

Guide for safe working on or near energised electrical equipment

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1. Scope

This guideline applies when electrical workers perform electrical work on or near the exposed parts of energised low voltage electrical equipment.

Specific recommendations in this guideline relate to managing the risk of electrical arc flash hazards and shocks. This guideline does not include work on high voltage electrical equipment.

Other workplace hazards and associated controls required are not covered within this guide but are to be identified and control measures implemented by risk assessment and subsequent application of the hierarchy of control.

2. Introduction

Serious electrical incidents have occurred when persons have been performing work on or near the exposed energised parts of electrical equipment.

It is a requirement for electrical equipment to be de-energised when performing electrical work. However, there are situations where electrical workers will need to perform work on or near energised electrical equipment, particularly involving testing or fault finding.

Correct assessment of the work to be performed and the implementation of appropriate risk mitigation will ensure the safety of persons and property when performing the work.

If you perform electrical work on an electrical installation where the supply is greater than 63A, it is recommended that the Electrical Safety Office's (ESO) Guide for fault currents be used as an additional resource.

When high fault currents are available there are considerable dangers inherent in incorrect selection of tools, equipment or personal protective equipment (PPE). The high levels of energy dissipated during faults involving high currents can extensively damage equipment and could lead to injury for not only the electrical worker but anyone working nearby.

3. Terms and definitions

Arc fault¹

Unintended and uncontrolled discharge of electrical energy through air, typically the result of malfunction, contaminant build up, insulation breakdown, or physical interaction.

Arc flash²

Generation and transfer of heat, plasma gas, light and sound from an arc fault.

¹ Source: AS/NZS 4836:2023 Clause 1.4.3 (Expanded) © Standards Australia. Used with permission.

² Source: AS/NZS 4836:2023 Clause 1.4.5 © Standards Australia. Used with permission

Arc flash boundaries³

Distances from the energised equipment that should be maintained to manage arc flash risk.

Competent person⁴

Person, who has acquired through training, qualification or experience or a combination of these, the knowledge and skill enabling that person to perform the required task correctly.

Note: Electrical work may only be performed by a person who:

- a. is the holder of an electrical work licence authorising the work

or

- b. otherwise authorised to perform the work under the Electrical Safety Act 2002.

De-energised

Separated from all sources of supply, but not necessarily isolated, earthed or out of commission.

Discharge

Removal of an electric charge by the application of a discharge device.

Disconnected⁵

Physically separated from any source of electrical energy, and where necessary insulated or secured in a position clear of any electrical equipment that is capable of being energised.

Electrical equipment⁶

Wiring systems, switchgear, control gear, accessories, appliances, luminaires, and fittings used for such purposes as generation, conversion, storage, transmission, distribution, or utilization of electrical energy.

Electrical work⁷

Physical work of installing, maintaining, repairing, altering, removing, testing, or adding to an electrical installation or supervision of that work.

Energised

Connected to a source of electrical supply or subject to hazardous induced or capacitive voltages.

³ Source: AS/NZS 4836:2023 Clause 1.4.6 © Standards Australia. Used with permission.

⁴ Source: *Electrical Safety Regulation 2013*, Schedule 9 © State of Queensland [CC BY 4.0](#).

⁵ Source: AS/NZS 4836:2023 Clause 1.4.11 © Standards Australia. Used with permission.

⁶ Source: AS/NZS 4836:2023 Clause 1.4.50 © Standards Australia. Used with permission.

⁷ Source: AS/NZS 4836:2023 Clause 1.4.17 © Standards Australia. Used with permission.

Isolated

Disconnected from all possible sources of electricity supply and thereby rendered incapable of being made energised without premeditated and deliberate action.

On or near

In relation to electrical equipment, means within three meters of an exposed energised part of the equipment.

Notes:

1. The term 'on or near exposed energised conductors or energised parts' does not apply if the uninsulated and energised part is safely and securely shielded by design or segregated and protected with barricades or insulated shrouding or insulating material to prevent inadvertent or direct contact.
2. The term 'on or near' includes an activity which may affect the properties of conductors or conductive parts and cause them to be exposed energised conductors or energised conductive parts.
3. Inadvertent or direct contact by a person includes any article of clothing worn by the person and any conductive object the person is handling or likely to handle.

Personal protective equipment (PPE)⁸

Clothing, equipment and/or substances, which when worn or correctly used, protect parts or all of the body from foreseeable risk of injury or disease at work or in the workplace.

Risk

Combination of the probability of occurrence of harm and the severity of that harm.

Risk assessment

Overall process of risk identification, risk analysis and risk evaluation.

Safety observer

A person who is competent to implement control measures in an emergency, and to rescue and resuscitate a worker who is carrying out work, if necessary and has been assessed in the previous one year as competent to rescue and resuscitate a person.

Safe work method statement (SWMS)⁹

A document that sets out the work activities to be carried out at a location, the hazards arising from the activities, and the measures to be put in place to control the risks.

Testing

Use of test instruments or test equipment by a competent person.

⁸ Source: AS/NZS 4836:2023 Clause 1.4.31 © Standards Australia. Used with permission.

⁹ Source: AS/NZS 4836:2023 Clause 1.4.39 (Varied) © Standards Australia. Used with permission.

Voltage

Differences of potential normally existing between conductors or between conductors and earth.

Extra low voltage

Not exceeding 50V a.c. or 120V ripple free d.c.

Low voltage (LV)

Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.

Note: Where a definition has not been provided, refer to Electrical Safety Regulation 2013 section 5 schedule 9 (Dictionary), and/or AS/NZS 3000:2018 Wiring Rules section 1.4 definitions, and/or AS/NZS 4836 Safe working on or near low-voltage and extra-low voltage electrical installations and equipment, section 1.4 terms and definitions, and/or the normative standard applicable to the installation.

4. Energised electrical work

The requirements for the performance of energised electrical work are detailed in *Electrical Safety Regulation 2013* (ESR) Part 3.

4.1. Electrical work on or near energised electrical equipment—ESR s.14

Electrical work on or near energised electrical equipment is only permitted in particular circumstances when:

- it is necessary in the interests of health and safety that the electrical work is carried out on the equipment while the equipment is energised

Example: It may be necessary that life-saving equipment remain energised and operating while electrical work is carried out on the equipment.

or

- it is necessary that the electrical equipment to be worked on is energised in order for the work to be carried out properly

Example: It may be necessary to perform energised testing of a consumer main to confirm correct polarity and neutral integrity.

or

- it is necessary for the purposes of testing required to determine if electrical equipment is energised or not

or

- there is no reasonable alternative means of carrying out the work.

