Portable Appliance Testing

– Learner Pre-Reading –

Name: _____ Date: _____

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AS/NZS 4836:2001 Safe working on Low-Voltage Electrical Installations
WorkSafe WA Guide to Testing and Tagging Portable Electrical Equipment and Residual Current Devices at workplaces
WA Occupational Safety and Health Act 1984
WA Occupational Safety and Health Regulations 1996
WA Mines Safety and Inspection Act 1994

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UEENEEP008B Conduct In-Service Safety Testing of Electrical Cord Assemblies and Cord Connected Equipment

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SECTION-1 OCCUPATIONAL SAFETY AND HEALTH

In Australia the OHS legal structure is designed to keep people safe while they are at work. The structure consists collectively of a group of Acts, Regulations, Codes of Practice, National and Industry Standards and Guidance Notes.

The following chart shows how the legal framework all comes together to achieve optimum safety and health for people whilst at work.

SAFETY AWARENESS TRAINING
ROLES AND RESPONSIBILTIES

AUSTRALIAN OSH PERSPECTIVE

ASCC (Australian Safety & Compensation Council)

- Codes of Practice
- Standards

WORKSAFE
Commission for Occupational Safety and Health

WESTERN AUSTRALIAN OSH LAWS

- Acts
- Regulations
- Codes of Practice
- Standards

DUTY OF CARE

EMPLOYER

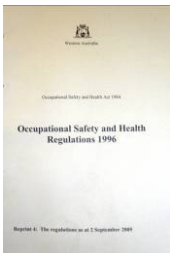
EMPLOYEE

SAFETY & HEALTH COMMITTEES & SAFETY & HEALTH REPRESENTATIVES

OSH Act

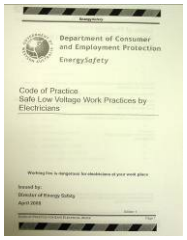
- Outlines the legal rules in Western Australia that must be adhered to in an effort to ensure people are safe whilst at work;
- Is legally binding hence failure to comply with the Act is regarded as an offence, and therefore **compliance is compulsory;**
- Is created and passed by Parliament and administered by Worksafe who are responsible for ensuring it is enforced correctly; and
- Determines the role of the Commissioner for Occupational Safety and Health.

Regulations



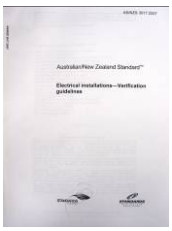
- Are designed to support and provide detailed requirements to follow in order to achieve compliance with the Act;
- Provide requirements that are specific to a particular hazard or safety and health issue, such as asbestos;
- Are also legally binding therefore **compliance is compulsory**; and
- If breached, may incur a penalty which is indicated along side each regulation.

Codes of Practice



- Are documents that provide guidance for controlling identified hazards and risks in the workplace;
- Offer sound advice and recommendations so legal obligations set out in the Acts and Regulations are met; and
- Are *not legally binding* but can be used in court to highlight that an employer could have done more to meet the requirements under the Act and Regulations to ensure safety and health in the workplace.

Standards



- Provide advice and guidance and set a benchmark or minimum standards that should be met in relation to a particular topic;
- Are not legislation unless they are mentioned in a State or Territory Safety and Health Regulation in which case are *enforceable by law*; and
- Consist of two main types of Standards – National Standards developed by Australian Safety & Compensation Council (ASCC) and Australian Standards developed by Standards Australia.

Guidance Notes

- Offer detailed and practical advice on how to deal with hazards and safety and health issues in the workplace;
- Are explanatory documents and are not legally binding but provide information on how to achieve legislative requirements; and
- Are developed by ASCC or Commission for Occupation Safety and Health.

Occupational Safety and Health Law in Western Australia

The Occupation Safety and Health Act (1984) outlines the OSH laws applicable in Western Australia. The aim of the Act is to promote and improve safety and health within the workplace.

The Occupational Safety and Health Regulations (1996) support the Act.

Workplaces can be similar yet very different. To achieve consistency across a diverse range of settings such as *commercial, general and civil construction sites,* offices and hospitals, schools and vehicles, the OSH Acts is purposely *general* in nature.

The Act applies to any place workers of self employed person(s) work. Commonwealth Agencies and Mining and Petroleum Industries do not fall under this category and each have their own Act. This is stipulated in *Part 1 Section 4 Application* of the Act.

Consultation and cooperation between employers and employees is the basis upon which the Act is developed.

Definitions

Part 1 (Preliminary) lists the various definitions used throughout the Act. Its purpose is to ensure parity throughout, allowing people to come to the same understanding for a specific work. This section is referred to in the Act as *Part 1 Section 3 Interpretation.* Many terms are defined in the Act, for example:

Employer
'An employer is a person who engages workers under a contract of employment, apprenticeship or traineeship scheme'. *(Guidance Note – General duty of care in Western Australian workplaces: Commission for Occupational Safety and Health 2005).*

Employee
'An employee is a person who works under a contract of employment, apprenticeship or traineeship scheme under the Industrial Training Act.' *(Guidance Note – General duty of care in Western Australian workplaces: Commissions for Occupational Safety and Health 2005).*

Role of WorkSafe

Enforcement is paramount if the effectiveness of the OSH Act (1984) and OSH Regulations (1996) are to be achieved. WorkSafe has the responsibility of administering the Act and Regulations.

To ensure the legislation is appropriately enforced, WorkSafe has a team of specialized Inspectors who have powers to visit a workplace at any time and must be granted *right of entry.* It is an offence for a person to threaten or interfere with an inspector. Inspectors are covered in *Part 5* of the Act.

Three important tools for the Inspectors to use the help organizations reach compliance are the issuing of:

Verbal Directions – if a problem is evident and can be rectified there and then, an Inspector may give a verbal instruction for a person to fix the problem that is in breach of the Act or Regulations.

Improvement Notices – If a problem is evident, an inspector will give a written direction that will state the reason for issuing the notice and the action(s) to take to rectify the breach of Act or Regulation. If the problem is not fixed by the set date the prosecution action may be taken.

Prohibition Notice – If an inspector believes there is an immediate risk of serious injury or harm to person(s), they may issue a written direction that prohibits the work from continuing. The Inspector will ensure employer has been informed and that the work has ceased. Failure to abide by the notice could lead to prosecution.

General Duty of Care

The OSH Act (1984) details general duties of care. Essentially everybody in the workplace has a duty of care, nobody is exempt.
This duty of care is designed to ensure people are safe whilst at work and not exposed to hazards.

Duties of Employers

Employers must, so far as is practicable, provide and maintain a working environment where their employees are not exposed to hazards.
General duties include:

- Safe systems of work;
- Information, instruction, training and supervision;
- Consulting and cooperation;
- Personal protection;
- Safe plant and substances; and
- Reporting of fatalities, injuries and disease.
  (Occupational Safety and Health Act 1984 (WA), s.23I).

