) Regulations 1991 – REG 55 (5) (c)

For the purposes of sub-regulation (4)(b)(i), there is no reasonable alternative to carrying out the work while the part of the electrical installation is energised if it is necessary that the part of the installation be energised in order to test, measure the performance of or detect or locate faults or defects in, the electrical installation or the part of the installation.

All the requirements prescribed in Regulation 55 and the precautions listed in section 6 of this Code must still be complied with whenever undertaking testing and fault-finding.

De-energised testing methods should be used before energised testing methods.

Fault finding should first be attempted in a de-energised environment using de-energised testing methods. If unsuccessful, energised testing methods may be used subject to the requirements of the Electricity (Licensing) Regulations 1991, the OSH Regulations 1996 and this Code for working on an energised electrical installation.

5.1 Planning and preparation

Before commencing any testing or fault finding in an energised environment:

- identify exposed conductive parts that are or could become energised while using test instruments;
- use temporary or fixed barriers to prevent electrical workers from inadvertently contacting exposed conductive parts;
- use only appropriate insulated and rated tools, test instruments and test probes;
- carry out checks to ensure the test instruments to be used are appropriate and functioning correctly;
- use only appropriately rated PPE;
- use a safety observer, if required by the risk assessment conducted for the work;
- ensure that only authorised persons may enter the immediate area where the work is to be carried out; and
- carry out a regular review of the work situation to ensure that no new hazards are created during the process.

All the requirements of section 4 of this Code must be complied with.

When testing or fault finding is completed, circuits and equipment must be restored to a safe condition. For example, disconnected conductors should be reconnected and left in a safe state, covers replaced, and accessories and equipment properly secured.

Procedures involving coordination, such as procedures related to switching circuits or equipment on and off during the fault finding or testing process, must be implemented and maintained at all times.

PART 3

This part of the Code applies to all employers of workers and workers performing work for reward in the roof space of buildings constructed or used as residential premises. It applies to all type of work requiring access to the roof space such as carpentry, plumbing, pest control, installation of ceiling insulation, solar panels, air-conditioning systems, security systems and builders in general. It also applies to electrical work.

6. WORK IN ROOF SPACES

Between 2013 and 2016, two electrical workers died in roof spaces of domestic dwellings in Western Australia.

The hazards of working in roof spaces have been highlighted in the Report of the Royal Commission into the Home Insulation Program (HIP). Three of the four fatalities of workers involved in the installation of insulation under the HIP were caused by electrocution, which would have been prevented if the main switch had been turned off prior to entry to the roof space. None of these workers were conducting "electrical work".

Workers in roof spaces can be inadvertently exposed to energised electrical installations whether they are carrying out electrical work or not.

The legislation now requires that all workers performing work for reward at "domestic-type" premises (see Section 6.2), turn off the main electricity switch at the Main Switchboard before entering the premise roof space.

6.1 What does the legislation say?

All workers, including persons who undertake electrical work and persons who do not undertake electrical work, **shall not enter** in a roof space of a Class 1, Class 2 or Class 10a building, unless the building's electrical installation, other than any service apparatus, is de-energised and isolated.

This applies to all work undertaken in the space in the building that is:

(i) immediately underneath the roof; or

(ii) if there is a ceiling under the roof, or a part of the roof, the space between the roof, or that part of the roof, and the ceiling.

This is prescribed in Regulation 3.59B of the Occupational Safety and Health Regulations 1996.

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.59B (2)

A person who, at a workplace, is an employer, the main contractor, a self-employed person, a person having control of the workplace or a person having control of access to the workplace must ensure that, before work is done in a roof space of a building at the workplace, the building's electrical installation, other than any service apparatus, is de-energised and isolated by a competent person.

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.59B (3)

An employee must not do work in a roof space of a building at a workplace unless the building's electrical installation, other than any service apparatus, is de-energised and isolated by a competent person.

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.59B (4)

If the roof space of a building to which sub-regulation (2) or (3) applies is divided into separate parts, such that a person cannot move from one part of the roof space to another without first exiting the roof space, and each part relates to a separate dwelling, the requirement to de-energise and isolate only applies to the part of the dwelling that relates to the part of the roof space in which the work is to be done.

In the above regulations,

"building" means a Class 1, Class 2 or Class 10a building as classified under the Building Regulations 2012;

"roof space, of a building" (a) means the space in the building that is (i) immediately underneath the roof; or (ii) if there is a ceiling under the roof, or a part of the roof, the space between the roof, or that part of the roof, and the ceiling. Roof space does not include an attic in the roof space

service apparatus has the meaning given in the Electricity Act 1945 section 5(1).

6.2 Applicable buildings

The legislation applies to work undertaken into the roof spaces of Class 1, Class 2 or Class 10a building as classified under the Building Regulations 2012. The applicable buildings are:

- *Class 1a - A single dwelling being a detached house, or one or more attached dwellings, each being a building, separated by a fire-resisting wall, including a row house, terrace house, town house or villa unit.*
- *Class 1b - A boarding house, guest house, hostel or the like with a total area of all floors not exceeding 300m^2, and where not more than 12 reside, and is not located above or below another dwelling or another Class of building other than a private garage.*
- *Class 2 - A building containing 2 or more sole-occupancy units each being a separate dwelling.*
- *Class 10a- A private garage, carport, shed or the like*

Buildings that were constructed as Class 1a, 1b, 2, or 10a buildings and have been repurposed for other uses (such as a medical practice or retail outlet) are also covered under these regulations.

Commercial buildings, shopping centres and other building specifically designed for such purposes are not included.

6.3 Electrical hazards in roof spaces

Electrical hazards include:

- Exposed live electrical conductor / wiring;
- Unenclosed joints in conductors i.e. no connection boxes;
- Electrical connections where the condition of wiring has deteriorated (often associated with older buildings);
- Unused wiring left in the roof space that could be still connected to the switchboard (i.e. not disconnected);
- Past electrical work not performed by a competent person and which could be sub-standard and unsafe;
- Solar Array DC and Service AC Cabling - Cabling carrying significant DC voltage from solar arrays to inverters may travel through roof spaces in a way that does not comply

with the Wiring Rules and other regulations requiring that they be clearly marked, appropriately fastened and protected by conduit to avoid contact. Many of these existing arrays cannot be isolated at the source and DC cabling remains live to the switchboard during daylight hours. Roof spaces may also contain AC cables running to the switchboard which remain live (e.g. service apparatus cable).