Example: It may be necessary, to avoid widespread outages, that works of an electricity entity remain energised and operating while electrical work is carried out on the works.¹⁰

4.2. Preliminary steps prior to carrying out electrical work on or near energised electrical equipment—ESR s.19

Prior to performing electrical work on or near energised electrical equipment the person conducting the business or undertaking (PCBU) must ensure:

- a competent person conducts a risk assessment in relation to the proposed electrical work and records the results of the risk assessment¹¹

Note: An assessment of risks associated with a class of hazards, tasks, things, or circumstances may be conducted if:

- » all hazards, tasks, things, or circumstances in the class are the same

and

- » the assessment of risks for the class does not result in any worker or other person being exposed to a greater, additional or different risk to electrical safety than if the risk assessment were carried out in relation to each individual hazard, task, thing or circumstance.¹²

- the area where the electrical work is to be carried out is clear of obstructions to allow for easy access and exit
- the point at which the electrical equipment can be disconnected or isolated from its electricity supply is:
 - » clearly marked or labelled
 - » clear of obstructions so it allows for easy access and exit by the worker who is to carry out the electrical work or any other competent person

and

- » capable of being operated quickly.
- the person authorises the electrical work after consulting with the person with management or control of the workplace.¹³

¹⁰ Source: Electrical Safety Regulation 2013, s 18 © State of Queensland [CC BY 4.0](#).

¹¹ Source: Electrical Safety Regulation 2013, s 19 © State of Queensland [CC BY 4.0](#).

¹² Source: Electrical Safety Regulation 2013, s 10 © State of Queensland [CC BY 4.0](#).

¹³ Source: Electrical Safety Regulation 2013, s 19 © State of Queensland [CC BY 4.0](#).

When developing a risk assessment as per ESR s.19(1)(a) consider risk control measures in the following order (hierarchy of control).

Elimination

Elimination, where possible, is the most effective risk control / mitigation method.

Example: RCD testing at the end of a final subcircuit with an appropriately designed plug-in test instrument will eliminate exposure to high fault currents within the switchboard.

Substitution

Replacing the higher risk activity with a lower risk.

Example: replacing a standard switchboard with one that has been designed and tested for arc-resistant construction.

Isolate

Minimising the risk by isolating or separating the hazard or hazardous work practice from any person exposed to it.

Example: Isolation of hazard which can be achieved by working on de-energised electrical equipment or using techniques like remote switching/racking.

Engineering

Engineering controls are physical control measures to minimise risk.

Example: Arc resistant switchboards designed to contain and redirect the arc flash. Alternately, incorporating faster protection settings during maintenance work using remote rack-able circuit breakers.

Administration

Administrative controls involve the use of safe work practices to control the risk.

Examples: Providing suitable and adequate training, documented procedures. Use of permits to work, signs, barriers and similar processes which ensure consistent work methods that minimise risk.

Personal protective equipment (PPE) and clothing

PPE is not a primary means of control but can be used to supplement higher controls. PPE should be rated for the work to be undertaken. PPE must be able to protect the user from the maximum expected energy available.¹⁴

¹⁴ [Electrical Safety Code of Practice 2020: Electrical equipment rural industry](#) © State of Queensland 2020 [CC BY-ND 4.0](#).

Note: It is normal to use a combination of control measures to reduce the risks associated with a serious hazard to a manageable level.

4.3. How work is to be carried out—ESR s.22

Where electrical work is carried out on energised electrical equipment, the electrical work must be carried out:

- by a competent person who has tools, testing equipment and personal protective equipment that:
 - » are suitable for the work
 - » have been properly tested
 - » are maintained in good working order
- in accordance with a safe work method statement prepared for the work. The safe work method statement must:
 - » identify the electrical work

and

- » specify hazards associated with the electrical work and risks associated with those hazards

and

- » describe the measures to be implemented to control the risks

Example of a measure: Preventing persons from accessing an area where electrical work is being carried out on energised electrical equipment if the persons are not needed for the performance of the work.

- » describe how the measures are to be implemented, monitored and reviewed.
- with a safety observer—a safety observer is not required if:
 - » the work consists only of testing

and

- » the person conducting the business or undertaking has conducted a risk assessment for the work that shows that there is no serious risk associated with the proposed work.

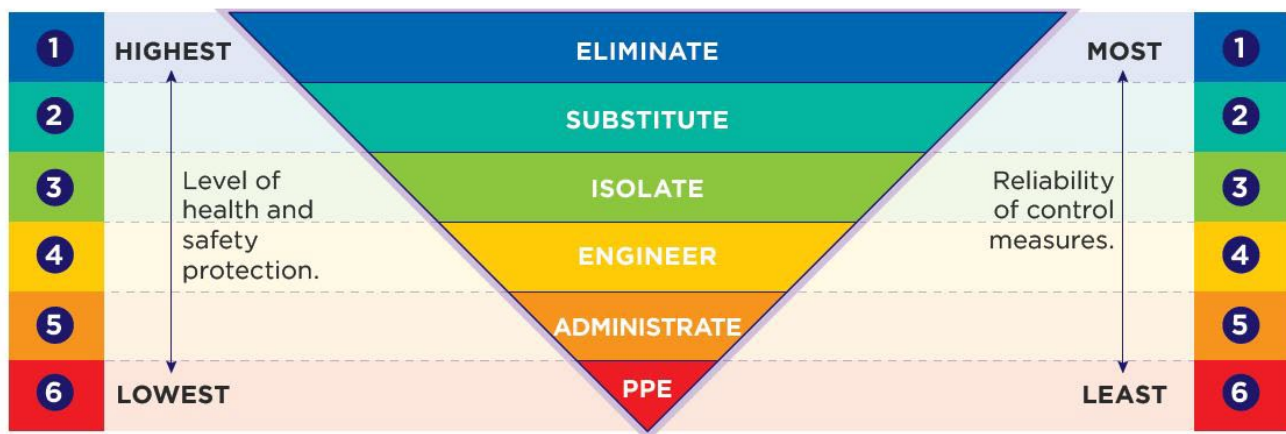
Example: A safety observer is not required to observe the testing of the polarity of an installed outlet if a risk assessment does not show there is a serious risk in performing the work.¹⁵

Take caution and assume all exposed electrical parts are energised, until isolated and proved de-energised.

5. Assessing the risk

This section is looking at electrical risks associated with low voltage electrical work only and does not identify or address other risk factors such as asbestos, environmental conditions, falls, falling objects, vehicles and chemical exposure.

There is a high risk of arc flash and electric shock incidents when working on or near energised electrical equipment without effective controls utilising the hierarchy of controls depicted in Figure 1 in place.



1. Eliminate the hazard
2. Replace the hazard with something safer
3. Separate the hazard from people

4. Reduce the risk through engineering controls
5. Change/control the way people work
6. Protect the worker

Electrical arc flash hazard management guideline 2019 © Australian Energy Council. Used with permission.

Figure 1 – Hierarchy of control diagram.

5.1. Arc flash

Arc faults arise when current flows through the air between phase conductors or between phase conductors and neutral or ground. Put simply, an arc fault could be described as an unexpected, violent, electrical short circuit in the air that produces an arc and associated by-products.

¹⁵ Source: Electrical Safety Regulation 2013, s 22 © State of Queensland [CC BY 4.0](#).