Duties of Employees

Employees must take reasonable care for their own safety and health at work and avoid harming the safety and health of other people through and act or omission at work.
General duties include:

- Follow the employer's safety and health instructions;
- Using personal protective clothing and equipment;
- Taking good care of equipment;
- Reporting hazards;
- Reporting work related injuries or harm to health; and
- Co-operating with employers so that employers are able to carry out their duties under the Act. *(Occupational Safety and Health Act 1984 (WA), s.20)*

Safety and Health Representatives and Committees

Employees have the right to have a workplace occupational safety and health committee with employee elected representatives and appointed employer representatives. Consultation about safety and health matters usually takes place between management and the employees through OSH representatives or committees.
Safety and health representatives:

- Inspect the areas the safety and health representative was elected to represent;
- Immediately investigate accidents or risk of serious injury or harm;
- Keep up with information provided by the employer on hazards in the workplace, and liaise with government and other bodies;
- Report hazards in the workplace to the employer;
- Refer safety and health matters they think appropriate to the safety and health committee (if the workplace has one);
- Consult and cooperate with the employer on safety and health matters; and
- Liaise with employees about safety and health in the workplace.

Safety and health representatives are responsible only for safety and health in the workplace or that part of the workplace that was agreed between the employer and employee delegates before the election.

Safety and health committees are vital because they provide an opportunity for employers and representatives of employers to regularly discuss and make decisions about occupational safety and health issues. These may include policy development, planning, monitoring programs, emergency procedures, safety and health training, trends in accidents and illness reports, accident investigations and new plant or processes to be introduced into the workplace that may affect employees' safety and health. The committee may also take part in resolving safety and health disputes (see page 49, Resolution of issues at the workplace).

A safety and health committee must be established if any employee requests their employer to start a committee, the employer decides to establish one or the Commissioner gives a notice to the employer to establish one.

Roles and Responsibilities

The law says the employer has the main responsibility to make sure that the workplace is safe and healthy. Managers and supervisors are required to help the employer meet these responsibilities.

Employers are required by law to consult with their employees about the health and safety aspects of their work, or any changes to the workplace that could affect their health and safety.

In addition to employers and employees, other people who have workplace health and safety responsibilities include people who sell materials and equipment, or who provide services to a workplace (e.g. maintenance, repairs, cleaning, building and construction). They must ensure that the goods they design, make, supply, install, maintain or repair will not cause injury or damage the health of people in workplaces.

Resolution of Workplace Issues

The Act provides for the resolution of workplace issues under *Part 3 s.24.*

Workplaces are encouraged to develop and implement procedures for the resolution of workplace issues that are in tune with the organizational needs. It is paramount that if the organization is to develop an in house procedure that it can be agreed upon between employers and employees.

If there is no workplace procedure, organizations can refer to the Regulation 2.6 as it provides a step by step guide for the resolution of workplace issues. Effort should always be made to ensure the process reaches a resolution fast and effectively through consistent consultation and cooperation between all parties involved.

Right to Refuse Work

The Act deals with the refusal by employees to work in certain cases under *Part 3 s.26.* An employee may be asked to participate in alternate duties until it is safe to resume normal working duties.

- Employees can refuse work under the Act provided they have a **legitimate** reason to believe continuing work would place themselves or others at risk of serious and imminent injury or harm to health. Only those persons who are in serious and imminent risk of injury or harm to health can refuse to work.
- Employees may be required to carry out alternate duties in the meantime, as refusal to work does not automatically mean time off, but does protect them from the immediate threat of danger.
- Employees must notify the employer and the safety and health representative(s) of the problem. Attempts must be made to resolve the problem so work can resume. If this cannot be achieved a WorkSafe Inspector may be requested to resolve matters.

Workplace Policies and Procedures

Policies and procedures outline the companies preferred way of dealing with issues in the workplace and may include a range of topics including:

- Alcohol and drugs
- Consultation
- Grievances
- Tool maintenance
- Personal protective equipment (PPE)
- Emergency procedures

Policies must be clear and simple and detail what the company expects.

Procedures should reflect the policy and outline instructions to be followed for achieving the objectives set out in the policy.

Policies and procedures must be well communicated to all employees as employees have a duty of care to ensure they act and work in accordance with the set policies and procedures. For example, if a company has developed a policy to ensure employees wear suitable personal protective equipment such as a helmet or fall protection while working at heights, then employees must follow and practice the safe working procedures.

For policies and procedures to work effectively, commitment is needed from both employers and employees.

Employers should:

- Provide employees with copies of all policies and procedures;
- Display copies throughout the workplace;
- Provide adequate training;
- Supervise work to ensure requirements are being met; and
- Regularly review and update contents of all policies and procedures.

Employees should:

- Follow instructions;
- Report problems ;
- Ask questions if unsure; and
- Be actively involved in the development and review of policies and procedures.

Reporting and Documenting

To help prevent accidents from occurring it is important to have an effective system in place for the reporting of workplace hazards.

Reporting allows for comprehensive documents to be developed that record valuable information used as a reference point so that procedures can be established to prevent similar events from occurring.

If an employee notices a hazard, then they have a legal obligation under their duty of care to report that hazard. It is important that everyone is made aware of the hazards present in their work area.

All accidents and injuries, including near misses no matter how minor or major, should be reported and noted down in a book or appropriate forms must be filled out. Report forms must be completed immediately so that the correct information is documented and an investigation (if needed) or remedial action can be quickly activated. If for some reason an accident cannot be reported immediately, it should still be reported to the employer within 24 hours.

Powers of WorkSafe Inspectors

An inspector may, for the purposes of the Act

a. At all reasonable times of the day or night, enter, inspect and examine any workplace;
b. Enter any workplace at any other time that the performance of their functions under this Act requires such entry;
c. When entering any workplace, take with them such equipment and material as they consider appropriate;
d. Conduct such examination as is considered necessary to ascertain whether there has been compliance with this Act;
e. Examine any plant, substance or other thing whatsoever at the workplace;
f. Take and remove samples of any substance or thing, without paying for it;
g. Take possession of any plant or thing for further examination or testing or for use as evidence;
h. Take photographs and measurements, and make sketches and recordings;

i. Require the production of, examine, and take copies of extracts of, any document;
j. Require the workplace , or any part of it, be left undisturbed for as long as is specified in the requirement;
k. Interview, either in private or otherwise, as is considered appropriate, any person found at a workplace or whom there are reasonable grounds to believe is, or was at any time during the preceding 2 years, an employee working at the workplace;
l. Require any person interviewed under paragraph (k) to answer any questions put to them and, if the inspector considers it appropriate, to verify any such answer by statuary declaration.
m. Require any person to state there name and address.
n. Require the employer or any person who works at a workplace to render such assistance to the inspector as the inspector considers necessary for the performance of there function under this Act;
o. Exercise such other powers as may be conferred by the regulations or as may be necessary for the performance of there functions under the Act.

SECTION-2 ELECTRICAL SAFE WORKING PRACTICES

The Law and Your Responsibility
In Western Australia, the Electrical Licensing Regulations (1991) prohibits unlicensed persons to carry out electrical work on electrical machines, instruments, electrical installations or electrical equipment to which electricity is supplied or intended to be supplied at a nominal pressure exceeding 50 volts AC or 120V DC, where the item on which the work is performed is part of or is connected to any Network Operator's distribution or private generating plant.

RISK MANAGEMENT

The inclusion of risk management strategies in any organization's work system is crucial to effectively reduce or at best eliminate workplace hazards.

Risk management can be simplified in a three-step process:

Step 1 Identification
Step 2 Assessment
Step 3 Control

Hazard Identification

What is a hazard?