- Cables whose insulation may have been damaged for e.g. chewed by rats or other rodents also presents a hazard if cables are energised.
  Some older established dwellings/buildings may still have electrical wiring with vulcanised Indian rubber (VIR) or tough rubber sheathed (TRS) insulation. These types of insulation can severely degrade over time and might be at the end of their serviceable life, presenting an electric shock hazard to persons using appliances or when entering the roof space. This represents a serious defect in the electrical installation. The remedial action requires replacement of all the VIR or TRS insulated wiring.
- Metallised foil insulation which may have been energised due to poor installation practices. If not properly installed, foil insulation can cause areas of the roof space to become energised. This is a danger to workers installing the insulation and individuals entering into the roof space. In some cases, gutters and fixtures around the home may also be energised.

6.4 Carrying out work in the roof space

Employers must ensure they provide the necessary tools and equipment (including adequate lighting, power tools etc.) to their employees to facilitate working in roof spaces with the main switch off.

Considerations to be made when carrying out work in roof spaces include:

- ensuring someone is aware of where you are and contact with them is maintained until work is completed;
- being aware that heat and humidity may cause heat stress, so make sure fluid intake is sufficient to ensure you do not become dehydrated;
- taking additional lighting (e.g. torch) with you as the lighting is generally poor in roof spaces;
- taking care accessing and traversing the work area, avoiding tripping over debris, material and the ceiling trusses;
- step carefully on joists or other beams – not the ceiling material (i.e. Gyprock sheeting) – to avoid risk of falling or injury;
- using/providing appropriate tools – preferably manual or battery operated tools;
- being aware of the location of electrical cables, fittings and equipment and avoiding contact with them;
- ensuring that, if fixing points are required (e.g. saddling TV aerial cable in place), fixings are well clear of all electrical cables and equipment;
- making sure you do not damage any electrical cables or electrical equipment. If any electrical cable or equipment is damaged, consult with the owner and engage a licensed electrical contractor to inspect the installation;
- wearing appropriate, well maintained and correctly-fitted personal protective equipment when working in dusty roof spaces, including: a half-face (class P1 or P2) disposable particulate respirator, in accordance with AS/NZS 1715:2009 Selection, use and maintenance of respiratory protective equipment;
- a head-covering and goggles, to avoid eye irritation;
- long-sleeved, loose-fitting clothing and gloves, to minimise skin contact with insulation material;
- wearing appropriate footwear;

- keeping your work areas clean and clear of fibres and dust and place waste in plastic bags capable of containing the dust.

6.5 Managing the risks

The only certain way to ensure a worker is not inadvertently electrocuted in a roof space is to ensure that no electricity is flowing through the installation while the work is being conducted. With the advent of battery-operated hand-held tools and powerful battery-operated LED lights, there is no reason why the main switch and all known sources of electricity running through the roof space cannot be isolated prior to work being commenced.

Turning off electricity to the property at the main switchboard does not turn off the electricity supply from the street to the switchboard.

The legislation does not require switching off any service apparatus upstream of the meter. This means the incoming overhead service lines and the cables supplying the switchboard will still be live. Extreme care must be taken to avoid touching any of these live overhead electrical lines or supply cables.

Before commencing work in the roof space:

- Inform the owner of the installation that you will need to switch off all supplies to the building;
- Conduct a Risk Assessment (see Appendix B of this Code). The Risk Assessment must ensure that control measures are undertaken to avoid contact with any energised service apparatus or overhead electrical lines or supply cables or consumer mains.
- Switch off and isolate the Main Switch at the main switchboard;
- Identify and isolate any other sources of electricity which run through the roof space;

<u>Alternative sources of electricity supply</u>

The Wiring Rules require the provision of an isolating device to isolate every source of electricity including inverters and battery banks.

The device must generally be installed adjacent to the electricity generating system.

If workers cannot isolate all sources of electricity and they have any concerns about the condition of the electrical installation, they should not proceed with the work. They should advise the occupant and their employer(s) about their concerns.

It is strongly recommended that workers are trained on the shut down procedures to shut down alternative sources of supply, including batteries.

Where solar photo voltaic (PV) systems are installed, supply cables from the solar cells on the roof to the inverter unit will be live when the solar cells are generating electricity. For this reason, care must be taken when working near these cables.

If workers are not trained and competent to shut down alternative sources of supply, they must not attempt to do so.

An exclusion zone must be maintained, at all times, near energised service apparatus, consumer mains and all energised cables and equipment running through the roof space. Other hazards such as working at heights must also be managed.

6.6 Exemption from OSH Regulation 3.59B (2) and (3)

Electrical work on energised electrical installations can almost never be justified at residential premises.

However, to allow for exceptional cases where there is no reasonable alternative than leaving the building's electrical installation energised while doing electrical installing work in the roof space, the legislation does provide for exceptions.

Any exceptional circumstances, justifying work on energised installations, must comply with Regulation 55 of the Electricity (Licensing) Regulations 1991.

OCCUPATIONAL SAFETY AND HEALTH REGULATIONS 1996 - REG 3.59B (5)

(5) Sub-regulations (2) and (3) do not apply in relation to electrical installing work carried out under the Electricity (Licensing) Regulations 1991 regulation 55(4).

Electricity (Licensing) Regulations 1991 – REG 55 (4)

A person may carry out electrical installing work, or cause electrical installing work to be carried out, on or near an energised part of an electrical installation if:

(a) a risk assessment has been undertaken by a competent person who is familiar with the type of work to be carried out; and

(b) the competent person is satisfied that-

(i) there is no reasonable alternative to carrying out the work while the part of the electrical installation is energised; and

(ii) the risks identified by the risk assessment are or can be reduced to as low as reasonably practicable; and

(iii) the work can be carried out safely; and

(c) where the Occupational Safety and Health Regulations 1996 regulation 3.143 does not apply to the work, a safe work method statement for the work has been prepared in accordance with regulation 3.143(4) of those regulations (as if the work were high-risk construction work and the place where the work is to be carried out were a construction site); and

(d) suitable personal protective equipment and safety equipment is used by the person carrying out the work.

All the requirements of section 4 of this Code must be complied with.

If degraded electrical wiring or unenclosed joints are identified in any installation, the risk assessment should identify that the risks are too high. The work should not proceed and the situation reported to the owner/occupant.

6.7 Working on gas appliances in roof spaces

Clause 6.3.1 (f) of AS/NZS 5601.1.2013 Gas Installations require, among other things, the provision of artificial lighting at gas appliances located in roof spaces. The Standard also requires the switch to be located adjacent to the access opening.

The legislation now requires that the building's electrical installation be de-energised and isolated prior to entering the roof space.

This includes switching off the circuit to the artificial lighting as well. Portable battery-operated lights should be used instead.