When arc faults occur, the resulting energy released may be enough to seriously burn or otherwise injure nearby persons, ignite flammable materials (including clothing), and cause significant damage to plant and equipment. Figure 2 is a representation of an arc flash event.

Any activity in the vicinity of energised parts poses a risk of initiating an arc flash. Arc flash incidents most commonly occur when a person is working on or near an energised electrical equipment. The risk increases by the degree of interaction with the energised equipment.

Some common causes of an arc fault are:

- loose or corroded connections
- damaged, frayed, or pinched wires
- poorly terminated or loose electrical connections
- mechanical damage to conductors caused by wayward drill bits, screws driven into energised cables
- rodents, reptiles or insects entering energised switchboards
- ionized gases released from switchgear clearing short circuits
- accidental contact between energised conductors and test probes or other tools.

A partial thickness (second degree) burn to unprotected skin is possible when exposed to an incident energy level of $5\text{J}/\text{cm}^2$ ($1.2\text{ cal}/\text{cm}^2$). Incident energy is dependent on fault current and disconnection time.

Incident energy should be estimated in accordance with IEEE 1584 (Guide for Performing Arc-Flash Hazard Calculations), and ENA NENS 09 (National Guideline for the Selection, Use and Maintenance of Personal Protection Equipment for Electrical Arc Hazards), or an equivalent standard or obtained from switchboard labelling, or from an arc flash study. Switchboards with a rated capacity exceeding 800A should have an arc flash study completed to enable hazard identification and control. Refer to Appendix A for an example of switchboard arc flash label.

Arc flash boundaries are the distances from energised equipment that should be maintained to manage arc flash risk. The boundaries are set around two key criteria:

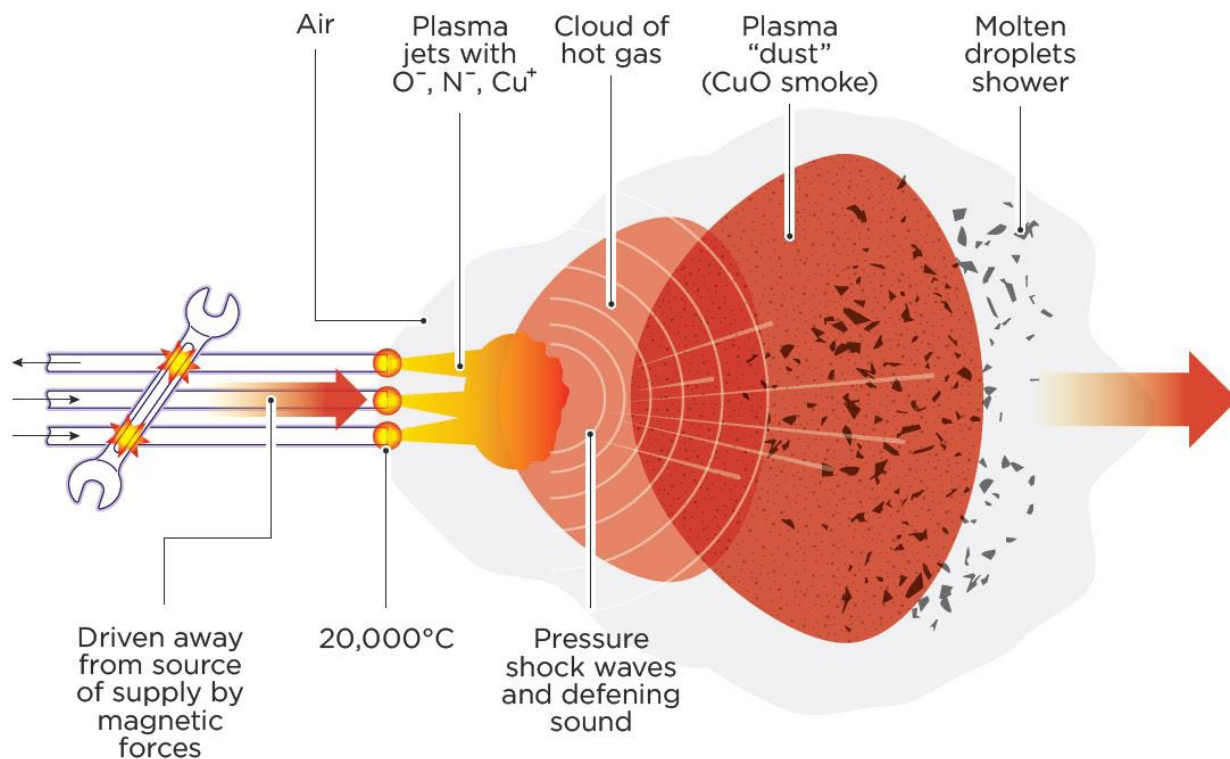
- The distance for the standard levels of PPE to protect the person.
- The amount of energy a person in the working position will be exposed to during an arc flash.

The flash boundary is the farthest established boundary from the energy source. If an arc flash occurred, this boundary is where a person would be exposed to a curable second-degree burn ($1.2\text{ cal}/\text{cm}^2$).

In the absence of incident energy calculation, all switchboards and electrical equipment with upstream protection exceeding 63A should be considered to have an incident energy exceeding $1.2\text{ cal}/\text{cm}^2$.

If the switchboard door is open, the plasma jet/fireball is highly likely to be directed to the personnel standing in front of the panel. This risk must be considered.

Refer to Appendix B for guidance on Incident Energy and arc flash boundary recommendations in the absence of an engineering study.



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Figure 2 – Depiction of an arc flash event.

5.2. d.c. Arcing current

There is an increase in the use of d.c. systems in electrical installations, particularly in the renewable energy systems. Previously d.c. systems were mostly used in industrial settings. With the advent of variable speed drives, it's use in industry has decreased.

Common d.c. installations include, but are not limited to:

- photovoltaic (PV) modules and arrays
- battery energy storage systems (BESS)
- capacitors
- power supplies.

Arc flash initiated from a d.c system is inherently different from an arc flash initiated from an a.c. system. During arc flashes on d.c. systems, the current never crosses zero. For arc flashes on a.c. systems, the arc extinguishes each time the current wave goes through a zero crossing and must reignite to maintain the arc. In a d.c. system, there is no need to reignite the arc. As a result, the energy generated by a d.c. arc flash is much higher and will sustain itself much longer than an a.c. arc flash.

This hazard should be considered when developing your safe work method statement.

Incident energy, to which an individual may be exposed, should be estimated by one of the following methods:

- Calculations based on formulae in ENA NENS 09 National Guideline for the Selection, Use and Maintenance of Personal Protection Equipment for Electrical Arc Hazards.
- Calculations based on the IEEE 1584 Guide for Performing Arc-Flash Hazard calculations.
- In accordance with AS/NZS 4836 Safe working on or near low-voltage and extra low voltage electrical installations and equipment, Table 11.2.