'A Hazard, in relation to a person, means anything that may result in:

(a) injury to the person; or
(b) harm to the health of the person.

(Occupational Safety and Health Act 1984 (WA), s.3)

Examples of workplace hazards:

Physical	Chemical	Biological	Psychological	Ergonomic	Mechanical
Noise	liquids	bacterial	stress	poor design of work stations	unguarded machines
Heat	vapours	viral	fatigue	height of work benches	sharp cutting equipment
Electricity	gases	animal	harassment		
Vibration	dusts		anxiety		
Radiation	metals				

Hazards can also be classified according to their energy source such as;

Kinetic	Electrical	Mechanical	Chemical	Radiation	Thermal

The most effective control measure is to completely eliminate the hazard from the workplace. When deciding which control measure to use it is useful to refer to the preferred line of action, commonly known as the '*Hierarchy of Controls'*.

Hierarchy of Controls

Elimination
Can the substance, process or activity that creates the hazard in the first place be eliminated?

Substitution
Can the hazardous substance, process or activity be substituted for a less hazardous one?

Engineering
Change the physical environment or surroundings in which hazards exist, such as general workshop design and machine guarding.

Isolation
Can welding screens/ curtains be used to stop hazardous light emissions and sparks from affecting other workers?

Enclosure
Is it possible to place sound barriers around noisy equipment such as generators?
Could a local exhaust system designed to remove contaminants before they enter the atmosphere be used?

Administration
The establishment of policies and procedures to minimize exposure to a particular hazard, such as strict safe work practices.

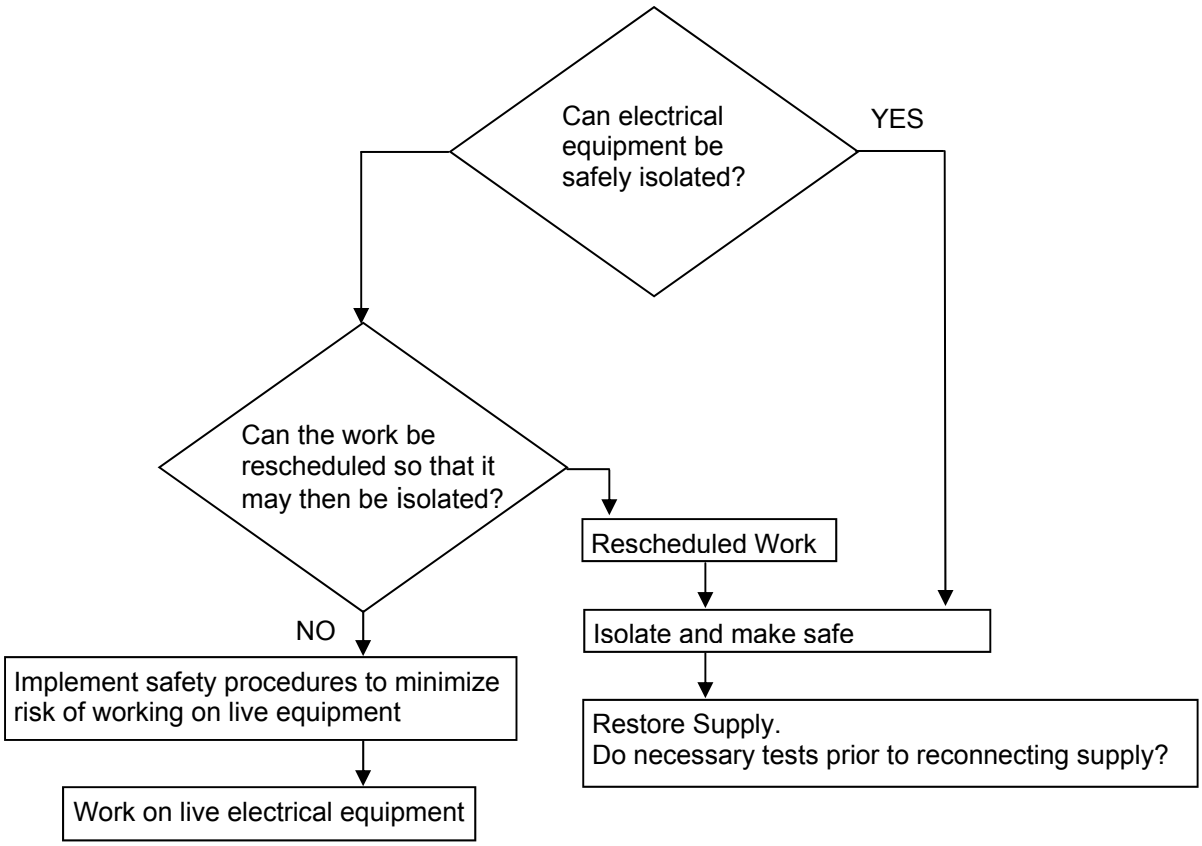
Personal Protective Equipment (PPE)
After all other measures have been employed and there is still a risk of injury or illness, the appropriate PPE must be worn. Ensure correct type, use handling and maintenance at all times.

ELECTRICAL HAZARDS

Assessments of all risks involved in undertaking work associated with either live (energized) or de-energized equipment shall consider all factors that may have the potential to cause injury or damage. Should this potential exist, precautions may include the use of a safety observer.

An assessment should be made so that work is planned to minimize the risk of inadvertent contact with live electrical equipment. Safety shall not be compromised because of operational pressures to carry out work quickly.

Any work being performed on or near electrical equipment shall be organized in such a way as to reduce, to an acceptable level, any conceivable risk of any person, either performing work or accidentally entering work areas, from coming into contact with live electrical equipment.



RISK CONTROL PROCEDURES

SECTION-3 BASIC ELECTRICAL PRINCIPLES

The Law and Your Responsibility

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ELECRICAL CIRCUIT REQUIRMENTS

Any electrical circuit consists of five components. They are:

- Power source
- Circuit conductors
- Load
- Control device
- Circuit protective device

Power Source

The source is essential to an electric circuit because it supplies electrons, which will flow through conductors that connect points within a circuit. Current will only flow between points that have a potential difference between them. Power sources provide the electromotive force (emf) necessary to drive the current around the circuit.

A power source may provide one of two types of current to an electrical circuit.

- Direct current or DC
- Alternating current or AC

Direct current
Direct current flows in one direction only. One very common direct current source is called a *cell.* This converts chemical energy into electrical energy. A single cell will have a positive and negative terminal which when connected via an external circuit will force electrons to flow through that circuit. Cells can be of two types.