All testing and fault-finding on the appliance must also be done de-energised. If any testing and fault-finding is necessary and there is no alternative than to energise the supply to the equipment, a Risk Assessment must be undertaken. The work can then proceed while ensuring it complies with a Safe Work Method Statement (SWMS) for the work, endorsed by the main contractor or employer or person in control of the workplace or sole-trader gas fitter.

6.8 Completion of work in the roof space of a building

The occupants of the residential premises and any other workers should be advised before the main switch is turned back on and the electrical installation energised. This is to ensure no other hazards are inadvertently caused by energising the building's electrical installation after completion of the work.

APPENDIX A – DEFINITIONS

competent person *means a person who holds an electrical worker's licence that is endorsed as an electrician's licence;*

electrical installing work *has the meaning given in the Electricity (Licensing) Regulations 1991 regulation 3(1);*

energised *means not electrically separated from a supply of electricity;*

near *means a position whereby an energised part of an electrical installation can be contacted by a person carrying out the work, directly or indirectly (including with a thing used or controlled by the person), with an uninsulated energised part of the electrical installation.*

network operator *has the meaning given in the Electricity Act 1945 section 5(1).*

risk assessment, *in relation to electrical installing work to be carried out on or near an energised part of an electrical installation, means the process of —*

> *(a) identifying the electrical hazards to which a person doing the work is likely to be exposed; and*
>
> *(b) assessing the risk of injury or harm, resulting from those hazards, to the person who will carry out the work.*

de-energised and isolated means

> (a) the electrical installation is electrically separated from the or each supply of electricity; and
>
> (b) measures are taken to ensure that it cannot be energised inadvertently.

Extra low voltage means voltage that does not exceed 50 volts alternating current (50 V a.c.) or 120 volts ripple-free direct current (120 V ripple-free d.c.).

Low voltage means voltage that exceeds extra-low voltage and does not exceed 1000 volts alternating current (1000 V a.c.) or 1500 volts direct current (1500 V d.c.).

High voltage means voltage that exceeds low voltage.

APPENDIX B – RISK MANAGEMENT PROCESS

Electrical hazards are an inherent part of electrical installing work. Appendix F provides guidance on some of the risks to be considered whenever undertaking electrical work. Whenever undertaking electrical installing work, the electrical risks associated with doing such work should be assessed

Electrical installing work (whether energised or de-energised) must only be carried out by appropriately licensed electrical workers.

Electrical installing work MUST NOT be carried out, on or near an energised part of an electrical installation.

If the person carrying out the work could make contact, directly or indirectly (including with a thing used or controlled by the person), with an uninsulated energised part of the electrical installation, it means the person is working near an energised part of an electrical installation.

Before electrical installing work is carried **on or near** an energised part of an electrical installation, the legislation requires that a **risk assessment be undertaken by a competent person** who is familiar with the type of work to be carried out. The systematic process must involve:

- identifying hazards;
- assessing the risks associated with these hazards;
- implementing and maintaining risk control measures; and
- developing a written safe work method statement to be followed when carrying out the work.

I. Identify the hazards

Identifying hazards involves finding all of the tasks, situations and sequences of events that could potentially cause harm.

The following initial tests should be applied to the risk assessment that must be undertaken before any work on or near energised electrical installations is contemplated:

- Will a planned shutdown cause a greater risk to safety than not having a shutdown?
- What provisions are in place to safeguard against any unplanned failure of the electricity supply?
- Are critical parts provided with redundant/standby plant to safeguard against unplanned failure of equipment?

Hazards arising from energised electrical equipment or installations may arise from:

- design change or modification;
- old equipment with inadequate or inactive electrical protection;
- where and how electrical equipment is used. Electrical equipment may be subject to operating conditions that are likely to result in damage to the equipment or a reduction in its expected life span. For example, equipment may be at greater risk of damage if used outdoors or in a factory or workshop environment
- type of electrical equipment;
- the condition of the electrical equipment and electrical installations;
- abnormal conditions such as earlier damage caused to the equipment;

- Potential electrical hazards may be identified in a number of different ways including:
- regularly inspecting and testing electrical equipment and electrical installations as appropriate;
- reading product labels and manufacturers' instruction manuals;
- talking to manufacturers, suppliers, industry associations, and health and safety specialists;
- reviewing incident reports;
- inspecting the electrical installation / equipment prior to commencing work.

II. Assess the risks

If electrical work on or energised uninsulated parts is proposed to be carried out, a risk assessment must be undertaken before the work starts and it must be carried out by a competent person and recorded.

The following risk factors associated with carrying out electrical work should be considered:

- sources of electrical risks, including energy levels at the workplace;
- the nature of the electrical work to be carried out;
- potential or actual high fault current levels (i.e. risks associated with arc flash)
- availability of isolation points;
- work practices;
- the type of plant, machinery and equipment to be used;
- availability of suitable test instruments;
- availability of properly rated PPE;
- the workplace and working environment, for example:
  - the number of people exposed to the risks;
  - weather conditions;
  - the presence of trenches, pits and underground ducts;
  - ladders, scaffolds, portable pole platforms, elevating work platforms, poles and towers;
  - confined spaces;
  - ability to safely rescue persons;
  - the competence of people carrying out the work, noting that licensing requirements may apply for the electrical work under local electrical safety laws.

Also consider individual workers' needs, for example:

- Is the worker experienced in, and have they been properly trained for, the working conditions?
- Is the worker physically fit for the proposed work, for example are they able to climb to heights to work on an overhead conductor or are they mentally alert and not fatigued?
- Does the worker have a visual or hearing impairment, for example do they have a visual colour deficiency or hearing loss?
- Does the worker take any medication that may increase their vulnerability to work in the required environment or conditions?

III. Control the risks

Once hazards have been identified and the risks assessed, appropriate control measures must be put in place. Electrical safety generally depends on appropriate training, work planning, and correct testing procedures and techniques.

The ways of controlling risks are ranked from the highest level of protection and reliability to the lowest. This ranking is known as the ***hierarchy of risk control***. You must work through this hierarchy to choose the control that most effectively eliminates or minimises the risk in the circumstances, so far as is reasonably practicable. This may involve a single control measure or a combination of two or more different controls.

Elimination

The most effective control measure is to remove the hazard or around a hazardous work practice. For example, working de-energised rather than energised eliminates significant electrical risks. That is why the legislation prohibits energised electrical work subject to certain exceptions.

Substitution

Replacing a hazardous process or material with one that is less hazardous will reduce the hazard, and hence the risk. For example, it may not be reasonably practicable to eliminate energised electrical work altogether; however, even if it is necessary (for one of the legally permissible reasons) to work on an energised electrical part, it may be possible to de-energise the surrounding parts.