Note: Further guidance including calculation of d.c. arcing faults, is available in the Guide for fault currents and AS/NZS 5139 Electrical installations – safety of battery systems for use with power conversion equipment.

5.3. Electric shock

Potential sources of electric shock must be identified before any work is carried out. Possible sources include:

- **Direct contact:**
 - » Voltage between phases or phases and neutral
 - » Voltage between phase and earth or parts in contact with earth
 - » Voltage from alternate energy supplies (e.g. generators, inverter energy systems, battery energy storage systems)
 - » Voltage across open switch contacts
 - » Voltage across capacitors which have not been discharged
 - » Induced or capacitively coupled voltage in disconnected conductors
 - » Voltage between neutral and earth if the MEN connection is removed, whilst an alternate energy source is connected (e.g. battery energy storage system inverter)
 - » Voltages caused by connected equipment, incorrect connections, or faults
 - » Voltages between neutral and the general mass of earth caused by excessive current, a high resistance termination or voltage drop.

- **Indirect contact**

- » Where the MEN system is used, the earthing system will become energised due to fault current, in the event of an earth fault, until automatic disconnection of the fault occurs.

Note: Further information and guidance regarding fault protection and indirect contact is available in the guide for testing low voltage installations AS/NZS 3017:2023 Electrical installations - Verification by inspection and testing and AS/NZS 3000:2018 Wiring Rules.

5.4. Considerations when assessing the risk

These are examples only and not everything that may need assessing.

- Task e.g. isolation, visual inspection, testing, or work.
- Equipment design and/or configuration, the following needs to be considered:
 - » Are all conductors insulated?
 - » Is equipment rated IP2X or better?
 - » What is the separation of uninsulated conductors or conductive parts. e.g. are there insulating barriers between conductors and where conductors are separated by an air gap, the distance between conductive parts of a different potential?
 - » Is the equipment suitably designed for the available fault current?
 - » Is the equipment fitted with an energy limiting protection system i.e. arc fault detection system?
- The age and condition of the equipment, the following needs to be considered:
 - » Has the equipment been appropriately maintained?
 - » Is there any sign of damage, heating, loose connections, or incorrect terminations?
 - » Is installed equipment suitable and compatible with the equipment design i.e. if a different brand of circuit breaker is fitted, it may not cascade with the upstream protection?
- Tools and equipment – are the tools fit for purpose and suitably insulated?
- Personnel:
 - » Are all persons suitably qualified and trained for the task?
 - » What is the worker location relative to exposed conductive parts, where high fault currents are available?
 - » Are there barriers or shields between the person and the source of the risk i.e. to prevent contact with energised parts?

- Impact of PPE:
 - » Will PPE introduce additional hazards?
 - » Reduced visibility, communication, or mobility.
 - » Heat stress.
 - » Dexterity.

All electrical conductors and parts, including neutral and earthing conductors, must be treated as energised until proven de-energised. Always test before touching.

6. Safe work method statement

Electrical work on or near energised electrical equipment must be carried out in accordance with a safe work method statement (SWMS).

SWMS document a process for identifying and controlling health and safety hazards and risks. They may also incorporate a risk assessment.

SWMS are also required in relation to prescribed 'high risk construction work' which includes construction work carried out on or near energised electrical installations or services.

SWMS should be developed in consultation with relevant workers.

SWMS must:

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

SWMS must be written in a way that is readily understandable by all workers who are to use them.

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

The PCBU must ensure that SWMS are regularly reviewed and, as necessary, revised if relevant control measures are revised under the WHS Regulation. They must, for example, be revised if a decision is made to change relevant safe work procedures at the workplace.

Examples of measures to control risk:

- Preventing persons from accessing an area where electrical work is being carried out on energised electrical equipment if the persons are not needed for the performance of the work.

- RCD testing at a socket outlet using an appropriate multifunction tester instead of testing at the switchboard where persons are exposed to the risk of electric shock and/or arc flash.
- Identifying and isolating alternate sources of supply.
- In situations where uninterruptible power supplies, backup generators, inverter energy systems, battery energy storage systems, auto-reclosing, or auto change over systems are installed, these facilities should be disabled.

Note: Ensure that the SWMS is understood by all persons performing the work and suitable tools, equipment, and PPE are readily available, tested and in good condition.

6.1. Conductive materials

Workers can be exposed to the hazards of electric shock, arcing and explosion without making direct contact with exposed energised parts. Other materials can provide current paths for the electric shock, fault current, or both.

All materials should be regarded as conductive, unless proven otherwise. Gases and liquids should also be regarded as conductive materials.

Particular care should be taken when exposed energised parts are near an earthed situation. The electric shock path to earth can be via conductive materials, such as concrete, or timber with a high moisture content or water.

Metallic personal items, such as watches and watchbands, should not be worn when working near exposed energised parts. Objects of this kind can result in electric shocks. In addition, burns sustained near these items can be worse because the objects retain heat and provide contact points for current to flow.

Examples of other metal objects that should not be worn when performing electrical work include:

- neck chains
- rings
- conductive watches
- bracelets
- earrings, body piercings
- metal spectacle frames.

6.2. Work position

To prevent electric shock, you should work from a position where it would require a deliberate movement to touch energised parts or create a current path. Adequate working clearance should be maintained to allow safe access and egress from the work position in the case of an emergency.

Examples:

- Choice of body position should be such that if you made an involuntary action such as sneezing, you would not touch exposed energised parts e.g. fault finding on an air conditioning unit located in a restricted roof space.
- When working in an awkward position—such as testing components towards the rear of a washing machine via the front panel e.g. in a laundromat—the work system, including body position, should be such that no electric shock path can be created.
- Performing phase sequencing or rotation testing at a switchboard, the work system, including body position, should be such that no electric shock path can be created.
- If a circuit breaker has the facility to be remotely operated, the preferred work position should be communicated to workers. For example, is operating a circuit breaker by standing at the unit acceptable, or is it preferred to use remote control facilities.

6.3. Safety observer

A safety observer (electrical) must be used when performing electrical work on or near energised electrical equipment unless the work involves testing electrical equipment and the risk assessment shows that there is no serious risk associated with the proposed work.

Where the electrical work has been assessed as high risk, a safety observer must be used as one form of control measure unless the SWMS specifically addresses the likelihood of inadvertent contact with exposed energised parts and the risk of arc flash through alternative measures.

Examples of high-risk work include:

- Fault finding at a switchboard that has a high prospective fault current level.
- Installing and replacing components at a switchboard.
- Connecting (deenergised) final subcircuits within an energised switchboard where there are exposed energised parts or an incident energy exceeding 4 cal/cm².

If a safety observer (electrical) is used as part of a risk management strategy, the following should apply:

- The safety observer's role should be clearly communicated and understood. The role is to warn the worker or workers of danger as well as to perform rescue and resuscitation, as required.
- A safety observer should have the authority to stop the work before the risks become too high.
- The safety observer should not carry out any other work or function that compromises their role as a safety observer.