- Primary cells
- Secondary cells

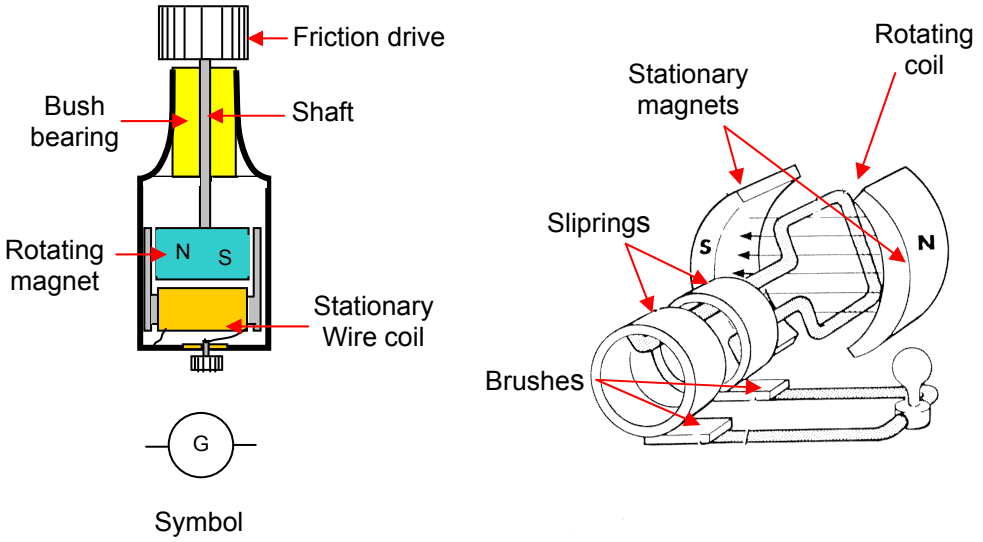
Primary cells
The chemicals in a primary cell are not renewable. Once they have been spent (used up), the cell must be replaced with a fresh one.

Secondary cells
Reversing the chemical process in a spent secondary cell can rejuvenate it. This can be done many times before the cell is discarded. If the chemical solution is in liquid form, the cell is often referred to as a wet-cell.

Battery
When a number of cells are interconnected, the resulting power source is called a battery. The terminal voltage of a battery is totally dependant on the voltage of each individual cell and the type of interconnection used.

Alternating current

Alternating current reverses its direction flow. Alternating current sources are produced by rotating coils of wire in a magnetic field. The resultant electromagnetic device is called a generator or an alternator.



Typical generators

Circuit conductors

Conductors are essential to an electric circuit because they form the pathway through for the electrons. Insulation surrounds the conductors to confine the electrons to the wire and prevent the wires from making unwanted connections when they cross each other.

Load

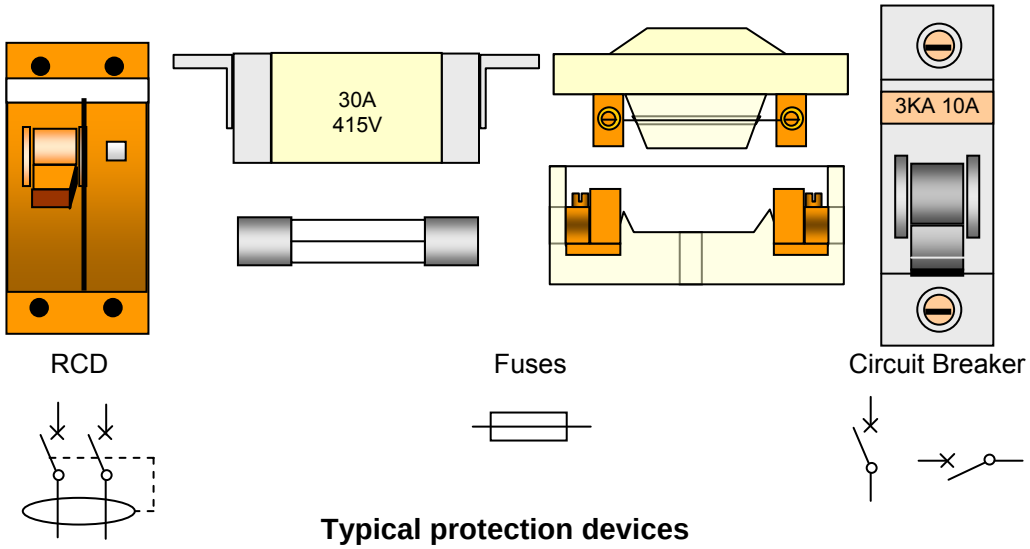
The final essential component of an electrical circuit is the load. A load is any device, which uses the electric current flowing through it to perform some useful task. The load may be an electric motor driving a compressor or hydraulic pump, a solenoid operated valve, a relay or any one of a number of devices designed to do work of some description.

Control device

In order for electrical current to do work when needed, we must be able to control when that current will flow and when it will cease flowing. Simple control devices such as switches are very commonly used to turn ON or OFF, more complex control elements may be used to regulate the quantity of current, when it is delivered and how it is delivered to the load.

Protective device

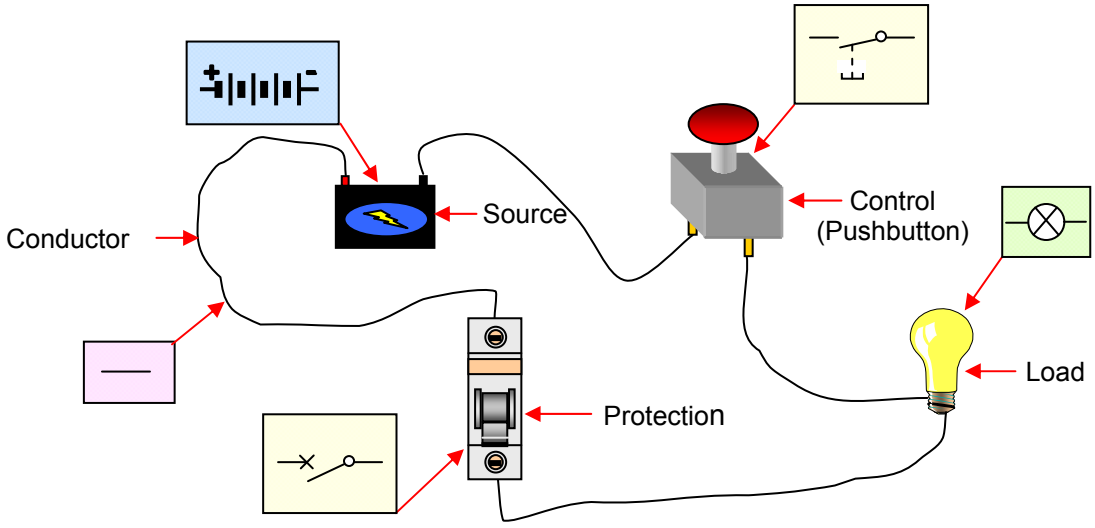
Protective devices monitor the level of current flowing in the conductors. If the level exceeds the maximum value, the protection device cuts the supply current OFF. Some common protection devices are rewireable fuses, cartridge fuses, circuit breakers and residual current devices.



Typical protection devices

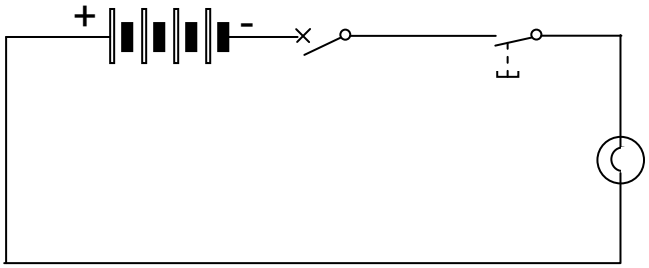
Simple Wiring Diagram

A simple electrical circuit incorporating each of the circuit elements is shown in a wiring diagram below. Each of the components in a wiring diagram is represented pictorially. Every component has a distinctive symbol (shown in boxes along side each component). These symbols are used when drawing an electrical circuit diagram.