Isolation

Preventing workers from coming into contact with the source of the electrical hazard will reduce the relevant risks.

Engineering controls

Use engineering control measures to minimise the risk, for example insulation, guarding and installing residual current devices to prevent electric shock.

Administrative controls

Administrative controls involve the use of safe work practices to control the risk, for example the provision of suitable and adequate training, establishing exclusion zones, use of permits and warning signs.

Personal protective equipment (PPE)

PPE includes protective eyewear, insulated gloves, hard hats, aprons and breathing protection. The PPE should be rated for the work to be done. If working on energised equipment, the PPE must be able to protect the user from the maximum prospective energy available at the work site.

Administrative controls and PPE do nothing to change the hazard itself. They rely on people behaving as expected and require a high level of supervision. Exclusive reliance on administrative controls and PPE is not permitted for work on energised electrical installations.

IV. Review the control measures

The controls that are put in place to protect health and safety must be reviewed regularly to make sure they work effectively.

The following questions will help you evaluate how well you are currently managing electrical risks in your workplace:

- Do you talk to your workers about electrical safety? Do any relevant new work methods or equipment have the potential to make work safer in your workplace?
- Are procedures for identifying electrical hazards in the workplace effective?
- Are electrical safety procedures followed? Do you encourage your workers to report electrical hazards?
- Do you regularly inspect and maintain your electrical equipment to identify safety problems?
- Do you fix or rectify identified electrical hazards in a timely manner?

FURTHER GUIDANCE ON RISK ASSESSMENTS

- Refer to AS/NZS4860:2004- Risk Management.
- In preparing the risk assessment, Standards Australia's handbook "HB 436:2004 - Risk Management Guidelines" may be of assistance.
- The Commission for Occupational Safety and Health's Guidance note: General duty of care in Western Australian workplaces.

APPENDIX C – PREVENTATIVE ACTIONS CHECKLIST

This checklist will help you to identify hazards associated with electrical work and develop safe work methods.

If you answer 'NO' to any question you must take action to put **appropriate risk control measures** in place.

PART 1: INITIAL ASSESSMENT	**Y**	**N**
Can the work be undertaken while the electrical equipment is de-energised? *If **Yes**, proceed to Part 2. If **No**, is it:* • necessary because carrying out the work by alternative means would put the safety and health or one or more persons in imminent and significant danger? **OR** • necessary that the part of the electrical installation to be worked on is energised in order for the work to be carried out effectively? **OR** • is it necessary to test, measure the performance of or detect faults in, the electrical installation or part of the electrical installation? **OR** • are there no reasonable alternative means of carrying out the work? *If your answer to any of these is 'yes' proceed to Part 3 after considering whether part of the installation may be de-energised while the work is carried out.* *If you cannot answer 'yes' to any of these proceed to Part 2—you must work de-energised.*		
PART 2: WORK DE-ENERGISED	**Y**	**N**
• Do you have approved test instruments suitable for the task?		
• Have you checked that the test instruments are functioning correctly?		
• Have you isolated the supply e.g. by switching off?		
• Have you conclusively tested that the installation is de-energised? *You must carry out the electrical work in accordance with any safe work method statement that must be prepared for the work.* *Proceed to Part 4.*		
PART 3: WORK ON OR NEAR ENERGISED EQUIPMENT	**Y**	**N**
Has a risk assessment been conducted by a competent person which identifies all electrical hazards and non-electrical hazards, both actual and potential?		
Is the work area clear of obstructions to allow for easy access?		
Is the isolation point clearly marked or labelled and capable of being operated quickly?		
Has the person with management or control of the workplace been consulted about the proposed electrical work?		

Do you have a safe work method statement for the task at hand? This should state the control measures required to eliminate or minimise the risks.		
Are you trained, competent and confident in applying the particular procedures or techniques that are required for the task?		
Have you checked to ensure that your tools and accessories are insulated and have been inspected and maintained to ensure they are serviceable?		
Is your test equipment appropriate to the task and functioning correctly?		
Are you wearing the appropriate clothing and associated PPE for the task e.g. safety helmet and boots, insulating gloves?		
Do you have the appropriate insulating mats and sheeting?		
Is a safety observer present? *Note: a safety observer is not required for electrical work if it only involves testing and the risk assessment shows that there is no serious risk associated with the work.*		
Are the necessary first aid facilities provided and accessible and are unauthorised persons prevented from entering the work area?		
REMEMBER: • Do the work very carefully. • Follow the safe work procedures. • Assume all exposed conductors are energised. • Be aware of the voltage to earth of all exposed conductors.		
PART 4: AFTER COMPLETING THE WORK	**Y**	**N**
Have the installations/circuits/equipment been restored to a safe and operable condition?		
Have all tags and locking-off devices been removed?		

APPENDIX D –ISOLATION AND TAGGING

Working de-energised on or near electrical installations requires the electrical installations to be effectively isolated from all relevant sources of electricity supply.

This may be done using opening switches, removing fuses or links, opening circuit breakers or removing circuit connections. The standard steps in isolation are:

Consultation	• consulting with the person with management or control of the workplace (e.g. in relation to the timing of the work) and notifying any other affected persons as appropriate; • consulting with occupants of domestic dwellings;
Isolation	• identifying the circuit(s) requiring isolation • disconnecting active conductors from the relevant source(s), noting there may be multiple sources and stand-by systems/generators/photovoltaic systems as well as auxiliary supplies from other boards • if a removable or rack out circuit breaker or combined fuse switch is used it should, if reasonably practicable, be racked out or removed then locked open and danger tagged
Securing the isolation	• locking the isolating switch(es) where practicable or removing and tying back relevant conductors to protect the person(s) carrying out the electrical work
Tagging	• tagging the switching points where possible to provide general information to people at the workplace
Testing	• testing to confirm the relevant circuits have been de-energised and any other relevant conductors in the work area
Re-testing as necessary	• for example, if the person carrying out the work temporarily leaves the immediate area, checks and tests must be carried out on their return to ensure that the electrical equipment being worked on is still isolated to safeguard against inadvertent reconnection by another person • for example, if a wire changes its status when cut, which can occur because it is lifted from earth.

The effectiveness of isolation procedures relies on:

- identifying the correct circuit(s) to isolate;
- isolation points being readily available/accessible and being suitable for the type of isolation (switching) being conducted;
- the necessary hardware;
- having isolation procedures documented and accessible to electrical workers in the workplace;
- the provision of instruction, information and training of electrical workers involved with the electrical equipment;
- appropriate supervision to ensure safe work procedures, including isolation procedures, are followed.

Safe isolation procedures (including the use of locks and tags discussed below) should be developed in consultation with relevant workers. If the workers are represented by a health and safety representative, the consultation must involve that representative.

