# Electrical Safety Code Of Practice 2010
# Works

Electrical Safety Office Queensland

Department of Justice And Attorney-General

Queensland Government

# Contents

# Part 1 : Introduction

## 1.1 Important Dates

- The *Electrical Safety Code of Practice 2010 – Works (the Code) replaces the Code of Practice Works 2002.*
- This Code was made on 18 December 2009.
- The Code commenced on 1 January 2010.
- This Code expires 10 years after the above commencement date

## 1.2 Legislative framework

The Queensland *Electrical Safety Act 2002* (the Act) is directed at eliminating the human cost to individuals, families and the community of death, injury and destruction that can be caused by electricity not only in workplaces but throughout the community.

The Act sets out the obligations that entities, employers, employees, workers, designers, manufacturers, importers and persons in control of electrical equipment must meet in order to comply with the requirements of the law.

The fundamental principle of the legislation is to set legal requirements to ensure the electrical safety of licensed electrical workers, other workers, licensed electrical contractors, consumers and the general public.

The *Workplace Health and Safety Act 1995* (WHS Act) places obligations on certain persons to ensure workplace health and safety. Workplace health and safety is ensured when persons are free from death, injury or illness and the risk of death, injury or illness created by workplaces, relevant workplace areas, work activities or plant or substances for use at a workplace.

In terms of electrical safety, where the Act and the WHS Act both apply, the Act takes precedence.

The *Electrical Safety Regulation 2002* (the Regulation) prescribes among other things the requirements for working around live electrical parts.

While this Code provides practical advice for an electricity entity on ways to manage their Act obligation, it does not provide advice about all electrical safety obligations. Four other codes of practice made under the Act are:

- *Electrical Safety Code of Practice 2010 – Working Near Exposed Live Parts*
  The *Electrical Safety Code of Practice 2010 – Working Near Exposed Live Parts* gives practical advice on ways to manage electrical risk when working near exposed live electrical parts. The code applies to people such as plant operators, painters, people erecting or working on scaffolds, sign makers and people working with irrigation pipes near exposed live electrical parts. The practical guidance provided in the code may be relevant to electrical workers when they are performing electrical work near another exposed live part.
- *Electrical Safety Code of Practice 2010 – Electrical Work*
  The *Electrical Safety Code of Practice 2010 – Electrical Work* provides practical advice and gives benchmarks for performing electrical work in ways that are electrically safe. The code provides guidance on managing electrical risk only; no guidance on other risks is provided. This code has been designed to reflect the two ways to perform electrical work – working de-energised and working live.
- *Electrical Safety Code of Practice 2010 – Electrical Equipment Rural Industry*
  The *Electrical Safety Code of Practice 2010 - Electrical Equipment Rural Industry* gives practical advice on a way of discharging a person's electrical safety obligation. Included in the code are ways to identify and manage exposure to risks of injury and property damage caused directly or indirectly by electricity.
- *Electrical Safety Code of Practice 2010 – Risk Management*
  The *Electrical Safety Code of Practice 2010 – Risk Management* gives practical ways of managing electrical safety risks. The code clearly defines and explains the five step risk management process that obligation holders under the Act should perform to make sure all electrical risks are minimised.

References to legislation, Australian Standards and other documents in this Code are current at the time of printing. From time to time amendments are made to legislation. The user should therefore check to ensure applicable legislation is current at the time of reading.

## 1.3 What is a code of practice?

A code of practice is a document made under the Act. It gives practical advice on ways to discharge electrical safety obligations. Included in a code are ways to identify and manage exposure to risks of injury and property damage caused, directly or indirectly, by electricity.

Under section 45 of the Act, the code of practice does not state all that a person must do, or must not do, to discharge their electrical safety obligation.

However, the person fails to discharge the electrical safety obligation if they:

(a) contravene, or otherwise act inconsistently with, the code of practice; and

(b) do not follow a way that is as effective as, or more effective than, the code of practice for discharging the electrical safety obligation.

## 1.4 What is this Code about?

This Code gives practical advice on ways for an electricity entity to manage electrical safety risks associated with earthing systems, underground cable systems, and supporting structures for overhead lines forming parts of the works of an electricity entity.

Appendix A contains the meaning of terms used in this Code.

## 1.5 What is an 'electricity entity'?

Under Schedule 2 of the Act, **electricity entity** means:

(a) a generation entity, transmission entity or distribution entity; or

(b) a special approval holder that is authorised under the Electricity Act 1994 to do something that a generation entity, transmission entity or distribution entity may do under that Act; or

(c) QR Network Pty Ltd ACN 132181116.

## 1.6 Obligations under the *Electrical Safety Act 2002*

Section 29 of the Act imposes obligations on an electricity entity ensure that its works are:

- electrically safe; and
- operated in a way that is electrically safe.

This obligation includes the requirement that the electricity entity inspects, tests and maintains the works.

**Works of an electricity entity** means the electrical equipment, and electric line associated equipment, controlled or operated by the entity to generate, transform, transmit or supply electricity (section 25 of the Act).

An example of the works of an electricity entity is an overhead distribution system of a distribution entity, including transformers and switches.

Examples of what is not works of an electricity entity are appliances or fixed wiring in an electricity entity's workshop or offices.

## 1.7 How can an entity meet its obligations?

Under sections 41 to 45 of the Act, there are three ways an entity can meet its electrical safety obligations – either through regulation, ministerial notices or codes of practice. Where applicable, the entity must comply in the following manner to meet its obligations:

a) if a regulation is identified as prescribing a way of discharging an electrical safety obligation, the entity will fail to meet its obligation if it contravenes the regulation;

b) if a ministerial notice prescribes a way of meeting an electrical safety obligation in relation to an electrical risk, the entity will fail to meet that obligation if it contravenes the ministerial notice;

c) if a code of practice states a way of meeting its electrical safety obligation, the entity will fail to meet that obligation if it:

- contravenes the code or act in a way inconsistent with the code; and
- does not follow a way that is equally effective to, or more effective than, the code of practice for discharging the entity's electrical safety obligation.

If this Code is inconsistent with the regulation, then the Regulation prevails to the extent of the inconsistency.

An electricity entity should also refer to Part 2 of this Code on risk management for meeting its obligations generally.

## 1.8 Requirements of the *Electrical Safety Regulation 2002*

**Performance and other requirements for works**

Under section 131 of the Regulation, the following requirements apply for the works of an electricity entity

(a) the works must be able to perform under the service conditions and the physical environment in which the works operate;

(b) the works must have enough thermal capacity to pass the electrical load for which they are designed, without reduction of electrical or mechanical properties to a level below that at which safe operational performance can be provided;

(c) to the greatest practicable extent, the works must have enough capacity to pass short circuit currents to allow protective devices to operate correctly;

(d) the works must have enough mechanical strength to withstand anticipated mechanical stresses caused by environmental, construction or electrical service conditions;

(e) the works must be;

  (i) designed and constructed to restrict unauthorised access by a person to live exposed parts; and

  (ii) operated in a way that restricts unauthorised access by a person to live exposed parts;

(f) design, construction, operation and maintenance records necessary for the electrical safety of the works must be kept in an accessible form;

(g) parts of the works whose identity or purpose is not obvious must be clearly identified by labels, and the labels must be updated as soon as possible after any change is made to the works; and

(h) electrical equipment intended to form part of the works of an electricity entity must undergo commissioning tests and inspection to verify that the electrical equipment is suitable for service and can be operated safely when initially installed or altered.