- The safety observer should be able to communicate effectively with the worker or workers. Specialist equipment may be necessary in situations where there is a barrier to communication.
- The safety observer should not have to observe more than one task at a time.
- A safety observer should not be situated in the work basket of the elevating work platform.
- To meet an electrical safety duty, a safety observer should not be regarded as the sole control measure to ensure electrical safety.

6.4. Emergency planning

An emergency plan for the workplace must be prepared, and maintained so that it remains effective, and implemented in the event of an emergency.

For the purpose of preparing and maintaining the plan, you must consider all relevant matters, including:

- the nature of the work being carried out at the workplace
- the nature of the hazards at the workplace
- the size and location of the workplace
- the number and composition of the workers
- other persons at the workplace
- availability of medical assistance.

Quick action after an electrical incident that has caused injury can save a life or significantly reduce the severity of the injury. Any person who is involved in an electrical incident involving an electric shock should receive medical attention.

Even if an electrical incident does not appear to have caused injury at the time, there may be delayed effects.

A well-prepared emergency response will assist in managing the severity of the injury where an incident has occurred, while also taking into account the health and safety of those required to respond to the incident. For example, in an exposed energised high voltage situation, the plan may include isolating the electricity supply and proving it is de-energised before carrying out a rescue.

Special consideration should also be given in relation to other higher risk activities including confined spaces, working at heights, use of elevating work platforms, hazardous atmospheres which present a risk to health or safety from fire or explosion, and trenches, shafts and tunnels.

6.5. Safety barriers and signs

Safety barriers and signs can be used to control risks associated with differences in potential between energised parts or energised parts and earth.

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

- protect the electrical worker from contacting energised parts
- ensure that access to and egress from the work location of energised work allows for clear, unobstructed passage
- warn others and direct them away from energised parts
- be temporary or permanent
- clearly designate the safe work area by defining the approach path to a piece of equipment.

6.6. Personal protection

Suitable clothing worn in the recommended manner will provide some protection from burns for someone in the immediate vicinity of a fault involving high currents. Flame-retardant clothing covering the full body must be worn. Clothing must not be made from conductive material or contain metal threads.

In the case of arc flash hazard, the main purpose of PPE is to reduce burn injury to a level of curable burn.

Clothing must be suitable for the prospective fault level where work is undertaken. Some energy levels may be too high for any PPE to be effective. In this case other methods or a combination of methods may be required to effectively manage the risk.

Synthetic materials including undergarments must not be worn!

Synthetics melt readily, then solidify deep within the burnt tissue, hindering the healing process.

Rings, bracelets, metal neck chains, exposed metal zips, watches and other conductive materials must be removed before starting work.

Whilst cotton clothing does not melt into the skin, untreated cotton is flammable and may continue to burn after ignition. Therefore, untreated cotton is not suitable for base or outer garments where the incident energy level exceeds 1.2 cal/cm² or above.

Base garments are considered as outer wear but may be in direct contact with the skin. e.g. Long-sleeved shirt and trousers or coveralls. Base garments manufactured from arc rated materials should be worn where there is a possibility of exposure to incident energy of 1.2cal/cm².

Flame retardant fabrics may burn while exposed to a heat source but will self-extinguish when the heat source is removed. Not all flame-retardant fabrics meet the requirements for arc rated

fabrics. Examples include wool, flame retardant cotton and non-melting synthetics such as modacrylics and aramids.

Arc rated fabrics have been tested and proven to extinguish when exposed to an arc event. Arc rated fabrics will specify an Arc Thermal Performance Value (ATPV) or Energy of Breakopen Threshold (Ebt) given in Joules/cm² or calories/cm².

Protective garments should provide limited arc protection for the entire upper and lower torso, arms, and legs.

Thermal outer garments may be worn i.e. Jackets and Pullovers. It is not essential that these garments are arc rated, however the outer layer must be flame retardant and there must be no flammable melting synthetic layers.

Arc rated clothing should be cleaned and maintained in accordance with the manufacturers recommendations.

Further information and guidance is also available in the Electrical Arc Flash Hazard Management Guideline – produced by the Australia Energy Council (EAC) [Electrical Arc Flash Hazard Guidelines Developed \(energycouncil.com.au\)](https://www.energycouncil.com.au)

Insulating gloves complying with AS/NZS IEC 60903 are worn to provide protection from the risk of electric shock. To provide protection from the thermal effects of an arc, insulating gloves should be worn in conjunction with appropriate outer protective gloves in accordance with the insulated glove's instructions for use.

AS/NZS 4836 - Safe working on or near low-voltage and extra low voltage electrical installations and equipment, section 11, Table 11.2 provides guidance on the selection of PPE based on electrical risk. Refer to Appendix C and D of this guide for the category and selection of PPE based on based on the tasks being performed and the electrical risk.

7. Tools, instruments, and equipment used for electrical work

7.1. General

In general industry, tools, instruments, and equipment that are poorly maintained, inappropriately used or not fit for purpose can cause injuries. With electrical work, there is the added risk of electric shock or large releases of energy from arcing and explosion.

The tools, instruments and equipment used by electrical workers often have special design characteristics. For example, many are insulated as a control measure, however, regular maintenance and inspection are required, otherwise, certain dangers can arise e.g. the insulating medium might conceal a mechanical defect that could cause an open circuit in the lead of a testing device.

The term tools, instruments and equipment, includes the following devices:

- insulated hand tools where the insulation is relied upon as a control measure
- rescue and escape kits
- portable short circuits and earth devices
- operating rods, including measuring sticks
- mechanical equipment such as serial hoists for line work
- cable spiking or stabbing equipment
- ladders and pole platforms
- insulating mats and covers
- harnesses, lanyards and fall restraint devices
- instruments and testing devices used for proving de-energised, testing and fault finding.

Workers should be trained and competent in the use of the device. Safe use includes:

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

7.2. Selection, testing, maintenance

When selecting or maintaining tools, instruments, and equipment, you should address a number of factors to ensure electrical safety. At least the following issues are to be addressed:

- The device must be fit for purpose.
- Equipment and test instruments that can be visually confirmed as functioning correctly should have visual confirmation of correct function each time before use.
- Equipment and test instruments should be maintained and inspected according to the manufacturer's instructions.
- Repairs and maintenance should meet appropriate standards and manufacturer's instructions.

Appropriate guidance and standards for testing, inspecting, calibrating, and maintaining these devices can be obtained from sources that include:

- manufacturers and suppliers
- industry groups
- national and international codes and standards such as those produced by Standards Australia e.g. AS and AS/NZS publications; and International Electrotechnical Commission e.g. IEC publications, i.e. HB 187 Selection of Multimeters.

When selecting devices, the following should be avoided:

- Flame producing devices, since flame conducts electricity.
- Fire extinguishers that contain conductive mediums such as water.