Simple Circuit

Both circuit breaker and the pushbutton are shown in their open condition. This is because, by convention, all control devices are always drawn in their non-operated state. The circuit must be complete for current to flow.



Circuit Conditions

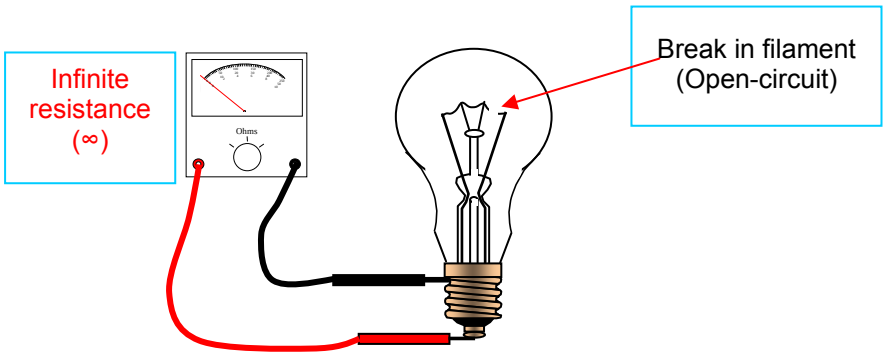
Various terms are used to describe certain circuit conditions. These are fundamental to understanding electrical terminology.

Normal Condition
A condition, which exists when a circuit is de-energised or a device is at rest in its de-activated condition. All electrical circuit components are drawn in their normal condition.

Normally Closed
The condition of the contacts of a switch or relay which will allow them to pass current when the switch is not activated, or the relay coil is not energised.

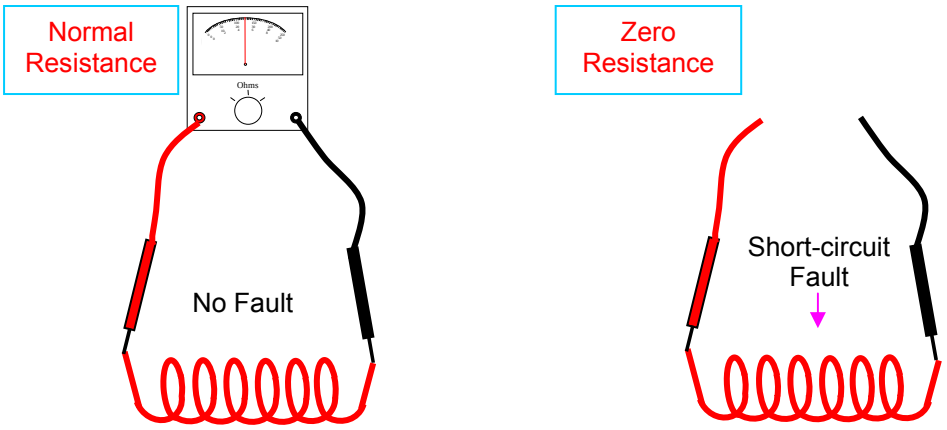
Normally Open
The condition of the contacts of a switch or relay when they are connected so that the circuit will be broken when the switch is not activated or the relay coil is not energised.

Open Circuit
Also called an *open,* represents an abnormal circuit condition (such as a break in the circuit conductor) that presents an infinite resistance in a current path preventing any current from flowing. A switch or contact that is in its open position, is not abnormal but no circuit current will flow because there is a break in the circuit.



Short Circuit

An abnormal circuit condition called a *short,* is one that provides a zero resistance current path. This type of fault bypasses the load resulting in an infinite current flow through that circuit.



Controlling Flow

Electric circuits are designed to work at their best when some specific level of current flows. If too little current flows, the load will not operate properly or may not work at all. If too much current flows, the load or conductors could be damaged.

Only two factors will determine the amount of current flow in a circuit. These are:

- The conductance of the material through which current flow's (it's resistance);
- The amount of voltage applied to the appliance.

SECTION-4 PROTECTIVE DEVICES

The Law and Your Responsibility

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PROTECTIVE MEASURES

Fuses and circuit breakers are intended primarily for the protection of conductors and equipment. They prevent overheating of conductors that might otherwise create hazards for installations. They also open the circuit under certain hazardous earth-fault conditions in an MEN system. Second, these protective devices may protect persons against electric shock.

Fuse

This device will open a circuit when a predetermined excess of current flows. It may be able to be rewired or alternatively may incorporate a wire embedded in insulating power within a cartridge case.

Circuit Breaker

This is a form of switch which opens automatically if the circuit is overloaded; it may operate on either a thermal, magnetic or thermal/magnetic principle.

Earthing

The external metal casing of electrical equipment (exposed conductive part), cables and conduit must be earthed. The reason for this is to prevent the metal rising to dangerous voltage because if an earth fault such as high resistance earth occurred, the touch voltage could be quite high. Earthing also ensures that a faulty circuit is automatically disconnected from the supply by drawing sufficient current to blow the fuse or operate the circuit breaker.

Residual Current Device

A residual current device (RCD) or safety switch is a device that immediately trips out the electricity supply in the event of a fault to earth (current leaking to earth). This devise can provide protection from harmful electric shocks in situations where a person comes into contact with a live conductor and earth. RCDs are designed to operate within 10 to 50mS.

PROTECTION DEVICE PRINCIPLES

In any circuit there are four main types of electrical faults which can occur, although there are varying degrees of each. The four types of faults are;

a. Short circuits.
b. Open circuits.
c. Earth faults.
d. Under or over voltage faults.

Fuses

A fuse is essentially a device which has a short length of wire of known current carrying capacity (called the fusible element), enclosed in a suitable insulated carrier mechanism – See Wiring Rules Clause 1.4.57. The fuse is connected in series with the supply line, so that if the current flow in the circuit exceeds a critical value for a pre-determined time the fusible element will melt, thus interrupting the supply of current to the circuit.
The most common types of fuses are:

a. High rupturing capacity (HRC) fuses.
b. Glass cartridge fuses.
c. Semi-enclosed rewireable fuses.

Fuses are rated according to the maximum current which they can carry continuously under normal conditions (not the current at which they will interrupt the supply). A 10 amp fuse does not 'blow' at 10 amps.

HRC fuse links are not repairable and must be replaced with the same size and type as the original. It would be highly dangerous to replace an HRC fuse link with a length of fuse wire of the same current rating, because the HRC fuse carrier is not designed to contain the arc which would result if the fuse blew. The time taken for an HRC fuse to interrupt a circuit under fault conditions is much more predictable than semi-enclosed rewireable fuses, so rewireable fuses are no longer used in new installations.

Circuit Breakers

A circuit breaker is a switch which automatically opens a circuit under pre-determined fault conditions (See Wiring Rules Clause 1.4.26). The operating mechanism can be thermal, magnetic or a combination of both, but in all cases the circuit breaker must be capable of interrupting any current up to and including the prospective short circuit current at the point where the device is installed (See Clause 2.5.2). Small moulded case breakers (MCCB's) are sealed and are not usually repairable.