## 1.9 Defences for failing to meet an entity's electrical safety obligation

Under sections 46 and 47 of the Act, if charged with a breach of obligation, an entity can provide a valid defence by establishing that the breach was due to causes beyond its control. In this instance, the entity cannot claim as a defence those sections of the Criminal Code relating to an accidental act or omission, or a mistaken belief.

Where there is no regulation, code of practice or ministerial notice that tells the entity how to meet its electrical safety obligation under the circumstances, the entity can seek to establish that it chose an appropriate way, took reasonable precautions and exercised proper diligence to discharge its safety obligation.

## 1.10 Penalty for failure to meet an electrical safety obligation

Under section 27 of the Act a maximum penalty for failing to discharge an electrical safety obligation is:

a) if the breach causes multiple deaths: 2000 penalty units or three years imprisonment; or

b) if the breach causes death or grievous bodily harm: 1000 penalty units or two years imprisonment; or

c) if the breach causes bodily harm: 750 penalty units or one year's imprisonment; or

d) otherwise 500 penalty units or six months imprisonment.

This Code should be read in conjunction with the Act, the Regulation, and other relevant codes of practice. Hard copies of these documents are available from the Queensland Government Bookshop by phoning (07) 3883 8700 or 1800 801 123 (outside Brisbane), or by visiting www.bookshop.qld.gov.au.

Further information on electrical safety is available from the Department of Justice and Attorney-General website at www.electricalsafety.qld.gov.au or by phoning the Infoline on 1300 650 662.

# Part 2 : Risk Management

‘Risk management’ is defined by the Australian / New Zealand Standard *AS/NZS ISO 31000:2009 Risk Management* as ‘the coordinating of activities to direct and control an organisation with regard to risk’.

The term ‘hazard’ is often used as an identifier of potential sources of risk. However in the practical application of risk management principles, it is the risk itself that must be addressed. The *AS/NZS ISO 31000:2009 Risk Management Standard* (the Standard) refers to the identification of risk, while the term hazard is used in Workplace Health and Safety and Electrical Safety legislation in the same context. Similarly, ’risk control’ is referred to in the Standard as ‘risk treatment’. These distinctions are definitional only and the terms ‘risk’ and ’treatment’ are used in this code for the purposes of clarity and consistency with the Standard.

The risk management process required by the WHS Act is systematically divided into five steps:

1. identify hazards (risks under the Standard), based on experience, recorded data and other information;

2. assess risks that may result by making an evaluation of the level of risks to the health and safety of workers, based on the consequences and likelihood of harm;

3. decide on control measures (risk treatment measures under the Standard) from the hierarchy of control (risk treatment hierarchy) i.e. eliminate, substitute, isolate or engineer out the risks, or reduce them through administrative measures or personal protective equipment to prevent or minimise the level of the risks. This should be achieved by selecting the highest order control (treatment) method possible and then proceeding down the list in order;

4. implement the selected control (treatment) measure(s) in the workplace; and

5. monitor and review the effectiveness of the control (treatment) measures to ensure that they are working correctly to control (treat) the risks and that no other risks have been introduced.

NOTE: Compliance with the risk management process does not excuse a person from ensuring workplace health and safety or from complying with an obligation under the Act.

Effective risk management involves identifying all of the risks in the workplace, and then carrying out a risk assessment for each, to assess its severity, before deciding its priority for treatment. When carrying out a risk assessment, determine the risks that have the greatest potential to cause harm and a greater likelihood of occurring. These risks are treated first, followed by the less serious risks.

Attention should be given to risks that may be easy to fix but may have low risk priority scores (e.g. power leads across the floor). These risks should be fixed promptly. Particular attention should be given to risks that may have very low likelihood of causing harm but may result in major consequences.

The Act requires that electrical work and associated equipment be electrically safe (sections 29 to 40); that is, free from electrical risk. Electrical risk can be managed through the risk management process as described below. Specific applications of the risk management process are covered in relevant following parts.

## 2.1 Risk

**Risk** is the likelihood and consequence of injury or harm occurring.

For example, if the risk is electricity, there the likelihood that a worker might be electrocuted because of the exposure to electrical live parts.

The degree of risk will depend on the amount of exposure to the risk. With regard to electricity, this would relate to aspects of the electricity i.e. voltage, frequency of exposure, and degree of risk treatment measures in place.

## 2.2 The risk management process

Effective risk management involves identifying all of the risks in the workplace, and then carrying out a risk assessment for each risk, to assess the severity of a risk, before deciding its priority.

When carrying out a risk assessment, determine the risks that have the greatest potential to cause harm and a greater likelihood of occurring. These risks are treated first, followed by the less serious risks.

As set down in the *Electrical Safety Code of Practice 2010 - Risk Management*, there are five basic steps in the risk management process.

**Step 1: Identify all risks** by:

- observing, inspecting, investigating, communicating and consulting; and
- making a record of the risks identified.

**Step 2: Assess the risks** by:

- assessing and prioritising the risks;
- dealing with the highest priority risks first; and
- dealing with less risks or least significant risks last.

**Step 3: Decide on measures to treat the risks** by:

**A.** eliminating the risk; or

**B.** if elimination of the risk is not possible, select these risk treatment measures in the following order of preference:

(i) substitution e.g. using machines with better guarding;

(ii) isolation (not administrative) e.g. remove or separate people from the risk;

(iii) minimisation by engineering means e.g. modify a machine so it can be used by remote control;

(iv) application of administrative measures e.g. using signs, training or policies to treat risk; and

(v) use of personal protective equipment (PPE), equipment or clothing designed to protect the worker.

**Step 4: Implement appropriate risk treatment measures** that will:

- adequately treat the risks;
- not create other risks; and
- allow workers to do their work without undue discomfort or distress.

**Step 5: Monitor the risk treatment measures and review the process:**

**A: Monitor**

- Have the measures been implemented as intended?
- Are the measures adequate?
- Did the implementation of treatment measures create other risks?

**B: Review**

- Has anything changed over time since the risk process was implemented?
- Is the treatment of risks still adequate?
- Was the risk management process conducted effectively?

For further information on risk management and guidelines on how to complete a risk assessment, please refer to the *Electrical Safety Code of Practice 2010 - Risk Management.*

The five step risk management process is illustrated in Figure 1.