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

Examples include:

- torches
- telescopic devices e.g. antennas, mirrors
- rulers and tape measures
- insulated tools e.g. screwdrivers, pliers, cable cutters, spanners, crimpers
- electrical or hydraulic powered tools.

7.3. Safety in the use of instruments and test devices

When performing any test to detect or confirm energised conductors, the following procedures should be adopted as part of safe work practices by a competent person:

- Ensure instrument is suitable for use on low impedance sources, such as main switchboards. (i.e. Testing at a commercial switchboard will require a category IV meter with category IV test leads).
- Always confirm the correct operation of the test device at the start of testing.
- Check correct operation at completion of testing, to guard against failure during testing.
- Check that the correct function and range has been selected on the test equipment. Attention is drawn to ensuring the correct a.c. or d.c. selection and that a hold function has not inadvertently been selected.
- When using testers in a manner that requires the completion of a circuit to earth, ensure that the earth is effective. This applies in particular to test lamps and solenoid type testers, which draw over 25mA, a level that presents a safety risk. If, for example, such an instrument was used for testing from an energised conductor to an unearthed metal

switchboard enclosure, the enclosure would become energised. Alternatively, connection to an earthing system which has unusually high main earth resistance to earth, could also result in the whole earthing system, including any appliances connect to it (e.g. stove or HWS), to become energised.

- To prevent personal injury and/or damage to equipment, all test instruments should be capable of withstanding the impulse voltages and fault current levels that may be experienced in the installation. e.g. The rating for test instruments and test probes used on 400/230V mains voltage equipment connected on the supply side of a main switchboard should be Installation Category IV for the rated voltage. (i.e., A rating of Cat IV 600Vac, Cat III 1000Vac would be suitable).
- When carrying out testing procedures prior to connection to supply, particular care should be taken to ensure there is no risk of injury to yourself or others.
- When carrying out mains polarity tests with the MEN link disconnected, a temporary shock hazard may arise. The earthing system, including the water piping and associated equipment can be raised above earth potential. Take appropriate measures such as using a remote earth as the testing reference point instead of the installation earth or using a high impedance test instrument such as a voltmeter to perform the tests.
- Ensure that alternate energy supplies are isolated at their source, prior to commencing testing. The neutral-earth connection for an alternate supply is the installation MEN connection. Neutral and earth circuits may become energised under fault conditions or when the MEN connection is removed.

8. Additional work practices

- Where possible, install approved covers to all uninsulated energised areas and exposed earthed metal work in proximity of the work area.
- When working on energised equipment, use insulated tools which are maintained in good condition and suitable for the task being performed.
- When working in confined areas such as switchboards, use tools and testing equipment specifically designed for this purpose.
- Test probes and other equipment must be designed or selected so they cannot inadvertently short between opposite phases or phase-to-earth.
- Ensure drill bits will not penetrate or touch energised equipment when drilling a switchboard. Precautions must be taken to ensure metal filings do not accumulate and initiate a fault.
- Do not pass or feed conductive material into a switchboard with energised equipment.

- Do not pass or feed cables into a switchboard unless the cable including the ends are effectively insulated and they are guided away from energised parts.
- Look for arc flash labelling and where provided ensure that risk mitigation, including PPE, is appropriate for the applicable incident energy and arc flash boundary.
- If there is no arc flash rating, assess the incident energy and ensure that risk mitigation including PPE is appropriate for the applicable incident energy and arc flash boundary. (Additional guidance can be obtained from the *Guide for fault currents* and/or AS/NZS 4836: Safe working on or near low-voltage and extra-low voltage electrical installations and equipment).
- Prior to operating electrical equipment, assess its age and condition. e.g. An old main switch which has not been operated for a number of years may not function as intended and could present additional risk during operation. Control measures could include upstream isolation or shedding load prior to operation.
- When testing, is it possible to de-energise the equipment, connect test equipment using suitable connections, clamps or clips and re-energise equipment to observe measurements from a safe location?

9. Reducing the risk by design

Switchboard and protection system design can reduce the risk of personal injury and/or equipment damage. Some methods which may be employed are:

- Segregation of switchgear assemblies using physical barriers.
- Arc fault rated switchgear certified to contain or redirect arc fault energy.
- Optimised protection settings can greatly reduce arc fault incident energy.
- Physical inspection, assessment, and maintenance of electrical equipment to ensure correct operation.
- Optical arc fault detection devices help to detect and assist in the speed of operation of protective devices under arc fault conditions. Optical arc fault detection devices can be used to detect the flash of light emitted early in the arc flash event and trigger the operation of circuit breakers well in advance of the normal trip caused by arc fault current.
- Arc quenching devices can be used in conjunction with an arc flash detection system to clear an arcing fault within a few milliseconds. An arc flash quenching device extinguishes an arc much faster than a circuit breaker by applying a rapid bolted short circuit between phases or between phases and earth close to the arcing fault location. This causes a collapse in the arc voltage, rapidly extinguishing the arc. The bolted short circuit current flows through the quenching device until it is interrupted by the primary protection device.

- Permanently installed metering equipment (voltmeters ammeters etc) or test points may remove the need to open escutcheons for testing.
- Remote operated devices.