Securing the isolation

For work on electrical installations or circuits, ensure that the correct point of isolation is identified, an appropriate means of isolation is used and the supply cannot be inadvertently re-energised while the work is carried out.

A fundamental principle is that the point of isolation should be under the control of the person who is carrying out the work on the isolated conductors.

Tagging systems should also be used at the point(s) of isolation where possible for general information.

The isolation should be secured by locking off (where appropriate) and tagging the electrical equipment as follows.

Instruction, information, training and supervision

Appropriate instruction, information, training and supervision must be provided to ensure that electrical equipment that has been de-energised to allow electrical work to be carried out is not inadvertently re-energised. This includes appropriate instruction, information and training on isolation procedures to everyone who may be affected at the workplace.

Locking off

Isolation points should be fitted with control mechanisms that prevent the electrical equipment from being inadvertently re-energised. The control mechanism should require a deliberate action to engage or disengage the device. It should be able to withstand conditions that could lead to the isolation failing, for example vibration.

This may include switches with a built-in lock and lock-outs for switches, circuit breakers, fuses and safety lock-out jaws (sometimes called ‘hasps’).

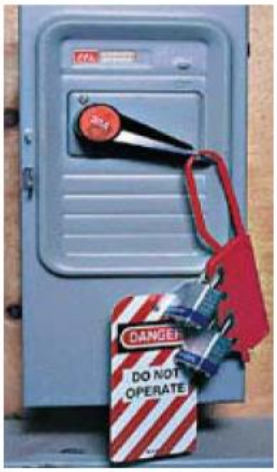
All circuit breakers, switches and combined fuse switch units should be locked off to secure the isolation where possible.

Alternative controls may include an additional component, for example a clip, screw, bolt or pin that can be inserted to prevent a switch from being operated. These types of controls should be used in conjunction with additional control measures, such as danger tags and permit systems.

If more than one person is working on the same de-energised electrical installation, individuals should ensure their own personal lock is applied to the isolation point, otherwise the principles of tagging apply (see below).

No-one should operate an isolator or knowingly use equipment where the isolator has a control mechanism attached.

In situations where isolation points are accessible by other persons at the workplace ensure, so far as is reasonably practicable, that the isolation method or system is not able to be inadvertently or easily compromised.



Danger tagged locking off hasp

Danger tagged circuit breaker locking off devices

Figure 2: *Locking off methods incorporating danger tags* ***Tagging systems***

Danger tags

Isolation involves using suitable warning or safety signs as well as locks or other controls to secure the isolation.

Where possible, a tag should be attached to normal locks (as shown in Figure 2) at all points of isolation used to de-energise electrical equipment from its electricity supply.

A tag does not perform the isolation function.

Danger tags are not required when using dedicated personal isolation locks.

Danger tags are used for the duration of the electrical work to warn persons at the workplace that:

- the electrical equipment is isolated or out of service
- the electricity supply must not be switched back on or reconnected
- reconnecting electricity may endanger the life of the electrical worker(s) working on the equipment.

The danger tag should:

- be durable and securely fixed to the isolator
- clearly state the warning, including any warning about specific hazards relating to the isolation (for example, multiple points of supply)
- be dated and signed by the worker or workers involved in carrying out the work or, where appropriate, by the supervisor in charge of the workers
- be attached in a prominent position on each isolation point (i.e. the point or one of many points used to isolate electrical parts) or device
- only be removed by the signatories to the tag. If unavailable and unable to return, measures must be put in place to manage risks associated with removing the lock or tag (e.g. thorough investigation to ensure all workers and others at the workplace are safe).

If the work is incomplete, for example at a change of shift, the last person removes their danger tag or lock and replaces it with a warning tag e.g. out of service or caution.

When work is resumed, the person in charge of the work removes the warning tag (out of service or caution) and each person then applies their danger tag and/or lock.

When work is finally completed, each person removes their danger tag and/or lock.

Where a formal permit system is used, all reasonable steps must be taken to ensure that the designated sign-on, sign-off and tagging procedures are followed.

Out of service tags

Out of service or caution tags are used to identify electrical equipment that is not safe to use or fit for purpose. The out of service or caution tag should:

- be durable and securely attached
- clearly state the nature of the defect or reason why the electrical equipment is unsafe
- be attached on a prominent position on each isolation point
- only be removed by a competent person after fixing or rectifying the defect and making the electrical equipment safe, or replacing with a danger tag in preparation to work on the equipment.

Figure 3: *Example of a danger tag and out of service tag*

Testing

Testing must be carried out to confirm the relevant circuits have been de-energised and the status of any other relevant conductors in the work area.

Bonding conductors

For guidance on bonding conductors if electrical equipment is isolated at a remote location or there is a risk of induced voltage being present, see Australian/New Zealand Standard *AS/NZS 4836: 2011 - Safe working on or near low-voltage electrical installations and equipment*.

Altering isolation for testing, fault finding and re-energising

It may be necessary to change an isolation point to allow for testing or fault finding on energised parts, for example testing that may be required before returning electrical equipment to service and commissioning new electrical equipment.

Any testing or fault finding on energised parts must be carried out in accordance with requirements for energised electrical work, which are discussed in Section 5 of this Code.

If electricity supply is restored to part of the circuit then safe procedures for restoring electricity supply must be followed.

Restoring the electricity supply

All reasonable steps must be taken to ensure that restoring electricity supply following isolation does not pose risks to health and safety at the workplace. For example:

- appropriately terminating all conductors;
- carrying out appropriate testing on any new, altered or repaired electrical equipment, for example tests for insulation resistance, earth continuity, polarity, correct connection and function testing;
- removing safeguards, including temporary bonds and short-circuiting devices;
- notifying all workers working on the electrical equipment and other affected workers at the workplace that electricity is to be restored;
- taking precautions as appropriate to ensure that other electrical equipment is not inadvertently energised;
- following procedures for removing any locks (or other control mechanisms), tags, notices and safety signs;
- carrying out a visual inspection to ensure that all tools, surplus material and waste has been removed from the workplace; and

When electricity is restored tests must be carried out to confirm that polarity is correct, active conductors are switched and, where applicable, phase sequences are correct before electrical equipment is used. For further information refer to Australian/New Zealand Standard *AS/NZS 3017:2007 Electrical installations – Verification guidelines*.