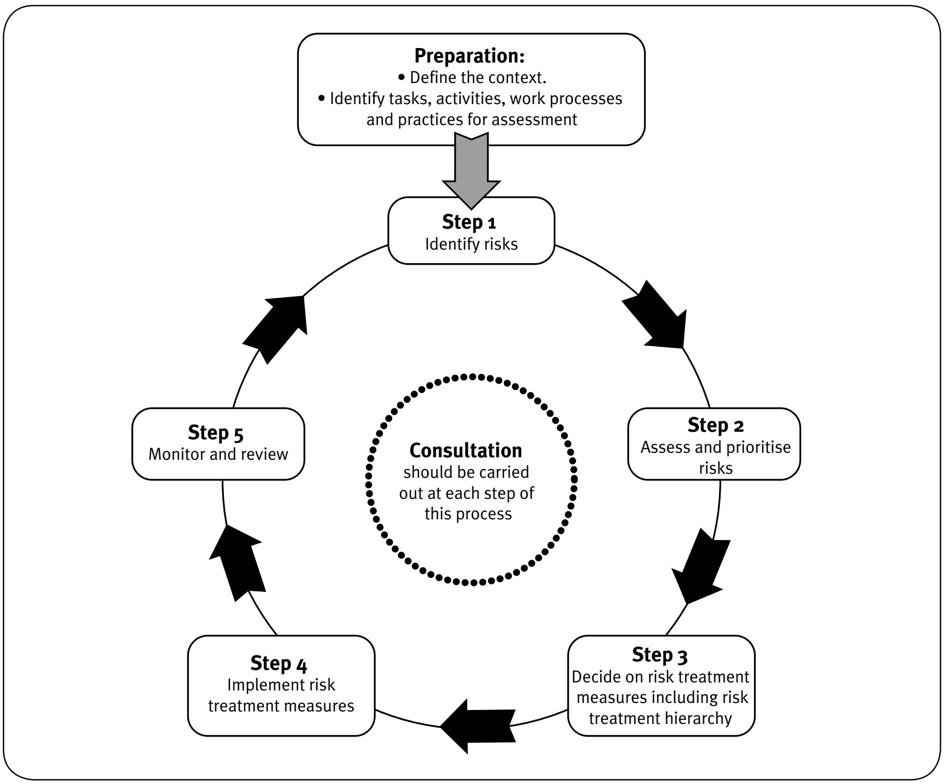


*Figure 1: The five step risk management process*

## 2.3 Common electrical risks

### 2.3.1 Electrical risks and causes of injury

The common electrical risks and causes of injury can be broken into three broad categories. These categories are:

- **Electric shock** causing injury or death. The electric shock may be received by direct contact, tracking through or across a medium, or by arcing.
- **Arcing, explosion or fire** causing burns. The injuries are often suffered because arcing or explosion or both occur when high fault currents are present. Overheating can also result in burns and fire.
- **Toxic gasses** causing illness or death. Burning and arcing associated with electrical equipment causes a range of gases and contaminants to be present. Compounds ranging from ozone to cyanide and sulphuric acids can be present as well as other risks such as low oxygen content in the air.

The three common electrical risks may be present individually or combined.

For example, if a fault occurred in the main switch-room of a large shopping centre all three of the electrical risks could be present. The presence of step and touch potentials should be addressed as well as the potential for an explosion. Further, burning materials such as PVC and epoxy resins can cause the atmosphere to become hazardous.

Under section 11(2)(a) of the Regulation, parts that are normally energised or that may become energised under fault conditions **must** be treated as live until the parts are proven de-energised. The categories of common electrical risks, listed above, are relatively clear. However, as electricity is not usually detected by sight, smell or sound, the identification (or recognition of the potential) of the risks can be more difficult. Refer to Part 3 of the *Electrical Safety Code of Practice 2010 – Risk Management* for guidance regarding the identification of risks.

Areas outside the scope of this Code that should also be addressed include:

- The flammable atmosphere in battery rooms or hazardous locations.
- Working in confined spaces.
- Electric field strength and magnetic field strengths. These fields, especially if the source of the field is a direct current, can cause interference with cardiac pacemakers and other medically implanted electronic devices. Precautions should also be taken to prevent other risks such as flying metal objects.

- Preventing falls, e.g. when working at height.
- Use of explosive powered tools.
- Working on roadways.
- The use of hazardous substances such as poisons, chemicals, solvents, synthetic resins, forms of asbestos and polychlorinated biphenyls (PCB).
- The use of flammable gases such as liquid petroleum, oxygen, acetylene etc.
- The use of explosives.

## 2.4 Instruction, training and supervision

Under sections 28 and 29 of the WHS Act, a person who conducts a business or undertaking must provide instruction, training and supervision to persons to whom they owe an obligation. Section 30 of the *Electrical Safety Act 2002* sets down the obligation of an employer to ensure that their business or undertaking is conducted in a way that is electrically safe. Providing training to workers helps to ensure that employers meet this obligation.

Workers who are likely to be exposed to electrical risks and anyone supervising these workers should be trained and provided with information and instruction.

Training should be appropriate to the type of work to be performed. In some cases, formal training may be required, in others, on-the-job training may be more appropriate. The special needs of workers should be taken into account in deciding on the structure, content and delivery of training. This assessment should include literacy levels, work experience and specific skills required for a job.

Adequate and appropriate training is a way of managing the risks associated with electrical risks. This can be done by:

(a) determining who needs to be trained;

(b) determining what training is required;

(c) determining how training will be delivered;

(d) ensuring that the training is provided;

(e) evaluating the training; and

(f) keeping training records.

The amount of training will be determined by:

(a) the nature of the workplace risks;

(b) the degree of risk associated with these risks;

(c) the complexity of work, such as operating procedures and equipment;

(d) other risk treatment measures being implemented; and

(e) the qualifications and experience of the worker.

### 2.4.1 Types of training

There are different types of electrical safety training that have different purposes, including:

(a) induction training - for workers when commencing employment or when new to the job. This training is general and may involve a workplace tour, and information about conditions of employment, administration, organisational structure, emergency procedures and workplace amenities;

(b) supervisor and management training - provided to help ensure that the supervision and management of the electrical safety issues are appropriately carried out in the workplace;

(c) specific job training or familiarisation training - providing information about the electrical and other risks associated with the job;

(d) specific electrical risk training - providing information about the risks associated with working near exposed live parts;

(e) ongoing training or refresher training - provided periodically to ensure that work continues to be performed safely;

(f) emergency procedures training - provided to ensure workers know what to do in the event of an emergency, including identifying persons with specific emergency roles and responsibilities; and

(g) first aid training - provided to ensure appropriate procedures are followed for administering first aid.

(h) job specific training under a Regulation e.g. safety observer and high voltage live line work training.

# Part 3: Protective Earthing

## 3.1 Scope

This part sets down the principles for the protective earthing of electrical equipment that forms part of the works of an electricity entity. The principles reflect established design principles used in the electricity supply industry.

Fundamental performance criteria are provided for ensuring permanent protective earthing systems are operated correctly. This is to ensure the correct operation of electrical protection systems so that exposed conductive parts of electrical equipment do not become energised to a potentially dangerous level.

## 3.2 Requirements under the *Electrical Safety Regulation 2002*

Under section 129 of the Regulation:

**(1)** The works of an electricity entity must incorporate an earthing and protection system, to a recognised electricity supply industry standard capable of ensuring the following:

- (a) reliable passage of fault current;
- (b) reliable passage of single wire earth return load currents to ground or source;
- (c) reliable operation of circuit protection devices;
- (d) safe step, touch and transfer potentials for all electrical equipment;
- (e) appropriate coordination with the earthing and protection systems of other electricity entities;
- (f) protection against likely mechanical damage, inadvertent interference and chemical deterioration; and
- (g) mechanical stability and integrity of connections.

**(2)** Without limiting subsection (1), the following specific requirements apply for the works of an electricity entity:

- (a) to stop, as far as practicable, a person suffering electric shock:
  - (i) if the Multiple Earthed Neutral system of earthing is used, the neutralconductor of the system must be effectively earthed; and
  - (ii) each non current carrying exposed conductive part of an electric line or generating plant must be effectively earthed;

(b) each non current carrying exposed conductive part of a substation must be effectively earthed;

(c) a system of earthing must be tested as soon as practicable after its installation to prove its effectiveness; and

(d) a high voltage electric line must be protected by a suitable fuse, circuit-breaker or equivalent device.