10. Appendix

10.1. Appendix A—Example of an arc flash label

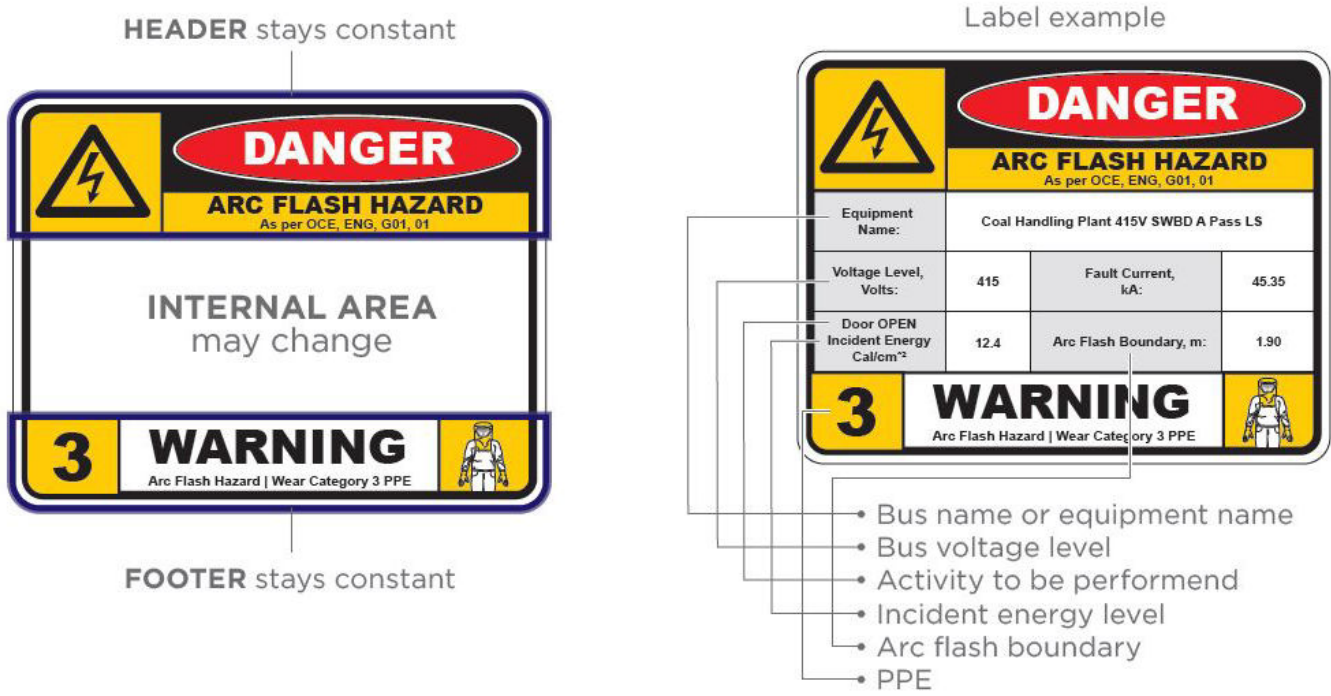


Figure 3 – Electrical arc flash hazard management guideline 2019, © Australian Energy Council. Used with permission.

10.2. Appendix B—P1 – Incident energy and arc flash boundary recommendations in the absence of an arc flash study

Select equipment rating. (Either less than or greater than 800A)	Select voltage range in column	What is protecting the supply upstream. If unknown select Transformer	Select protection device rating or transformer size	Resulting PPE and boundary requirements are shown in columns E and F	
A	B	C	D	E	F
Equipment	Nominal voltage	Upstream device type	Upstream device rating	Minimum arc rating PPE, cal/cm ²	Arc flash boundary
Switchboards rated ≤ 800 A (IEEE 1584 equipment type: Panel/MCC) Minimum working distance: 46 cm	230 V (1Ø)	Transformer	≤ 15 kVA	NOTE 1	< 0.46 m
			≤ 75 kVA	8	1.5 m
			≤ 250 kVA	40	3.0 m
		Fuse	≤ 150 A	NOTE 1	< 0.46 m
			≤ 600 A	8	1.5 m
			≤ 800 A	40	3.0 m
		Circuit breaker T/M or M	≤ 80 A	NOTE 1	< 0.46 m
			≤ 800 A	8	1.5 m
			≤ 800 A	40	3.0 m
Switchboards rated ≤ 800 A (IEEE 1584 equipment type: Panel/MCC) Minimum working distance: 46 cm	400 V (3Ø)	Transformer	≤ 10 kVA	NOTE 1	< 0.46 m
			≤ 40 kVA	4	1.0 m
			≤ 75 kVA	8	1.5 m
			≤ 400 kVA	40	3.5 m
		Fuse	≤ 63 A	NOTE 1	< 0.46 m
			≤ 250 A	8	1.5 m
			≤ 800 A	40	3.5 m
		Circuit breaker (At maximum settings, instantaneous enabled)	≤ 100 A	4	1.0 m
			≤ 250 A	8	1.5 m
			≤ 630 A	40	2.5 m
		Circuit breaker	≤ 100 A	40	1.5 m
			≤ 400 A	40	2.5 m

		Short time pickup: $\leq 10\times$ rated Short time delay: ≤ 100 ms No instantaneous	≤ 630 A	40	3.0m
		Circuit breaker Short time pickup: $\leq 10\times$ rated Short time delay: ≤ 300 ms No instantaneous	≤ 630 A	40	3.0 m

Source: AS/NZS 4836:2023 Table B1 © Standards Australia. Used with permission.

(Reproduced from information within AS/NZS 4836 Table B1)

10.3. Appendix B—P2 – Incident energy and arc flash boundary recommendations in the absence of an arc flash study

Equipment	Nominal voltage	Upstream device type	Upstream device rating	Minimum arc rating PPE, cal/cm ²	Arc flash boundary
Switchboards rated ≤ 800 A (IEEE 1584 equipment type: Panel/MCC) Minimum working distance: 46 cm		Circuit breaker Short time pickup: $\leq 10\times$ rated Short time delay: ≤ 500 ms No instantaneous	≤ 630 A	75	3.5 m
Switchboards (IEEE 1584 Equipment type: Switchgear) Minimum working distance: 61 cm	400 V (3Ø)	Transformer	≤ 10 kVA	NOTE 1	< 0.46 m
			≤ 40 kVA	4	1.0 m
			≤ 75 kVA	8	1.5 m
			≤ 400 kVA	40	3.5 m
		Fuse	≤ 1600 A	40	3.5 m
			≤ 2000 A	40	4.0 m
		Circuit Breaker At maximum settings, instantaneous enabled	≤ 1600 A	40	3.5 m
			≤ 2000 A	75, NOTE 2	4.5 m
		Circuit Breaker Short time pickup: $\leq 10\times$ rated Short time delay: ≤ 100 ms No instantaneous	≤ 800 A	40	3.5 m
			$\leq 2\,000$ A	75, NOTE 2	6.5 m
		Circuit breaker Short time pickup: $\leq 10\times$ rated	≤ 800 A	40	3.5 m
			$\leq 2\,000$ A	75, NOTE 2	6.5 m

		Short time delay: ≤ 300 ms No instantaneous			
		Circuit breaker Short time pickup: $\leq 10\times$ rated	≤ 800 A	40	3.5 m
		Short time delay: ≤ 500 ms No instantaneous	$\leq 2\,000$ A	75, NOTE 2	6.5 m

Note 1: Suitable PPE should be worn for the task being performed.

Note 2: In some cases, for 2000 A circuits, incident energy exceeds 75 cal/cm². 75 cal/cm² is the maximum arc rated PPE prescribed by this document. Empirical evidence suggests that any arc rated PPE is better than none. For 2000 A circuits, the risk should be assessed and as with all scenarios, work on de-energized conductors is the priority.

Note 3: This table is based on the following assumptions:

- Motor contributions are not factored into calculations.
- Devices are tested over a range of prospective fault levels including 0.5 kA, 1 kA, 2 kA, 5 kA, 10 kA, 20 kA, 28kA, 36 kA.
- Calculations are in accordance with IEEE 1584:2018.
- VCBB electrode configuration (i.e. vertical electrodes terminating in an insulating barrier inside an enclosure) are considered in all cases. Standard box dimensions in accordance with IEEE 1584 are applied.

Source: AS/NZS 4836:2023 Table B1 © Standards Australia. Used with permission.