Leaving unfinished work

If work is left unfinished, the workplace must be left in a safe state including, for example, by:

- terminating any exposed conductors;
- physically securing any exposed conductors or surrounding metal work;
- tagging, taping off the electrical equipment and the workplace area;
- informing affected persons at the workplace the work is not complete and advising of potential hazards;
- taking any necessary precautions to ensure that electrical equipment cannot become inadvertently re-energised;
- ensuring that the status of switchboards and electrical equipment are clearly and correctly labelled; and
- handing over adequate information to workers taking up the unfinished work to allow them to continue the work safely.

APPENDIX E – TOOLS AND EQUIPMENT

Inspection and testing

Tools, instruments and equipment that are poorly maintained, inappropriately used or not fit for purpose can cause injuries, for example:

- inadequately insulated tools and test instruments; or
- incorrectly rated instruments.

Unrestrained tools may fall into energised switchboards and compromise the integrity (including safety) of the equipment. The use of lanyards around wrists, tool holders and restraints such as tool pouches and baskets may be used to address these risks.

The tools, instruments and equipment used by electrical workers often have special design characteristics, for example many are insulated. Inadequate maintenance may lead to serious electrical risks, for example insulating medium might conceal a mechanical defect that could cause an open circuit in a testing device.

Insulated tools and equipment must be suitable for the work and be maintained in good working order, including by regular maintenance, inspection and testing. Where any doubt exists that the insulation of tools and equipment might not be adequate they should not be used.

Maintenance and inspection should be carried out according to manufacturer's instructions.

Ladders, scaffolds and similar equipment

Certain ladders, scaffolds and similar equipment may pose electrical risks including:

- metallic or wire reinforced ladders and scaffolds are conductive and may create an electric shock path, for example:
    - a ladder slipping while work is being carried out on it, causing the worker on the ladder to touch exposed energised parts, for example grabbing a mains box;
    - a gust of wind blowing an extension ladder into nearby overhead power lines;
    - in switchrooms and switchyards—conductive devices such as aluminium ladders and scaffolds creating electric shock paths and current paths to earth, for example a metal wire reinforced ladder causing a fault to ground if the ladder touches an energised high-voltage busbar;
- when using ladders, scaffolds and similar equipment, workers are more likely to touch open wiring such as overhead lines;
- in cases where lines are carrying large currents, conductive scaffolds may become subject to induction; and
- portable scaffolds may damage insulation when moved if the scaffold strikes conductors or leads.

Consideration should be given to eliminating the use of metallic, wire reinforced or otherwise conductive ladders; these items should not be used in close proximity to equipment where an electrical hazard may result from their use. These types of ladders should be avoided for any kind of electrical work.

Other effective risk control measures may include:

- identifying if there are exposed energised parts nearby. In this situation, risk control measures such as de-energising, fitting covers, using a safety observer, or a combination of these, should be considered;

- employing safe work practices, including:
    - two or more people carrying long items in switchyards and switchrooms in a position below shoulder height;
    - two people handling extension ladders in windy conditions;
    - restraining ladders using head ropes or footropes, or both
    - if practicable—using a platform-style step ladder;
- if conductive scaffolding is used within high-voltage enclosures or in situations where there is induction, bonding the structure to the earthing system. Depending on the construction of the scaffold, a number of sections may need to be bonded to ensure an equipotential state.

Insulating barriers and insulating mats

Insulating covers and mats used for electrical safety purposes should comply with AS/NZS 2978:1995 *Insulating mats for electrical purposes*.

Insulated barriers should be of suitable material to effectively separate electrical workers from adjacent energised equipment.

Insulated covers and mats should be visually inspected for possible defects before and after each use.

Test instruments

The tools, testing equipment and PPE for testing and fault finding must be suitable for the work, properly tested and maintained in good working order.

Workers carrying out electrical testing must be appropriately trained and competent in test procedures and in the use of testing instruments and equipment, including:

- being able to use the device safely and in the manner for which it was intended
- being able to determine, by inspection, that the device is safe for use, for example the device is not damaged and is fit for purpose
- understanding the limitations of the equipment, for example when testing to prove an alternating current circuit is de-energised, whether the device indicates the presence of hazardous levels of direct current
- being aware of the electrical safety implications for others when the device is being used, for example whether the device causes the electric potential of the earthing system to rise to a hazardous level
- knowing what to do to ensure electrical safety when an inconclusive or incorrect result is obtained.

Checks carried out on test instruments

Test instruments that are to be used or connected to electrical equipment should meet the following conditions:

- be suitable for the work in terms of their function, operating range and accuracy
- be in good condition and working order, clean and have no cracked or broken insulation. Particular care must be taken regarding the condition of the insulation on leads, probes and clips of test equipment
- pose no danger of electrocution to workers or damage to the electrical equipment during testing

- have suitably insulated leads and connection probes that enable connection or contact with energised parts to be made with minimal risk to the electrical worker
- provide suitable protection against hazards arising from over-voltages that may arise from or during the testing or measurement process.

Australian Standard AS 61010.1:2003 *Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – General requirements* provides a classification for instruments on the basis of their immunity to over-voltage, which is liable to be experienced in different parts of electrical equipment. Devices should be rated as Category III or IV to enable their use on all parts of the installations.

Test probes and other equipment should be designed and selected so that they cannot inadvertently short circuit between energised conductors or energised conductors and earth. The terminals of test equipment should be shrouded and all other test sockets on measuring instruments should be designed so as to prevent inadvertent contact with any energised test socket or conductor when equipment is in use. Where appropriate, test leads and testing devices need to be provided with suitable fuse protection. Testing equipment, where used in hazardous flammable areas, should be designed and clearly marked as being suitable for use in these conditions.

Testing equipment used for detecting an energised source should be trialled first to prove that it is functioning correctly immediately before and after the test has taken place. The standard test regime is to test a known source of energy, test the de-energised circuit for zero volts then test the known source again. A faulty indicator will always read zero so must be proved before and after the test.

Proximity voltage testers

To confirm a positive indication and to establish the circuit voltage, the use of an alternative test instrument that incorporates a visual display should be used before commencing electrical work on the equipment.

Testers for detecting an electric field surrounding an energised conductor may not be suitable for testing cables that are surrounded by a metallic screen, enclosed in a metallic pipe or duct, or cables carrying direct current and in some other circumstances.

Proximity voltage testers are not reliable in proving de-energised and should only be treated as an indicator. Proximity voltage testers should be tested for correct operations immediately before use and again immediately after use, particularly if the test result indicates zero voltage, to confirm that the instrument is still working correctly.

Personal protective equipment (PPE)

PPE for electrical work, including testing and fault-finding, must be suitable for the work, properly tested and maintained in good working order. The PPE must be able to withstand the energy at the point of work when working energised.

Training must be provided in how to select and fit the correct type of equipment, as well as training on the use and care of the equipment so that it works effectively.