**(3)** Earthing is not required under subsection (2)(a)(ii) or (b) in circumstances where the electricity entity, in accordance with a recognized practice in the electricity industry, considers that for safety reasons earthing is not appropriate.

**Connection of high voltage circuit to earth**

Under section 130 of the Regulation:

(1) Each distinct high voltage system included in the works of an electricity entity must be connected to earth by direct connection or through a resistance or a reactance.

(2) All reasonable precautions must be taken to ensure that, for the circumstances in which the system is to operate, fuses or circuit-breakers in the system will operate during fault conditions.

**Insulation of stay wire**

Under section 132 of the Regulation:

- If a stay wire attached to a pole or structure supporting an overhead electric line forming part of the works of an electricity entity does not form part of an earthing system, the wire must be insulated to prevent, as far as practicable, any person suffering an electric shock.

**Protection of earth conductors**

Under section 133 of the Regulation:

- To prevent, as far as practicable, any person suffering an electric shock, earthing conductors installed on the outside of a pole or structure supporting an overhead electric line forming part of the works of an electricity entity must be, from ground level to a height of at least 2.4m:

  (a) insulated or suitably covered by a nonconductive material; and

  (b) protected from mechanical damage.

## 3.3 Earthing system requirements

### 3.3.1 The Multiple Earthed Neutral (MEN) system

Where an MEN earthing system is used, the following conditions should be met:

- The neutral conductor should be earthed at or near each LV distribution centre; and
  - where necessary, the neutral should be earthed at other points along the distribution system; and
  - the earthing should be arranged so as to ensure that resistance of neutral to earth at any location does not exceed 10 ohms.

In the MEN system the high voltage and low voltage earthing systems should be kept separate if resistance to ground of 1 ohm cannot be achieved (Separate Earthing System).

The high voltage earthing system provides an earth return path for the high voltage system. The earthing system protects plant and equipment capable of being energised by the high voltage system e.g. surge arrester or transformer tank. This earth should always be insulated from the low voltage earth.

Where the LV distribution centre is in a remote location, permanently electrically isolated from other distribution centres and is rated at not more than 63 kVA, the limit of 10 ohms may be increased provided that:

- where there are bare high voltage conductors above the low voltage conductors of an overhead electric line, the low voltage conductors must be insulated with 0.6/1 kV grade insulation; and
- the high voltage protection will clear any high voltage to low voltage fault in less than 0.2 seconds.

### 3.3.2 Earthing of LV distribution centres

If an MEN system is used, the low voltage earthing system should be separate and distinct from the high voltage earthing system for the distribution centre. The earthing systems should be designed and installed to prevent any significant portion of the high voltage system voltage gradient being superimposed on the low voltage earthing system and as a result, transferred to the customer's electrical installation through the MEN system.

When the two earthing systems are located where a person may make contact between the earthed exposed conductive parts or conductors connected to the earthing systems, adequate separation or insulation should be provided between the exposed conductive parts or conductors or both.

The following should be connected to the high voltage earthing system:

- Transformer tank or tanks.
- HV surge protection devices.
- HV cable sheaths/screens/guards.
- Exposed conductive parts of all other HV equipment. The design and impedance to remote earth of the high voltage earthing system should be arranged so that:
  - the HV protection system will operate in the event of a high voltage to exposed conductive parts fault; and
  - the prospective touch voltage on uninsulated conductive parts up to 2.4 metres above ground level and prospective step voltages meet requirements set down in the prospective touch and step voltages section.

The low voltage earthing system should be bonded to:

- the neutral terminal of the distribution transformer; and
- any earth leads of low voltage surge protection devices at the distribution centre.

The impedance to remote earth of the low voltage earthing system should not exceed the value for the high voltage earthing system except in the case of some SWER applications which may require a HV earth resistance value below 10 ohms.

### 3.3.3 Exposed conductive parts within 2.4m above ground associated with high voltage in an MEN system

Exposed conductive parts that may become energised from the electricity supply system if there is an insulation failure or contact with a conductor, should be:

- insulated; or
- earthed to a separate and distinct earthing system from the high voltage earthing system; the impedance to remote earth should allow the HV protection system to operate in the event of a high voltage to exposed conductive part fault; and
- be designed so that the prospective touch and step voltages meet the requirements set down in the prospective touch and step voltages section.

### 3.3.4 The Common Multiple Earthed Neutral (CMEN) system

If an electricity entity uses a CMEN system, the low voltage neutral conductor, and the low voltage earthing system, should be connected to the high voltage earthing system. This requirement includes the earthing system of transformer stations, zone substations and at poles carrying exposed conductive parts associated with high voltages.

The CMEN system should only to be used for distribution voltages up to and including 33 kV and where the design limits prospective touch voltages – including within any part of the associated LV installations – to within curve A1 of Figure 2.

The resistance to ground of the LV neutral at any location should be no greater than 1.0 ohm.

### 3.3.5 Earthing at a distribution centre (CMEN)

If a CMEN system of earthing is used at a distribution centre the following should be connected to it:

- the transformer tank and any high voltage surge protection devices;
- the low voltage neutrals and earth leads of low voltage surge protection devices;
- any exposed conductive parts that may reasonably be expected to become energised from the electricity supply system if there is an insulation failure or contact with a conductor; and
- a separate earthing system with a resistance to earth that will ensure the HV protection system operates in the event of a high voltage to exposed conductive parts fault and where the low voltage neutral may be disconnected.

### 3.3.6 Exposed conductive parts within 2.4m above ground associated with high voltage in a CMEN system

Exposed conductive parts that may reasonably be expected to become energised from the electricity supply system if there is an insulation failure or contact with a conductor, should be:

- insulated; or
- bonded to the CMEN system low voltage neutral.

### 3.3.7 The Single Wire Earth Return (SWER) system

If an electricity entity uses the single wire earth return earthing system, a separate high voltage earthing system and low voltage earthing system should be used. Thus, for each installation, there will be only a low voltage earth electrode system at the transformer and an earth electrode at the customer's premises earthing the low voltage neutral.

The high voltage and low voltage earthing systems should be separated to avoid any significant portion of the SWER earthing system voltage gradient being superimposed on the low voltage earthing system and as a result, transferred to the customer's electrical installation through the MEN system.

Where the two earthing systems are located so that personal contact may be made between the earthed exposed conductive parts or conductors connected to the earthing systems, adequate separation or insulation should be provided between the exposed conductive parts or conductors or both. This does not apply to spark gap devices fitted to protect the transformer against lightning damage.

The earthing of SWER distribution centres should be designed for continuous passage of electric current, in addition to protective earthing.

For a SWER distribution centre, two separate and distinct earthing systems should be provided:

- a SWER earthing system; and
- a low voltage earthing system.

The following exposed conductive parts should be connected to the SWER Earthing System:

- transformer tank or tanks;
- HV earth bushing;
- HV surge protection devices; and
- exposed metalwork of all other HV equipment.

The SWER earthing system should be designed so that:

- at least two earthing conductors are installed with maximum separation. The conductors should:
  - be connected to an inter connected earthing system that consists of at least three earthing electrodes not less than three metres apart; and

- arranged so that in the event of one or two earthing conductors between two electrodes being severed, at least one earth path will remain.

- any joint in the SWER earthing conductors between the transformer terminals and the earth electrodes should not be disconnectable;
- at a SWER LV distribution centre, earthing conductors within 2.4m of the ground should be insulated with 0.6/1.1 kV grade insulation and must be mechanically protected; and
- the maximum voltage on the earth lead with respect to remote earth under operating conditions resulting in maximum continuous earth current, should not exceed 20 Volts.