10.4. Appendix C—An example of a PPE category system

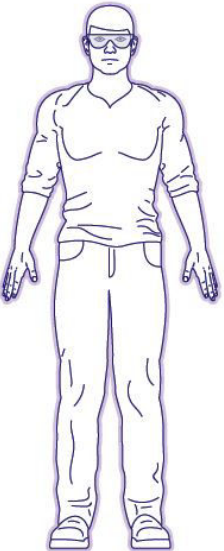
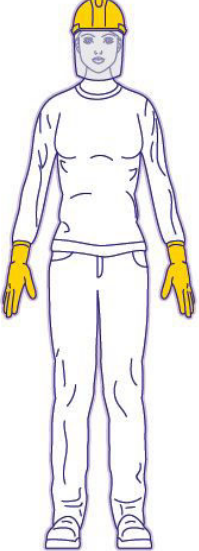
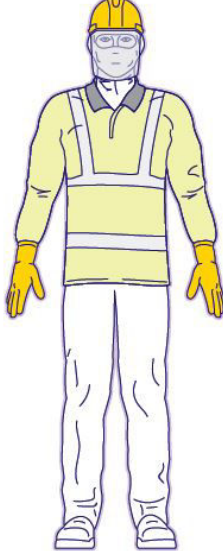
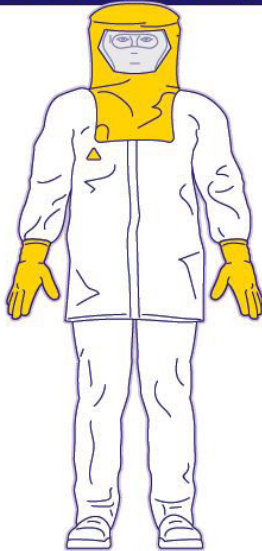
0 cal/cm ²	4 cal/cm ²	8 cal/cm ²	25 cal/cm ²	40 cal/cm ²
PPE CATEGORY 0	PPE CATEGORY 1	PPE CATEGORY 2	PPE CATEGORY 3	PPE CATEGORY 4
				
• No protection	• Arc-rated long sleeve shirt • Arc-rated pants or overalls • Arc-rated face shield with hard hat • Safety glasses • Hearing protection • Leather & voltage rated gloves (as needed) • Leather work shoes	• Arc-rated long sleeve shirt • Arc-rated pants or overalls • Arc-rated face shield & balaclava or Arc flash suit with hard hat • Safety glasses • Hearing protection • Leather & voltage rated gloves (as needed) • Leather work shoes	• Arc-rated long sleeve jacket • Arc-rated pants • Arc-rated flash hood with hard hat • Safety glasses • Hearing protection • Leather & voltage rated gloves (as needed) • Leather work shoes	HAZARD - Be aware of heat stress when wearing Cat 4 clothing • Arc-rated long sleeve jacket • Arc-rated pants • Arc-rated flash hood with hard hat • Safety glasses • Hearing protection • Leather & voltage rated gloves (as needed) • Leather work shoes

Figure 4 – Electrical arc flash hazard management guideline 2019 © Australian Energy Council. Used with permission.

10.5. Appendix D—Guide to the selection of PPE based on electrical risk

Table 11.2 — Guide to the selection of PPE based on electrical risk

Task	Single-phase installations	Three-phase installations (No intentional protective device delay)				
	≤ 230 Vac, ≤ 63 A	≤ 400 Vac, ≤ 63 A	≤ 400 Vac, > 63 A, ≤ 160 A	≤ 400 Vac, > 160 A, ≤ 250 A	≤ 400 Vac, > 250 A, ≤ 800 A	≤ 400 Vac, > 800 A, ≤ 2 000 A
Work (isolated and tested)	PPE based on electrical risk	PPE based on electrical risk	PPE based on electrical risk	PPE based on electrical risk	PPE based on electrical risk	PPE based on electrical risk
Switching, isolating, removing fuses or links (in normal operating condition ^a)	PPE based on electrical risk	PPE based on electrical risk	Minimum arc rated PPE 4 cal/cm ² Arc rated long sleeve shirt and pants (or overall) Arc rated face shield with chin return Arc rated, leather, or voltage rated rubber gloves with leather protective outer Safety glasses	Minimum arc rated PPE 4 cal/cm ² Arc rated long sleeve shirt and pants (or overall) Arc rated face shield with chin return Arc rated, leather, or voltage rated rubber gloves with leather protective outer Safety glasses	Minimum arc rated PPE 4 cal/cm ² Arc rated long sleeve shirt and pants (or overall) Arc rated face shield with chin return Arc rated, leather, or voltage rated rubber gloves with leather protective outer Safety glasses	Minimum arc rated PPE 4 cal/cm ² Arc rated long sleeve shirt and pants (or overall) Arc rated face shield with chin return Arc rated, leather, or voltage rated rubber gloves with leather protective outer Safety glasses
Authorized live work, proving isolation, energized testing or fault-finding Racking of withdrawable circuit breakers and MCC units Work on or near isolated electrical equipment where energized equipment is within the same open metal clad enclosure	PPE based on electrical risk	PPE based on electrical risk	Minimum arc rated PPE 4 cal/cm ² Arc rated long sleeve shirt and pants (or overall) Arc rated face shield with chin return Arc rated leather, or voltage rated rubber gloves with leather protective outer	Minimum arc rated PPE 8 cal/cm ² Arc rated long sleeve shirt and pants (or overall) Arc rated face shield with chin return Arc rated, leather, or voltage rated rubber gloves with leather protective outer	Minimum arc rated PPE 40 cal/cm ² Arc flash suit and hood Arc rated leather, or voltage rated rubber gloves with leather protective outer Hearing protection Safety glasses Leather boots	Minimum arc rated PPE 75 cal/cm ² Arc flash suit and hood Arc rated, leather, or voltage rated rubber gloves with leather protective outer Hearing protection Safety glasses Leather boots

^a Normal operating condition exists when it is satisfied that the equipment is properly installed and maintained, used in accordance with the manufacturer's instructions, doors and covers are closed, in place and secured, and there is no evidence (such as unusual smells, sounds or temperatures) of impending failure.

NOTE 1 This table takes account of a maximum supply fault level of 28 kA (approximately that of a 1 MVA transformer). For higher fault levels and supply scenarios exceeding 800 A, a risk assessment including an arc flash incident energy analysis should be performed.

NOTE 2 Where significant motor load is present on three-phase installations, PPE for the next horizontal level (i.e. one column to the right) should be used.

WARNING: BRACELETS, RINGS, NECK CHAINS, EXPOSED METAL ZIPS, WATCHES AND OTHER CONDUCTIVE ITEMS SHALL NOT BE WORN WHILE WORKING ON OR NEAR EXPOSED ENERGIZED CONDUCTORS OR LIVE CONDUCTIVE PARTS.

WARNING: PPE SHALL BE WORN WITH COLLAR UP, TOP BUTTONS DONE UP AND SLEEVES DOWN. SYNTHETIC UNDER GARMENTS WORN UNDERNEATH PPE MAY BE A FIRE RISK.

Source: AS/NZS 4836:2023 Table 11.2 © Standards Australia. Used with permission.

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Document approval process

Version	Action	Date of action	Approval date
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