Depending on the type of work and the risks involved, the following PPE should be considered:

- *Face Protection*—use of a suitably arc rated full face shield may be appropriate when working where there is potential for high current and arcing.
- *Eye Protection*—metal spectacle frames should not be worn.
- *Gloves*—use gloves insulated to the highest potential voltage expected for the work being undertaken. Leather work gloves may be considered for de-energised electrical work.

- *Clothing*—use non-synthetic clothing of non-fusible material and flame resistant. Clothing made from conductive material or containing metal threads should not be worn.
- *Footwear*—use non-conductive footwear, for example steel toe capped boots or shoes manufactured to a suitable standard.
- *Safety Belt/Harness*—safety belts and harnesses should be checked and inspected each time before use with particular attention being paid to buckles, rings, hooks, clips and webbing.

First Aid

All workplaces must first aid facilities appropriate to the type of hazards and the risk of those hazards at the workplace, and sufficient for the number of persons at the workplace. All workplaces must ensure, as far as practicable, that persons trained in first aid are available to give first aid at the workplace, having regard to the type of hazards at the workplace, the risk from those hazards, and the number of persons at the workplace.

More information on first aid is provided in Commission for Occupational Safety and Health's *Codes of practice: First aid facilities and services; Workplace amenities and facilities; Personal protective clothing and equipment*.

Special requirements for safety observers apply in relation to certain energised electrical work. See Section 4.9 of this Code.

APPENDIX F – RISKS ASSOCIATED WITH ELECTRICAL WORK

Activity	Risks
Isolation and access	• Correctly isolating supply but not discharging residual energy e.g. a capacitive charge may be present in power supplies, single-phase motors or high power factor fluorescent fittings. • Insulation and equipment failing or partially breaking down. • Earth connection failing to stop an electric shock in earthed conductive parts when step and touch potentials exist. • Carrying out the task causes a person, something a person may be handling or something a person is in contact with to intrude into minimum safe approach distances. • A power system conducting fault current or being subject to high inrush currents. • Instructions or markings on the parts being inadequate, incorrect or both. • Using equipment not designed for, or capable of, an operation e.g. opening a 'no load – bus tie' under load conditions or relying on an open circuit breaker as an isolation point. • Another person energising circuits while a worker is working on them, or a vehicle hitting a pole. • Natural elements (i.e. lightning or wind) causing static charges, overhead mains to clash or a high-voltage circuit to fall onto a low-voltage circuit. • The inter-core capacitive effects of long multi-phase cables. • Changes to wiring not being reflected in drawings i.e. the drawings are not 'as built' e.g. a live control or supervision circuit being present though the drawing indicates otherwise. • If there has been an error in wiring, opening the isolator may not de-energise the switchboard e.g. if incorrect connection (incorrect polarity) occurred in the service to an installation, opening the main switch will open circuit the neutral rather than the active. • Intentionally disabling an interlock to perform a task e.g. opening the shutter of a 'rackable' circuit breaker test to prove de-energised in the orifice. • Inadvertently disabling an interlock while performing a task e.g. in a switchboard with an integrated circuit breaker, isolator and earth switch, the operator accidentally moving the isolator into the earthed position. • Poor direction and insufficient knowledge e.g. a worker is instructed to apply a set of earths and short circuits at a Ring Main Unit (RMU). The worker correctly observes the isolator is open, however they assume the earth switch can be closed because the isolator is open. As most RMUs are configured so the earth switch earths the cable, not the busbar, it is possible the worker would be earthing and short-circuiting a live circuit. • When applying a set of portable earths and short-circuits, accidental or inadvertent contact is made with live parts. If this occurs, the worker is using a device that is conducting fault current. • The threshold value (lowest level of indication or reading) of a test device causing a misleading interpretation of a test to prove de-energised. Depending on the device used, an indication that parts are not energised in a high-voltage situation does not mean that low-voltage and direct current voltages are absent. • Application of earthing and short-circuiting devices that depend on a conductive path through a fuse or circuit breaker that is not fit for purpose.

Activity	Risks
	• Ineffective connection to the general mass of the earth e.g. the electrode, grid or temporary electrode that the earth and short circuits relies upon in a situation where a single phase becomes energised. • Application of the short circuit portion of portable earthing devices prior to the earth tail being connected to the earth. • Arcing and splattering associated with the application of earths and short circuits, causing a risk. The arcing or splattering may result from using the device in situations that range from energised conductors to residual energy such as capacitance. If the parts are energised, the worker can draw the arc from one phase to the other, causing a phase-to-phase fault. • A potential electric shock path existing once the earth tail is connected to earth. A worker may touch another live part and the earthed connector at the same time, for example in a Common Multiple Earthed Neutral (CMEN) area, even when working on high-voltage, contact between the earthed connector and a low-voltage phase can cause an electric shock.

Working near sources of arcing, explosion or fires	Arcs, explosions and electrical faults can cause burns. Workers should be protected from the effects of burns. Examples include:
	• materials providing a conductive path between sources of potential, for example uninsulated tools falling across busbars
	• abnormal conditions on circuits such as:
	  ○ lightning striking mains
	  ○ circuits of different voltages touching each other e.g. high-voltage contacting low-voltage circuits
	  ○ high voltage in the secondary circuit of a current transformer if an open circuit occurs when current is flowing in the primary circuit.
	• abnormally high voltages when synchronising different supplies. For example, if the waveforms are 180° out of phase, twice the peak-to-peak voltage may be imposed
	• voltage multiplication effects, including:
	  ○ ferro-resonance where the capacitive and inductive components of underground cables and transformers can significantly increase voltages when single-phasing occurs
	  ○ re-strike can occur if capacitors are energised, de-energised and re-energised in rapid succession
	• leakage or electrical discharge causing insulation to be compromised, for example a combination of a build-up of contaminants on insulators, wet weather or tracking through air voids in pitch filled insulating chambers
	• failure of insulating mediums.

Working in unsafe atmospheres	After faults and fires, often in emergencies, electrical workers may be exposed to unsafe atmospheres. Toxic gases and lack of oxygen can cause illness and death. General workplace health and safety risk control measures should be used in these situations. The method of extinguishing fires should be addressed. Typically, carbon dioxide or powder type devices are used against electrical fires. Extinguishers including water, foam and wet chemical should not be used as they significantly increase the risk of electric shock.
Modifying or repairing existing low-	• Electrical drawings/tables not reflecting ‘as installed’ installations. • More than one source of supply or energised circuit may be available on the premises or at the equipment.