The low voltage earthing system should be bonded to:

- the low voltage neutral terminal of the transformer; and
- any earth leads of low voltage surge protection devices at the distribution centre.

The design and impedance to remote earth of the low voltage earthing system should be arranged so that the MEN system complies as documented in the MEN section.

### 3.3.8 Exposed conductive parts within 2.4m above ground associated with high voltage in a SWER system

Exposed conductive parts that may reasonably be expected to become energised from the electricity supply system if there is an insulation failure or contact with a conductor, should be insulated.

### 3.3.9 Earthing of high voltage distribution centres

Earthing of exposed conductive parts of HV distribution centres including external metal fences should comply with the *ENA EG1-2006: Substation Earthing Guide and the Institute of Electrical and Electronics Engineers Guide for Safety in AC Substation Grounding – IME Std. No. 80. Earthing of Works other than distribution centres.*

### 3.3.10 Exposed conductive parts within 2.4m above ground associated with high voltage transmission systems

Exposed conductive parts that may reasonably be expected to become energised from the electricity transmission system in the event of failure of insulation or contact with a conductor, should be designed so that the prospective touch and step voltages do not exceed the allowable prospective touch and step voltages.

### 3.3.11 Exposed conductive parts within 2.4m above ground associated with low voltage only

Exposed conductive parts that may reasonably be expected to become energised from the electricity supply system in the event of failure of insulation or contact with a conductor, should be either insulated or bonded to the low voltage neutral of the system.

### 3.3.12 Induced voltage on the sheath of underground electric lines

Cable sheaths or screens should be earthed to ensure that the prospective touch voltages that may appear on any accessible exposed conductive parts of the underground electric line for both load and fault current conditions, meet the requirements set down in the prospective touch and step voltages section.

### 3.3.13 Exposed conductive parts higher than 2.4m above ground

Non-current carrying exposed conductive parts located 2.4m or higher above ground and not exposed to personal contact need not be earthed. If these parts are associated with high voltage or low voltage works or both and are required by the electricity entity to be earthed, these parts should be earthed in accordance with sections on high voltage in an MEN system, CMEN system or low voltage only systems.

## 3.4 Earthing Conductors

### 3.4.1 Minimum size of earthing conductors

Earthing conductors should have sufficient cross-sectional area and mechanical strength to be capable of carrying, without sustaining damage or deterioration, any currents that may reasonably be expected.

### 3.4.2 Materials for earthing conductors

The material for earthing conductors should be suitable for site conditions.

### 3.4.3 Mechanical protection of earthing conductors

In locations controlled by an electricity entity and where a suitable enclosure prevents unauthorised access, the following apply:

- the entity should effectively protect an earthing conductor against mechanical damage to a height of 2.4m above ground level; and
- where the earthing conductor is installed below ground level, it should be buried to a minimum depth of 0.5m. Where necessary, this can be done by installing the earthing conductor in a channel chased in the rock and covered with concrete at least 50mm thick.

### 3.4.4 Materials for earthing electrodes

Earthing electrodes should be made from metals that will not be materially affected by any corrosive or other adverse influences.

### 3.4.5 Test links

If test links are inserted in earthing conductors connected to earthing electrodes, the test links should be arranged so that the opening of any one link does not interfere with earth connections, other than the one under test. Links should not be installed in a SWER earthing system.

### 3.4.6 Earth fault currents

Earthing electrodes should be capable of carrying, without sustaining damage, any earth fault currents that may reasonably be expected.

## 3.5 Prospective touch and step voltages

### 3.5.1 Prospective touch voltages – special locations

Lines operating at voltages less than or equal to 66kV should comply with the requirements of curve A1 of Figure 2. Lines operating at voltages greater than 66 kV should comply with the requirements of curve A2 of Figure 2.

### 3.5.2 Prospective touch voltages – frequented locations

Lines operating at voltages less than or equal to 66kV should comply with the requirements of curve B1of Figure 2.

Lines operating at voltages greater than 66 kV should comply with the requirements of curve B2 of Figure 2.

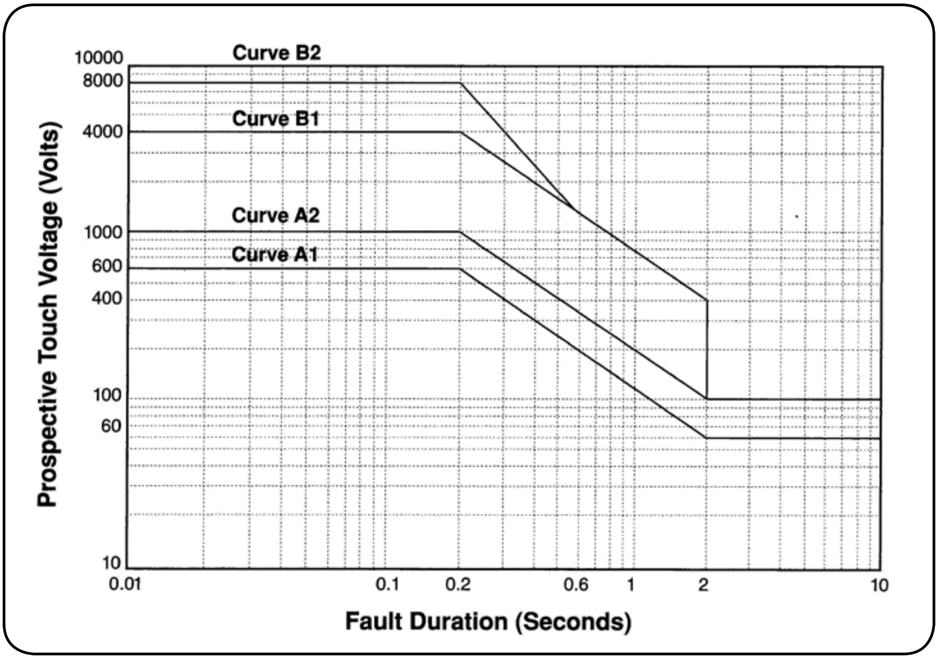


*Figure 2: Touch Voltage versus Fault Duration*

### 3.5.3 Remote locations

Aside from ensuring positive primary protection operation, it is not necessary to make specific provisions for limiting prospective touch and step voltages on exposed conductive parts. However, in the case of pole-mounted equipment that may be operated from the ground in remote locations, you should consider limiting step and touch voltages to the levels recommended for frequented locations.

To protect workers working near exposed conductive parts in remote locations, special operating procedures such as temporary earth rods or portable equipotential mats and gloves may be used.

### 3.5.4 Prospective step voltages

Prospective step voltages should not exceed twice the value of the prospective touch voltage determined for the corresponding location as outlined in the sections, Prospective touch voltages – special locations and Prospective touch voltages – frequented locations.

### 3.5.5 Testing and maintenance of earthing systems

All earthing systems should be tested periodically to ensure the earthing system integrity. Adequate records of all earthing system tests should be maintained.

## 3.6 References

*Institute of Electrical and Electronics Engineers Guide for Safety in AC Substation Grounding – IEEE Std. No. 80.*

*Institute of Electrical and Electronics Engineers Recommended Guide for Measuring Ground Resistance and Potential Gradients in the Earth - IEEE Std. No. 81.*

# Part 4: Design and installation of underground electric cable systems

## 4.1 Scope and application

This part sets down the principles for the mechanical and electrical design of underground electric lines, other than those operating at voltages normally not exceeding 50 volts alternating current or 120 volts ripple-free direct current.