Air circuit breakers (ACB's) have similar operating characteristics to HRC fuses, but they have the advantage that power can be restored to the circuit by simply turning them back on (after the fault has been corrected). Another advantage is that multi-phase circuit breakers disconnect all phases if a fault occurs on one phase.

Care must be taken when examining the status of air circuit breakers because they are usually ON in the fully UP position; this is the reverse of the usual convention used for switches in W.A, where the UP position is OFF.

Circuit breakers have contacts which must open under specified high current fault conditions. Interruption of the current, results in potentially dangerous arcing which must be controlled (or extinguished). In typical small moulded case air circuit breakers the arc is usually extinguished by a mechanism known as a 'De-ion grid' in which the arc is cut it into a series of smaller sections within the body of the circuit breaker. In larger circuit breakers the arc can be extinguished by a blast of compressed air (an 'air-blast' circuit breaker) or by using a mechanism based on the insulating properties of a vacuum (a vacuum circuit breaker).

Under-Voltage Protection

An under-voltage fault is said to have occurred when the supply voltage falls below a pre-determined value. Under-voltage and no-volt protection can be provided by incorporating magnetically operated relays or contactors in the circuit, so that if the voltage falls below the hold-in value the relays or contractors drop out and disconnect the supply.
Under-voltage faults can cause lamps to dim or fail, and they can cause electric motors to draw excessive currents, resulting in the operation of the associated overcurrent protection device.

Over-Voltage Protection

In any supply system the switching or control of various types of load give rise to short-duration increases in the supply voltage – these are known as voltage surges, spikes, voltage transients, electronic noise and similar terms. Increase in the voltage in installations can also result from lightning strikes. These voltages may cause a breakdown of the installation in particular devices, or in the case of sensitive electronic devices such as computers, permanent damage to internal electronic components.

Discrimination

When two or more circuit protection devices are connected in series (one on a main switchboard and another on a sub-board), the protection devices need to be selected so that the device closest to the fault operates first – that is, the sub board fuse operates before the main board fuse. Providing this characteristic in a circuit is known as discrimination.

RCD EARTH LEAKAGE PROTECTION

Protection Systems

An earthing system which requires exposed metal of electrical devices to be connected to the general mass of earth provides protection against electric shock and fire by automatically isolating the supply if a live part comes in direct contact with the exposed metal of the device. No protection is provided if a person inadvertently touches a live component while in contact with earth.

A residual current device (RCD) is a supplementary type of protection which provides for the supply to automatically be disconnected if a person touches a live component in such circumstances as will result in a current of more than a pre – set value (typically 10 – 30 milliamps) flowing through him or her to earth. RCD protection is in addition to the earthing system – it does not replace it.

RCDs are also known as ‘safety switches’, ‘core balance earth leakage circuit breakers’ or core balance ELCBs. There is another type of ELCB system known as the ‘voltage operated ELCB system’ – this is a system of earthing and is not the same as the RCD system, so the use of the term ELCB to describe the RCD system is not recommended.

Types of RCD

There are four different types of RCD in common use – they are classified according to the leakage or residual current at which tripping will occur (also known as their ‘sensitivity’). The classifications are:

Type I	Residual current ratings not exceeding 10mA.
Type II	Residual current rating exceeding 10mA but not exceeding 30mA.
Type III	Residual current rating exceeding 30mA but not exceeding 300 mA (without selective tripping time delay).
Type IV	Residual current rating exceeding 30mA but not exceeding 300 mA (with selective tripping time delay). Type IV is also known as an ‘S type’ RCD.

Single phase general purpose socket outlets are available which incorporate 10mA or 30mA residual current protection – they have the same general physical shape as other socket outlets. If a residual current type socket outlet is installed as the first point in a power circuit, it will provide earth leakage protection for all outlets ‘downstream’ of the protected unit.

SECTION-5 TESTING AND MEASURING DEVICES

The Law and Your Responsibility

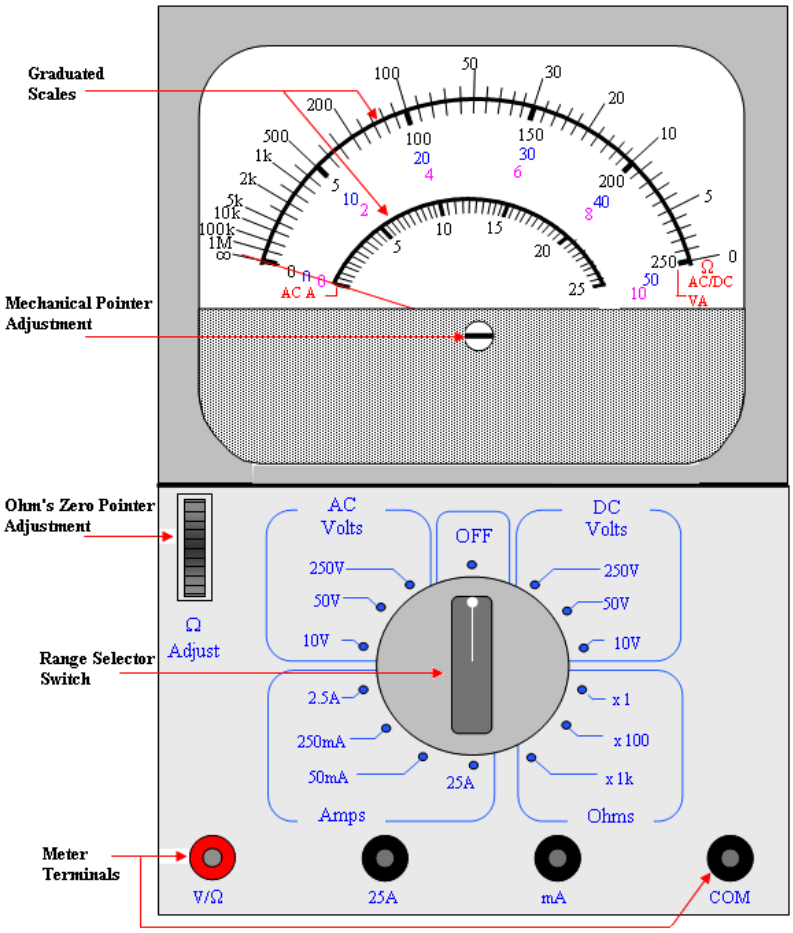
In Western Australia, the Electrical Licensing Regulations (1991) prohibits unlicensed persons to carry out electrical work on electrical machines, instruments, electrical installations or electrical equipment to which electricity is supplied or intended to be supplied at a nominal pressure exceeding 50 volts AC or 120V DC, where the item on which the work is performed is part of or is connected to any Network Operator's distribution or private generating plant.

ELECTRICAL MEASUREMENTS

Three measurements are common in electrical circuits, voltage, current and resistance. Each of these may be done with separate single purpose instruments or, with a single instrument that has selectable functions. A single instrument is more convenient and often less expensive than a number of individual instruments.

Analogue Meter

One instrument that measures all three parameters is called a Multimeter. The many possible range settings, scales, scale markings and the pointer's position with respect to a given scale, make the analogue meter appear difficult to use.



Digital Meter

Digital meters have a direct numeric read-out so interpolation and scale interpretation problems disappear. Although most digital meters will still have a selector switch, some of the latest models have dispensed with it and allow a microprocessor to sense the parameter being measured and select it automatically. The microprocessor also automatically selects the range to provide the most accurate reading.