Activity	Risks
voltage - electrical installations	• The supply becoming energised during the work. • Automatic starting of machinery after supply is restored. • Managing metallic shavings (swarf) ingress into conductive parts of equipment. • A conductor considered to be de-energised was found to be energised. • Old installations (where several modifications may have been made, circuits have not been identified, or the insulation has deteriorated). • Voltages on disconnected conductors, particularly neutrals. • Installations where the MEN system is used, the rise in the earth potential due to a high impedance return path to the distribution neutral. • Lack of information about isolation, sources of supply or the location of electrical conductors. • Lack of clear safe access to locate electric cables (other hazards may be present such as exposed conductors). • Damage to conductors in metallic conduits where earthing continuity of the conduit has not been maintained. • Equipment located in hazardous areas, which includes bolt-on or screw-on covers, can be dangerous if opened without obtaining specialist advice. • Working alone on energised equipment. • Drilling into switchboards/electrical enclosures. • Contact with cables in walls, floors or roof spaces. • Contact with cables during excavation work or cutting/drilling concrete. • Exposure to asbestos material/switchboards. • Variable frequency devices. • Multiple circuits located within the one conduit. • Use of conductive/flammable cleaning solvents creating an explosive atmosphere.
Testing and fault finding low-voltage equipment and installations	Risks arise as it is difficult to find faults or malfunctions in electrical equipment when the circuits are not energised or when the equipment is not operating, especially if feedback circuits or sensors are involved. Risks can include: • electrical drawings/tables not reflecting ‘as installed’ installations • exposed energised terminals or conductors • terminals or conductors being energised under different conditions of operation of the equipment • loose or disconnected test leads or wiring becoming energised • test equipment and leads bringing electrical hazards closer to the worker • test equipment inappropriate for the task (particularly test probes) • inadequate test points • inadvertent attempts to start machinery by other persons • incorrect or poorly maintained testing instruments • inadequate knowledge of equipment or causes of faults • lack of information about circuits or equipment • equipment located in hazardous areas, which includes bolt-on or screw-on covers, can be dangerous if opened without obtaining specialist advice • testing or fault finding alone on energised equipment • testing or fault finding in cramped or restricted work situations • rotating or moving machinery (crush hazards) • overriding of interlocks or forcing of control equipment • re-setting of protective devices in energised switchboards

Activity	Risks
	• electrical installations where unauthorised electrical work has been undertaken.
High fault currents – working, testing or fault finding energised	When working, testing or fault finding on energised electrical equipment, a fault current of up to 20 times the rated current of the supply transformer can flow for short duration during fault conditions. Arcs can have the energy to cause an explosion and/or melt metallic switchboard cubicles and equipment. Arcs may cause severe burns to the skin and flash burns to the face and eyes. Inhaled hot gases and molten particles can cause serious internal burns to the throat and lungs. Injury can also occur through the impact from flying debris and dislodged components. Circuit protection devices may not operate in such circumstances.

Testing, fault finding or working on or near low voltage equipment	• Voltages between phases and between phases and neutral.
	• Voltages between phases and earth.
	• Voltages across open switch contacts, for example voltage across a light switch on an incandescent lighting circuit or the voltage across a bus tie where one side is de-energised.
	• Voltages on disconnected conductors (particularly neutrals).
	• Voltages from sources near the work being performed, for example:
	  ○ working on a remote area power supply where both a.c. and d.c. voltages may be present
	  ○ repairing lights on a shop fascia when overhead power lines are nearby
	  ○ working on transducer circuits when other a.c. and d.c. circuits are present
	  ○ working on a power system with multiple circuits that may be of multiple potentials.
	• Voltages on the circuit being worked on from other sources including:
	  ○ illegal connections or reconnections
	  ○ Uninterruptible Power Supplies (UPS) and backup supplies
	  ○ motor generators or alternators
	  ○ d.c. on a.c. circuits or a.c. on d.c. circuits
	  ○ harmonics, for example 3rd harmonic 150 Hz in neutrals and earths where there is a large fluorescent light load and switch mode power supplies
	  ○ back Electro Magnetic Forces (EMF) from collapsing magnetic fields or rotating machinery
	  ○ solar panels or photovoltaic.
	• Voltages across undischarged capacitors.
	• Voltages across the secondary terminals of transformers, including current transformers.
	• Voltages caused by static electricity, leakage or discharge, or lightning.
	• Voltages between energised exposed conductors and the surrounding environment (including metalwork, damp situations, other conductive surfaces and persons nearby).
	• Voltages between parts, or open-circuited parts of one earth system, or voltages between different earthing systems.
	• Induced voltages from sources other than the circuit being worked on, for example nearby circuits or radio frequency transmitters.

Activity	Risks
	• Multiple supply sources (more than one source of supply or energised circuit may be available on the premises), for example 'essential services' on a switchboard, emergency backup generators or UPS. • Electrical testing or operating equipment with open enclosures in hazardous areas (as defined by AS/NZS 3000:2007). • The potential (voltage) between parts of the earth in Multiple Earthed Neutral (MEN) systems can change, sometimes causing electric shocks. The changing earth potential can be due to a number of causes including a high impedance return path to the low-voltage distribution neutral, faults on other parts of the power system or lightning strikes. • Incorrect wiring connections, for example transposing active and neutral, commonly referred to as incorrect polarity. • Switched off circuits becoming energised. • Faulty equipment, for example the frame of faulty equipment may become energised. • Step and touch potentials and transferred earth potentials. Transferred earth potentials often result from system faults. • Hygroscopic materials that become conductive, for example fertiliser dust.
Other Hazards	• Working at heights and danger of falling objects. • Removal of cover plates near energised equipment, for example escutcheon plates. • Confined spaces (where there may be a hazardous atmosphere). • Inadequate light to work safely. • Lack of ventilation leading to uncomfortable, hot and humid working conditions. • Excessive worker fatigue, due to pressure of deadlines or other factors. • Obstacles to getting the equipment switched off. • Using a gas flame near exposed electrical conductors (a flame is a conductor). • Using conductive or flammable cleaning solvents. • Temperature rise as a result of combustion. • Cramped working conditions, including cable trenches and cable pits. • Explosive atmospheres. • Use of conductive tools and equipment, for example metallic tape measures and rulers. • Electric tools and equipment (for example, hand lamps, drills, saws, torches and test instruments). • Personal effects (for example, rings, jewellery, watches, pens, cigarette lighters, matches, hearing aids, mobile phones and pagers, transistor radios and similar). • General work activities (for example, welding, cutting, brazing, using hand saws, drilling of all types, hammering and chiselling). • Hot metal surfaces due to drilling, grinding or welding. • Excavation associated with electrical work. • Molten metal from arcs. • Asbestos material/switchboards. • Polychlorinated biphenyl (PCB) in transformers, capacitors and electric motors.