The requirements have been based on recognised industry standards. They represent the minimum standards necessary to meet an electricity entity's obligations.

Unless otherwise expressly stated, this Part does not apply to:

- any underground earthing conductor not specifically associated with an underground electric line or with an underground control cable;
- underground electric lines or underground control cables fully or partly constructed in places owned only by an electricity entity and where a substation enclosure prevents unauthorised access;
- submarine cables; or
- fibre optic cables.

## 4.2 Compliance with Standards

Underground electric cable systems should be designed in accordance with an appropriate Australian Standard or ENA Guideline. Where there is no appropriate Australian Standard, an appropriate IEC Standard should be used.

## 4.3 Selection of cables

### 4.3.1 General

Cables used in underground cable systems should comply with an appropriate Australian Standard.

In addition, consideration should be given to the following:

- safety;
- environmental conditions;

- life cycle assessment;
- insect or vermin attack;
- vibration;
- ultraviolet degradation;
- economic, security and reliability factors;
- forces incurred during installation;
- forces incurred during the service life of the cable; and
- corrosion protection of armouring and sheathing.

### 4.3.2 Conductors

When selecting the cross-sectional area of the conductors of an underground electric cable, keep in mind the:

- prospective load;
- voltage drop;
- fault currents;
- fault clearing times;
- proximity of other heat sources, e.g. cables; and
- thermal properties of the surrounding environment.

### 4.3.3 High voltage cables

High voltage underground cables should have integral metallic conducting screens or sheathing or both.

### 4.3.4 Low voltage cables

All conductors including the neutral should be insulated to the full voltage rating of the cable. Bare neutral conductors should not be used.

### 4.3.5 Neutral connections

The connections between neutral conductors should be designed and installed to ensure the connections maintain the required conductivity during the service life of conductors.

### 4.3.6 Route selection

Basic factors to be considered during the selection of an optimum cable route are set out in *ENA C(b)2*.

In addition, consideration should be given to:

- EMF mitigation; and
- Environmental impact issues.

## 4.4 Installation

### 4.4.1 General

Underground electric cables and underground control cables should be installed having regard to system reliability, ease of future maintenance and safety. Consideration should also be given to minimising damage to underground assets.

Basic factors to be considered during the installation of underground cables are set out in *ENA C(b)2*.

### 4.4.2 Cable depths

The depth of cover for underground electric cables and underground control cables should not be less than:

For open trench construction:

- 750mm below the surface of a roadway for any cable installed under a roadway; and
- 600mm below the finished ground surface for cables installed in other locations.

Where physical obstructions such as other services make it impossible to achieve these depths, additional mechanical protection should be provided by means of a minimum cover of 100mm of 20 MPa concrete or equivalent. Any additional mechanical protection should be marked with the words electric cable or similar along its length.

For trenchless construction:

- 900mm below the finished ground surface.

This clause does not apply to that part of an underground cable or an underground control cable entering or leaving the ground vertically or fixed above the ground to a secure structure, so long as adequate mechanical protection is provided.

### 4.4.3 Laying of cables

The technique used for installing underground cables should ensure that damage to the cables is negligible. Consideration should be given to:

- maximum hauling tensions;
- minimum bending and setting radii;
- cable side wall pressures; and
- cable abrasion avoidance.

### 4.4.4 Separation of cables

When determining minimum separation from telecommunication plant in a shared trench, refer to *HB 100-2000 (CJC 4): Coordination of power and telecommunications - Manual for the establishment of safe work practices and the minimization of operational interference between power systems and paired cable telecommunications systems.*

Consult the authority concerned about separation from other services sharing the trench, keeping in mind:

- employee and public safety;
- potential cable damage due to failure of other services; and
- future access for repairs/maintenance.

## 4.5 Protection of cables

### 4.5.1 Identification of underground cables

The presence of buried underground electric cables and underground control cables should be identified. Accepted methods of identification include:

Where the depth of cover is between 600mm and 900mm:

- laying a strip of bright orange polyvinyl chloride or polyethylene or similar marker tape above the cable. The tape is to have the words electric cable or similar, boldly printed on the upper side continuously along its length; and
- where appropriate, using on-ground or above ground marker systems.

The position of marker tape, should provide effective warning to anyone engaged in manual or machine excavation.

Where the depth of cover is 900mm or greater, it is not a requirement to place cable protection covers or marker tape above the cable or conduits. However, the location of cables should be marked with permanent on-ground or above ground cable marker systems.

### 4.5.2 Protection general

An electricity entity should have procedures in place to protect people and prevent damage to underground cables during excavation near underground cables.

These procedures should include but are not limited to:

- maintenance of 'as installed' records of underground cables by an electricity entity;
- provision at the worksite of 'as installed' underground cable records to anyone concerned with planning, organising and supervising excavation work;
- the use of records and other locating methods to positively identify the position of underground cables; and
- exercising care during subsequent excavation.

### 4.5.3 Protection – mechanical

In addition to the principles outlined in parts 4.5.1 and 4.5.2 of this Code, mechanical protection should be provided to minimise the risk of injury to anyone digging by hand near underground cables by:

- providing the minimum requirement for mechanical protection of underground cables in accordance with the table below.

| Cable Location | Minimum Requirement |
|---|---|
| Where the underground electric cables and underground control cables are installed with a depth of cover between 600mm and 900mm. | Install the cable in a suitable conduit for application under roads, and LD Class electrical conduit for application in the electricity footpath allocation. For application outside the electricity footpath allocation LD Class electrical conduit with a polymeric cable protection cover complying with AS4702 not less than 75mm above the cable or, polyethylene orange coloured pressure pipe of minimum rating PN10 for PE80 Class pipe complying with AS/NZS4130.<br>OR<br>A polymeric cable protection cover complying with AS4702, not less than 75mm above the cable.<br>OR<br>Approved bricks manufactured especially for the protection of electric cables. Assess the risk for each location type to determine the method of mechanical protection. |
| Where the depth of cover for any underground electric cables and underground control cables is 900mm or greater. | No additional mechanical protection is required. |

**Note:** Polymeric cable protection cover and approved bricks provide superior protection. These should be considered for locations where cables would not normally be found e.g. parklands or unsealed walkway easements. Also consider using armoured or metallic sheathed cable buried according to cable depths in this part.

For cable circuits requiring high security or where the risk of excavation is high, increased protection should be provided by:

- using a combination of the above provisions for mechanical protection; or
- the use of a heavier duty conduit; or
- encasing the cables in concrete.

Where there is a risk of cable or duct damage by excavating plant or vibration, increased protection should be provided by:

- laying the cable at a greater depth; or
- selecting a less exposed cable route.

### 4.5.4 Protection – above ground

Looping, linking and servicing connections made above ground should be housed in pillars or pits that must:

- be externally marked to include the words electric, electrical, or electricity;
- be secured using a special tool or key;
- when enclosing switchgear, be constructed to prevent water from accumulating, unless the switchgear is specifically designed for operation when submerged;
- be designed so that an object (defined as a standard test finger by AS/NZS 3100) cannot be inserted into the interior and come into contact with or within arcing distance of live parts; and
- be installed in places where vehicles are not likely to damage them.

Where an underground electric cable or underground control cable is located between the laying depth prescribed in this part and a distance of 2.4m above ground, the cable must be suitably protected so that the cable will withstand, without undue damage, any impact that might normally be expected at that location.