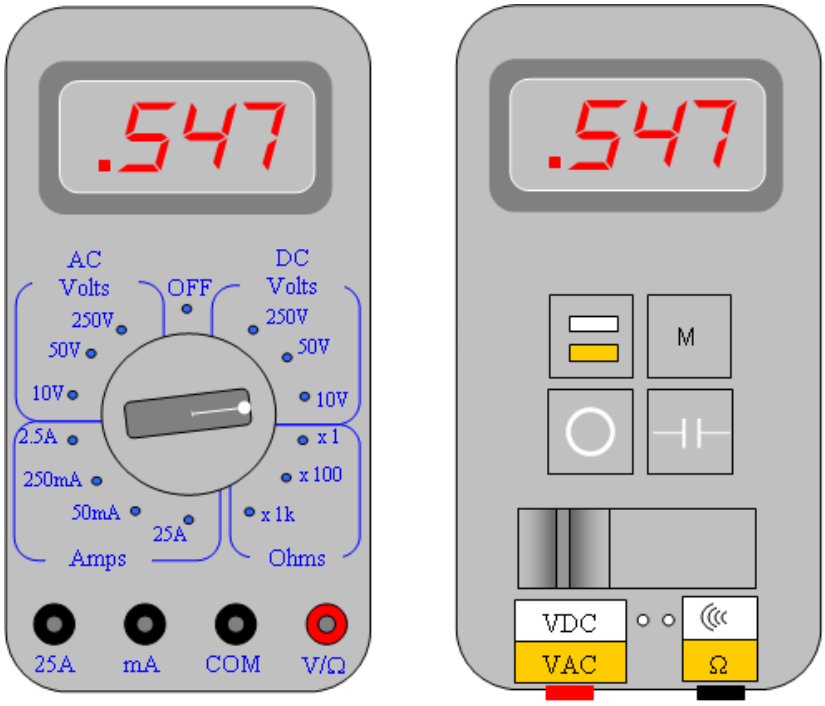
Another feature that has disappeared from digital meters is the Ohm's zero adjustment control.

Display

Digital meters are not necessarily more accurate than their analogue counterparts, but they do provide much better resolution. The digital display will have a minimum of three digits allowing it to display values from 000 to 199.

Since the most significant digit is always 1, this display is sometimes referred to as a 2 ½ digit display. Meters with a 4 digit display will display values in the range of 0000 to 1999. These are called 3 ½ digit displays.

The display device is generally of the liquid crystal (L.C.D) type because of its low current consumption and excellent contrast in bright ambient light conditions. L.C.D displays can be difficult to read when ambient light levels are low. Some meters will be provided with a back light to overcome this problem.



Range Selector

The range setting indicates the maximum numeric value that can be displayed in that switch position. For example, if the 10V will cause an out of limit will show on the display. On many digital meters, this is 'OL' and others, the most significant digit only, will turn on.

Measurement

Making measurements taken with a digital meter are identical to those already covered for the analogue type. The same precautions need to be taken with respect to isolation of power sources as with analogue meters.

Whereas an analogue meter's pointer movement is heavily damped to allow quick settling time with minimum over and under shoot, this is not the case for digital meters.

It is not uncommon for the last digit in the display to continually change when taking measurements where the levels being measured have small variations, this is normal and when it does occur, the average of the last digit should be taken.

The input resistance of digital meters is much higher than for the analogue variety (11MΩ or more). This makes them more accurate when taking readings of high impedance components because they do not load the circuit they are connected to, to the same extent as a standard analogue meter.

SECTION-6 STANDARDS, REGULATIONS AND CODES OF PRACTICE

The Law and Your Responsibility

In Western Australia, the Electrical Licensing Regulations (1991) prohibits unlicensed persons to carry out electrical work on electrical machines, instruments, electrical installations or electrical equipment to which electricity is supplied or intended to be supplied at a nominal pressure exceeding 50 volts AC or 120V DC, where the item on which the work is performed is part of or is connected to any Network Operator's distribution or private generating plant.

OSH REGULATIONS

The Occupational Safety and Health Regulations 1996 have been amended. As from 1st January 2009 the OSH Regulations will encompass new laws for testing and tagging in relation to electrical work.

The amendments apply to three distinct groups, construction and demolition, mining and other work places.

Construction and Demolition Sites

Regulation 3.60 requires that; all RCDs be kept in a safe working condition and tested regularly.

Regulation 3.61 requires the employer, self-employed person or main contractor at a workplace to ensure compliance with Australian Standard AS/NZS 3012 *Electrical Installations-Construction and Demolition Sites*.

Regulation 3.62 requires the testing and tagging of portable electrical equipment or a portable RCD on any construction or demolition site to be carried out by a competent person. The tester's name must appear on the tag, along with the test or re-test date, as specified in AS/NZS 3012.The tester's license (or Certificate) number must also be included on the tag.

Regulation 3.63 states that any worker bringing a portable item of electrical equipment or RCD to a construction or demolition site that is required to be tested under AS/NZS 3012, **must**, before the item is used :

- provide the main contractor with a record of the relevant testing data; and
- ensure the tag bears the name of the competent person who conducted the test.

Mining

Regulation 5.27 of the Mines Safety Inspection regulations prescribes that each responsible person at a mine site must ensure that a maintenance system is in place at the mine so that electrical equipment and installations are maintained in a safe working order. The maintenance system must include quarterly testing and tagging of any portable appliances normally used in heavy operating environments, such as workshops, mining areas, processing areas and construction sites.

Other Work Places

Regulation 4.37 deals with the duties as to the use of any electrical equipment or RCD at workplaces other than construction and demolition sites, and mining operations. Under this regulation, an employer, self-employed person, main contractor, person having control of a workplace or person having control of access to a workplace must ensure that electrical equipment and RCDs at the workplace are subject to the appropriate checks, tests and inspections necessary to reduce the risk of injury or harm occurring to a person at that workplace.

AS/NZS 3012 Electrical Installations-Construction and Demolition Sites

This Standard sets out minimum requirements for the design, construction and testing of electrical installations which supply electricity to appliances and equipment on construction and demolition sites, and for the in-service testing of portable, relocatable and fixed electrical equipment used on construction and demolition sites.