### 4.5.5 Protective earthing of cables

When earthing single core cables, consider the special bonding arrangements used to minimise sheath losses and induced sheath voltages.

### 4.5.6 Records

Records should be current for all cable installations using maps, plans or computer databases. When preparing a record system, consider the following details:

- alignments;
- cable depths;
- number of cables;
- cable details;
- specialised backfill;
- reduced levels;
- direct buried or ducted;
- service history;
- position of joints; and
- date of installation.

## 4.6 References

### 4.6.1 Cable Selection

| | |
|---|---|
| AS/NZS 1026: 2004 | Electric cables – Impregnated paper insulated – Working voltages up to and including 19/33 (36) kV. |
| AS 1049 - 2003 | Telecommunication cables – Insulation, sheath and jacket. |
| AS/NZS 1429.1:2006 | Electric cables – Polymeric insulated – For working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV. |
| AS/NZS 1429.2 :1998 | Electric cables – Polymeric insulated – For working voltages above 19/33 (36) kV up to and including 76/132 (145) kV. |
| AS/NZS 5000.1:2005 | Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 kV. |
| AS/NZS 4961:2003 | Electric cables - Polymeric insulated - For distribution and service applications. |
| AS/NZS 4026:2001 | Electric cables – For underground residential distribution systems. |

### 4.6.2 Route Selection & Cable System Accessories

| | |
|---|---|
| ENA C (b)2 | Guide to the Installation of Cables Underground. |
| HB 100-2000 (CJC 4) | Coordination of power and telecommunications - Manual for the establishment of safe work practices and the minimization of operational interference between power systems and paired cable telecommunications systems. |
| AS/NZS 2053 | Conduits and fittings for electrical installations. |
| AS 4702: 2000 | Polymeric cable protection covers. |
| AS/NZS 3100:2002 | Approval and test specification - General requirements for electrical equipment. |
| AS/NZS 4130: | Polythene (PE) pipes for pressure applications. |

# Part 5: Maintenance of supporting structures for lines

## 5.1 Scope and application

This part sets down the principles and minimum requirements for maintaining the supporting structures for overhead lines.

An electricity entity should have a maintenance system that achieves a minimum three-year moving average reliability against the incidence of failure of 99.99 per cent a year.

Special consideration should be given to poles in areas of higher risk, such as cities and towns.

This part does not apply to safe access for work on poles. For this information, see the *Electrical Safety Code of Practice 2010 - Electrical Work* under the Act.

## 5.2 Serviceability determination

Provisions of this Code should be accompanied by responsibly developed and documented procedures for inspecting, assessing, marking and maintaining poles and structures that support overhead lines. Such procedures should be supported by appropriate work practices, and competency training and assessment.

The serviceability of a pole shall be determined by its:

- above ground condition;
- ground line and below condition; and
- strength in its 'as is' condition.

An electricity entity should develop a periodic maintenance program to deliver the reliability level set out at the beginning of this part. This program should include an inspection system to verify structural integrity, both above and below ground.

Where appropriate for the supporting structure, the inspection should also determine the bending strength of a pole for comparison with its design load and an applied factor of safety.

Pole strength may be determined by:

- measuring physical dimensions and calculation; or
- proof testing; or
- non-destructive evaluation.

Where resultant pole top forces result in a bending moment at ground line of equal to or close to zero e.g. a fully supported pole situation, the following requirements should be satisfied:

- the conductors and attachments should be capable of continuing to support the pole top loading conditions; and
- a minimum pole tip loading should be adopted to ensure the groundline shear strength of the pole is adequate.

Poles should be classified as either serviceable, suspect or unserviceable.

### 5.2.1 Frequency of inspection

An electricity entity's inspection program should ensure the entity meets its safety obligations. Each pole should be inspected at intervals deemed appropriate by the entity. The intervals may be based on documented knowledge of the durability rating, preservation type, inspection procedures, age, performance of the poles, fungal decay, termite risk and so on.

In the absence of documented knowledge of pole performance, poles should be inspected at least every five years.

## 5.3 Marking of poles

### 5.3.1 General

An electricity entity should mark poles assessed as suspect or unserviceable. All markings should be about 1.5m above ground line and on the side of the pole to which the pole identification record is fixed e.g. pole number. Markings should be in white or yellow paint and bold enough to be easily identifiable, even when visibility is poor. Any suspect or unserviceable poles shall be appropriately marked before the inspector leaves the site.

### 5.3.2 Marking scheme

- Serviceable poles – No marking required.
- Suspect Poles – A single diagonal stripe '/'.
- Unserviceable poles – A single 'X'.

### 5.3.3 Removal of markings

Where it is necessary to remove the suspect or unserviceable mark, the painted cross or diagonal slash should, on the authority of a responsible officer, be either over-painted with a dark coloured paint or removed.

### 5.3.4 Resultant action and timeframes

Once a pole's serviceability has been determined, the following action and timeframes should apply:

- Serviceable pole – no further action.
- Suspect pole – assess pole within three months.
- Unserviceable pole – replace or reinstate pole within six months.

When a pole, at the time of inspection or assessment, is considered to present a high risk of injury or damage to property, immediate remedial action should be taken.

### 5.3.5 Pole records

An electricity entity should develop a reference system for supporting structures, to establish inspection and maintenance records.

Pole records should enable an electricity entity to:

- demonstrate that the entity's pole reliability objective is achieved;
- compile statistics to determine the service performance of poles;
- determine future policies from a better knowledge of pole performance, maintenance and preservation methods;
- demonstrate that this part's requirements have been complied with; and
- programme the inspection and maintenance of poles.

## 5.4 Reference

*ENA C(b)1-2006: Guidelines for design and maintenance of overhead distribution and transmission lines.*

# Appendix A: Meaning of terms used in this Code

**CMEN:** Common Multiple Earthed Neutral.

**Design load:** the calculated load imposed upon a pole under the loading conditions (calculated maximum service load) adopted by the electricity entity.

**Distribution system:** a system operating at a nominal voltage not exceeding 33 kV.

**Earth connection:** a connection to the general mass of earth by means of an earthing electrode or earthing electrodes electrically connected at a given location.

**Earth resistance:** in relation to an earth connection, this means the resistance to the general mass of earth measured in ohms.

**Earthing conductor:** a conductor connecting any portion of the earthing system to works required to be earthed, or to any other portion of the earthing system.

**Earthing electrode:** a metal rod, tube, pipe, plate or other conductor buried in or driven into the ground and used for making a connection to the general mass of earth.

**Earthing values:** values measured with an earth resistance tester.

**Earthing system:** all conductors, piping, electrodes, clamps and other connections whereby conductors or other works are earthed.

**Electrical installation** (see section 15 of the Act) is a group of items of electrical equipment. However, a group of items of electrical equipment is an electrical installation only if:

(a) all the items are permanently electrically connected together; and
(b) the items do not include items that are works of an electricity entity; and
(c) electricity can be supplied to the group from the works of an electricity entity or from a generating source.

An item of electrical equipment can be part of more than one electrical installation.

For an electrical installation where all the items are permanently electrically connected together:

(a) an item of electrical equipment connected to electricity by a plug and socket outlet is not permanently electrically connected; and
(b) connection achieved through using works of an electricity entity must not be

taken into consideration for deciding whether items of electrical equipment are electrically connected.

*Examples of an electrical installation:*

- The switchboard, wiring, lighting, socket outlets and other electrical equipment permanently connected for a house or residential unit.
- The switchboard, wiring, lighting, socket outlets and other electrical equipment permanently connected for a shopping centre. The electrical installation for the shopping centre generally includes the electrical installations for the individual shops.
- The switchboard, wiring, lighting, socket outlets and other electrical equipment permanently connected for a residential unit complex. The electrical installation for the residential unit complex generally includes the electrical installations for the individual residential units.
- The switchboard, wiring, lighting, socket outlets and other electrical equipment permanently connected within a caravan.

**Electrical safety** (see section 10(3) of the Act), for a person or property, means the person or property is electrically safe.

**Electrically safe** (see section 10(2) of the Act) means:

- for a person or property, that the person or property is free from electrical risk; and
- for electrical equipment or an electrical installation, that all persons and property are free from electrical risk from the equipment or installation; and
- for the way electrical equipment, an electrical installation or the works of an electricity entity are operated or used, that all persons and property are free from electrical risk from the operation or use of the equipment, installation or works; and
- for the way electrical work is performed, that all persons are free from electrical risk from the performance of the work; and
- for the way a business or undertaking is conducted, that all persons are free from electrical risk from the conduct of the business or undertaking; and
- for the way electrical equipment or an electrical installation is installed or repaired, that all persons are free from electrical risk from the installing or repairing of the equipment or installation.

**Electricity footpath allocation:** the corridor in the footpath allocated by the local authority for installation of electric cables and plant.

**EMF:** Electro Magnetic Field.

**Exposed conductive parts:** includes electrical equipment that can be touched by the standard test finger as specified in AS/NZS 3100 and is not live, but can become live if basic insulation fails. The term includes reinforced concrete work or reinforced concrete parts but excludes minor fastenings, wood pole identification discs and street lights.

**Factor of safety:** the ratio of assessed pole bending strength to its design bending strength.

**Failed pole:** a pole which, due to loss of strength has broken off or become incapable of standing without mechanical means of support other than permanent reinstatement. The following exclusions apply:

- weather more severe than design conditions allowed for at that location e.g. lightning, severe storms and so on;
- impact loads contacting poles or their attachments, e.g. vehicles, falling trees or wind borne objects;
- unforeseeable changes in ground conditions e.g. flooding or earthworks;
- bush fires and grassfires; and
- vandalism.

**Fault duration:** the time during which a fault current may flow before being cleared by the primary protection of a distribution or transmission system.

**Frequented location:** any urban area associated with a city or town other than special locations.

**Fully supported pole:** a pole in which resultant pole-top forces are countered by changed tensions in conductors or stay wires or both (other than service lines). This support ensures little or no bending moment at ground line.

**HV distribution centre:** any substation or generating station other than a low voltage distribution centre including high voltage switching stations.

**IEC Standard:** a standard rule, code or specification of the International Electrotechnical Commission.

**Insulated:** separated from adjoining conducting material by a non-conducting substance which provides resistance to the passage of current, or to disruptive discharges through or over the surface of the substance at the operating voltage, and to obviate danger of shock or injurious leakage of current.

**LV distribution centre:** any substation or generating station from which electricity is or can be supplied directly at low voltage to a distribution system or to a consumer's electrical installation. A Single Wire Earth Return (SWER) isolating transformer substation and compact standalone distribution switchgear shall be classed as LV distribution centres for the purposes of this Code. An LV distribution centre may consist of one or more transformers on a pole, on or under the ground or in a building, or it may consist of one or more low voltage generating sets. A low voltage distribution centre may be located in a generating station or in a zone substation.

**MEN:** Multiple Earthed Neutral.

**Must:** where the word 'must' is used in this Code, it reflects the fact that a mandatory requirement exists in the Act or Regulation.

**Non-destructive evaluation:** an assessment in which the strength of a pole is verified by validated non-destructive techniques.

**Plant** includes:

- machinery, equipment, appliance, pressure vessel, implement and tool;
- personal protective equipment;
- a component of plant and a fitting, connection, accessory or adjunct to plant; and
- specified high risk plant[1] (unless otherwise stated).

**Pole:** an overhead line or street light support structure, excluding attachments e.g. x-arms.

**Proof testing:** an assessment in which the strength of a pole is verified by validated application of a mechanical load to simulate the design load multiplied by the factor of safety.

**Prospective step voltage:** the voltage that may appear between any two points on the surface of the ground one metre apart. This voltage is defined as an open circuit voltage measured using a high impedance voltmeter.

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1 Refer Workplace Health and Safety Act 1995 schedule 2.

**Prospective touch voltage:** the voltage that may appear between any point of contact with exposed conductive parts within 2.4 metres of the ground, and within a radius of 1.0m at ground level. This voltage, too, is defined as an open circuit voltage measured using a high impedance voltmeter.

**Reinstated pole:** a pole in which the original foundation has been supplemented or replaced by a structurally effective support system.

**Remote location:** an area not defined as either special or frequented.

**Risk:** Risk is the likelihood and consequence of injury or harm occurring.

**Risk assessment:** The process of evaluating the severity of a risk, for the purposes of prioritising and taking action to treat the risk. Assessing a risk involves considering the likelihood of harm arising from an electrical risk and the severity of the consequences that could result. This process may also be known as risk profiling.

**Roadway:** that part of a road intended for use by vehicles but not including a driveway crossing a footpath.

**Serviceable pole:** a pole in service which, at the time of inspection and assessment, is considered capable of bearing its design load with the relevant Factor of Safety (FOS). The FOS for wood poles is equal to or greater than 2. The FOS for other structures as per *ENA C(b)1.*

**Should:** Where the word 'should' is used in this Code, it should be interpreted as meaning a requirement which needs to be equalled or exceeded so that an obligation to be discharged. If this Code states that something should be done, the requirement is to do what the Code says or do it in a manner which is equal or better (electrically safer) than the Code.

**Special locations:** a location within a school's grounds or within a children's playground, or within a public swimming pool area, or at popular beach or water recreation area, or in a public thoroughfare within 100 metres of any of the above locations.

**Step voltage:** the voltage drop caused by a current flowing through the body between both feet, in contact with the ground one metre apart.

**Suspect pole:** a pole in service which, at the time of inspection, is considered to require further assessment to determine whether or not it is serviceable.

**SWER:** Single Wire Earth Return.

**The Act** means the *Electrical Safety Act 2002*.

**The Regulation** means the *Electrical Safety Regulation 2002*.

**Touch voltage:** the voltage drop caused by a current flowing through the body between both hands and both feet. In this instance, the hands are in contact with an earthed conductive part within 2.4 metres of the ground. The feet are within a radius of 1.0m at ground level.

**Transmission system:** a system operating at a nominal voltage above 33kV and includes a sub transmission system.

**Trenchless construction:** the technique of installing cables and ducting by means of directional drilling and systems with minimum excavation.

**Underground cable:** one or more insulated conductors encased in a protective sheath or enclosure and forming part of an underground electric circuit.

**Underground control cable:** an auxiliary cable with one or more insulated conductors encased in a protective sheath or enclosure and forming part of a measuring, control, protection or communication circuit.

**Unserviceable pole:** a pole in service which, at the time of inspection and assessment, is considered incapable of bearing its design load with the relevant Factor of Safety (FOS). The FOS for wood poles is equal to or greater than 2. The FOS for other structures as per *ENA C(b)1*.

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