The Standard consists of three sections and six appendices:

Section-1 Scope and General

1.1 Scope
1.2 Application
1.3 Referenced documents
1.4 Definitions

Section-2 Installation

2.1 Supply
2.2 Maximum demand
2.3 Switchboards installed for the purpose of construction and demolition
2.4 Control and protection
2.5 Construction wiring
2.6 Flexible cords, cord extension sets, flexible cables and accessories
2.7 Lighting and luminaires
2.8 Lift shafts
2.9 Transportable Structures

Section-3 Verification (Inspection and Testing)

3.1 Application
3.2 Frequency of verification (inspection and testing)
3.3 Personnel
3.4 Construction wiring and Transportable structures
3.5 RCDS
3.6 Other electrical equipment on site
3.7 Connection between generator windings or frame and Equipotential bonding systems
3.8 Actions resulting from inspection and test
3.9 Portable Generator sets and Inverters
3.10 Documentation

Appendices

A List of referenced documents
B Electrical installations in the domestic housing construction industry
C Classification of buildings and structures
D Regulatory application on construction and demolition sites
E Marking of switchboards to indicate the presence of live parts
F Recommended colours for tags on tested equipment
G Electrical verification of generators with RCD protection to AS/NZS 3012 and AS/NZS 3760
H Electrical verification of portable Inverters
I New Zealand Only….Verification form for Construction and Demolition Sites
J Guide to Arrangement of Switchboards, Construction Wiring and Equipment
K Alternative Supply System for Construction and Demolition Sites

Table 1 Maximum Lengths of Flexible Cords and Flexible Cables

Table 2 Minimum Insulation Resistance

Table 3 Inspection and Testing Intervals

AS/NZS 3760 In-service Safety Inspection and Testing of Electrical Equipment

This Standard specifies procedures for the safety inspection and testing of low voltage single phase and poly-phase (3 phase) nominal 230V and 400V electrical equipment, connected to the electrical supply by a flexible cord and/or connecting device, which is new equipment placed into service for the first time, is already in-service, has been serviced or repaired, is returning to service from a second-hand sale, or is available for hire.

The Standard consists of two sections and nine appendices:

Section-1 Scope and General

1.1 Scope
1.2 General
1.3 Interpretation
1.4 Definitions

Section-2 Inspections and Tests

2 General
2.1 Frequency of inspections and tests
2.2 Personnel
2.3 Inspection and testing
2.4 Action resulting from inspection and testing
2.5 Documentation

Appendices

A Background (Informative)
B Guidelines on the Electrical Knowledge of a Competent Person (informative)
C Polarity for Cord Sets
D Test of earth continuity (Normative)
E Insulation testing (Normative)
F Insulation resistance testing of portable isolating transformers
G Insulation Resistance Testing of a Power Supply (Normative)
H Test for operating time of RCDs (Residual Current Devices)(Normative) J Background
J Arc Welders (Informative)
K Regulatory application of this Standard (Informative)

Tables

1 Leakage Current Limits
2 Insulation Resistance Limits
3 Maximum Tripping Times
4 Indicative Testing and Inspection Intervals for electrical equipment
C1 Conductor Colours for Flexible Cords
C2 Colour Schemes of conductor in modern sheathed flexible cords
H1 Tripping time accuracy

Figures

C1 Cord set
C2 Cord extension set
D1 Measurement of the earth continuity resistance between accessible earthed metal parts and the earth pin of the mains plug
D2 Measurement of the earth continuity resistance between the mains plug earth pin and the earthing aperture contacts of an EPOD

In accordance with *AS/NZS 3760 Appendix A6 the equipment required to carry out the tests detailed in the standard should be subjected to routine verification at regular intervals to ensure it is working correctly and its accuracy is maintained.*

SECTION-7 PORTABLE APPARATUS TESTING

The Law and Your Responsibility

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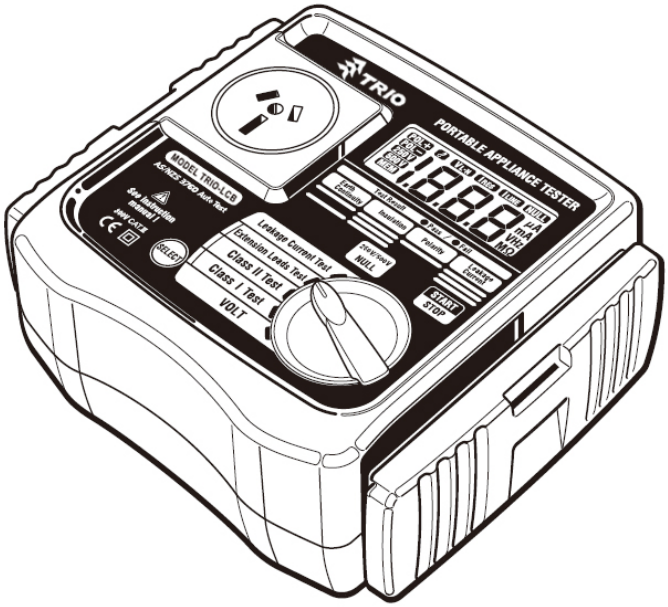
INSPECTION, TESTING AND TAGGING

All portable electrical equipment and RCDs used in a workplace must be regularly inspected and tested in accordance with the OSH or MSI regulations, as appropriate.

The frequency of inspection and testing varies for different work situations:

- construction and demolition sites — the inspection and testing intervals must be in accordance with **AS/NZS 3012**;
- mining operations — quarterly testing and tagging must be carried out on all portable appliances normally used in heavy operating environments such as workshops, mining areas, processing areas, construction sites and similar places; and
- all other workplaces — require a risk management approach to determine the type of inspection and if necessary any testing required.

Inspection needs to be done more frequently in an operating environment where electrical equipment is, during normal usage, subjected to adverse operating conditions likely to result in damage to the electrical equipment, such as potential exposure to moisture, heat, vibration, corrosive chemicals or mechanical damage. The risk assessment should determine where more specific testing of electrical equipment is necessary and the frequency of such testing.



In accordance with *AS/NZS 3760 Appendix A6 The equipment required to carry out the tests detailed in the standard should be subjected to routine verification at regular intervals to ensure it is working correctly and its accuracy is maintained.*

SECTION-8 RECORDING AND DOCUMENTING RESULTS

The Law and Your Responsibility

In Western Australia, the Electrical Licensing Regulations (1991) prohibits unlicensed persons to carry out electrical work on electrical machines, instruments, electrical installations or electrical equipment to which electricity is supplied or intended to be supplied at a nominal pressure exceeding 50 volts AC or 120V DC, where the item on which the work is performed is part of or is connected to any Network Operator's distribution or private generating plant.

WA OCCUPATIONAL SAFETY & HEALTH REGULATIONS

Regulation 3.63 of the Occupational Safety and Health Regulations, in part states that any worker bringing a portable item of electrical equipment or RCD to a construction or demolition site that is required to be tested under AS/NZS 3012, **must**, before the item is used:

(a) provide the main contractor with a record of the relevant testing data under that Standard for the thing; and
(b) ensure that the tag bears the name of the competent person who conducted the test.

This practice should be followed at other workplaces.

What records need to be kept?

Copies of the results of all inspections, tests and maintenance should be retained by the relevant duty holder and the competent person who carried out the work if not employed by the equipment owner. In particular, the following information should be kept:

- name of the person who made the inspection or carried out the test or maintenance;
- date on which, or dates over which, the inspection was made or the test or maintenance was carried out;
- result or outcome of the inspection, test or maintenance;
- date by which the next inspection and test should be carried out;
- if applicable, license or certificate number of the competent person who carried out the electrical inspections and tests; and
- if applicable, plant number or inspection number of the item or items inspected.

Where required by regulation, the record may be a logbook, register or a computerized database, and should be located conveniently so that managers can access the information. The employer should also keep a record of how the competency for the person who carried out the testing and tagging was determined. WorkSafe and mines inspectors, as appropriate, have the right to examine the records kept by employers. For construction and demolition sites, the following documentation *must* be kept for all electrical equipment and RCDs:

- register of all equipment;
- record of formal inspections and tests;
- repair register; and
- record of all faulty equipment showing details of services and corrective actions.