

Guide for isolation and lockout procedures

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Source number PN13159

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1. Scope

This guideline applies when electrical industry workers are required to perform work on or near low voltage electrical equipment. The *Electrical Safety Regulation 2013* requires that electrical equipment is de-energised prior to carrying out electrical work and steps are taken to ensure the electrical equipment cannot be inadvertently re-energised whilst the work is being performed. The processes outlined in this guide are to assist employers and workers implement appropriate measures to ensure that correct isolation and lockout procedures are undertaken.

For guidance on safe systems of work refer to the guide: Safe working on or near energised electrical equipment.

Exception: This guide may not apply where it is necessary to perform the work energised and the work meets all the applicable requirements of the *Electrical Safety Regulation 2013* for performing electrical work on or near energised electrical equipment. Refer to the Guide for safe working on or near energised electrical equipment

This guide does not include isolation, lockout, or access to high voltage equipment.

Recommendations in this guideline relate to arc flash hazards and electrical hazards. 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

Electric shock and/or arc flash often result in serious injury or death. Consider the effect that burn treatment, loss of mobility or amputation of a limb would have on your life and your family. This guide provides practical guidance to assist you in completing your work safely and to ensure the safety of others that may be affected by the work.

Many preventable incidents have occurred when persons have been working on or near energised electrical equipment. In many of these incidents it was not necessary for the electrical equipment to be energised to undertake the work. This includes instances where the equipment was either intended to be de-energised or had been de-energised and was inadvertently re-energised during the work.

These incidents highlight the need to ensure safety tag and lockout procedures are implemented and followed as part of safe system of work during the repair, maintenance and installation of electrical equipment.

In recent years there has been a substantial increase in the number of electrical installations where alternate supplies such as photovoltaic (PV) inverter energy systems, Battery Energy Storage Systems (BESS), and generators are installed. All these systems influence the electrical installation and must be considered when performing work on the electrical installation.

This guide outlines legislated requirements and accepted industry practices for correct isolation and lock out requirements for work involving electrical equipment not exceeding 1000Va.c. or 1500Vd.c.

Included are the fundamental steps for placing safety tags and, lockout procedures where equipment:

- is in a dangerous condition
- is being worked on
- has not been completely installed
- is out of operation for repair or alteration.

The effectiveness of isolation procedures relies on:

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

Safe isolation procedures (including the use of locks and tags) should be developed in consultation with relevant workers.

3. Important risk control measures and warnings

Prior to commencing isolation and lockout, the applicable hazards at the specific site shall be identified and appropriate risk control measures implemented.

All persons who will perform work on or near the electrical equipment must be involved in the isolation process.

In most circumstances, the process of isolating electrical equipment will require work on or near energised electrical equipment. e.g. Testing with a voltmeter as part of the isolation process. The *Electrical Safety Regulation 2013* has specific requirements in relation to work on or near energised electrical equipment. Refer to the Guide for safe working on or near energised electrical equipment.

Where work on or near energised electrical work is performed, the work must be carried out in accordance with a safe work method statement and the risk assessment.

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.

Where several persons are to perform work on or near the isolated portion of the electrical installation, ensure that all persons are involved in the isolation, have control over the point of isolation and has verified the testing. All persons should additionally perform testing of the

equipment they are performing work on. This process should be documented or recorded by another appropriate means.

Circuit wiring of electrical equipment, or conductors may become energised due to the operation of automatic control devices, e.g. thermostats, switches, PLC's, and other interface devices.

Back-up supplies such as generators; battery energy storage systems (BESS) and uninterruptable power supply (UPS) systems rely on the MEN connection in the main switchboard. Removal of the MEN connection without all supplies fully isolated (active and neutral) may result in a potential between the installation neutral and earth conductors.

When interconnectors e.g. MC4 connectors in PV installations are used for isolation, the circuit must be proven to have zero current flowing prior to disconnecting the interconnector. Failure to do this will result in an arc being drawn out of the interconnector.

Current transformers (CT's) may produce a high voltage if disconnected from their low impedance circuit. Current transformers shall be shorted by CT shorting block, links or bridges installed at all times when the CT circuit is interrupted.

To prevent personal injury and/or damage to equipment, all test instruments shall be capable of withstanding the impulse voltages and fault current levels that may be experienced in the particular installation category 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 1000V would be suitable).

Proximity testers do not always provide a reliable indication and shall not be used as the primary instrument for testing de-energisation. Proximity testers do not detect d.c. voltage. The use of a proximity tester is recommended as a secondary test on conductive parts when performing work, prior to making contact.

4. Isolation

4.1. Consultation

Consult with the person in control or management of the place as applicable (e.g. in relation to the scope and timing of the work) and notify any other affected persons as appropriate.

4.2. Identification

The following must be positively identified prior to proceeding, so that risks can be effectively controlled, and a safe system of work implemented:

- The electrical equipment to be worked on.
- Any electrical equipment near the electrical equipment to be worked on, which may present a risk whilst performing work.
- All energy sources, both electrical and non-electrical. Some additional sources to consider are:
 - » Electrical energy may be stored in capacitors or batteries.
 - » Hydraulic or pneumatic energy may be stored on pressure reservoirs, water tanks or as mechanical energy supported by hydraulic rams.
 - » Mechanical energy may be stored in an object (e.g. the mass of an object, tension or compression of a spring).
 - » Energy in the form of heat could be stored in equipment which has been in operation or in direct sunlight.
- The points of isolation for the equipment to be worked on and any other equipment which may create a risk, whether electrical or not.
- Identify any part of the installation or electrical equipment which may require a backup supply of energy to safely function during the isolation period (e.g. a medical oxygen concentrator, emergency lighting in an occupied building).

Procedures shall be adopted to identify alternative energy sources connected to the electrical installation. Isolation procedures shall include steps to isolate all alternative supplies. Alternate supplies may include:

- photovoltaic (PV) systems
- battery energy storage systems (BESS)
- generators
- uninterruptible power supplies (UPS)
- energised neutral conductors as a result of incorrect circuit connections
- luminaires supplied from emergency sources
- wind generation systems.

4.3. Isolation of electrical equipment

The electrical equipment to be worked on shall be isolated from all sources of electrical supply either by opening switches, removing fuses or links, opening circuit breakers, or removing circuit connections.

Control circuits or electronic switching devices shall not be used as a method of isolation. Functional switches such as light switches are not rated for or safe to use as an isolation point, unless specifically rated as an 'isolation switch'. Refer to AS/NZS 3000 Clause 2.3.2.2 for further information on devices for isolation.

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 may include upstream isolation or shedding load prior to operation:

- Implement appropriate risk controls taking into account proximity to energised parts and available fault current at the equipment to be operated.
- Disconnect all active conductors (or all energised conductors for systems other than the MEN system). This may be achieved by opening switches, removing fuses or links, opening circuit breakers, or removing circuit connections.

Note: Active conductors should be disconnected first, followed by neutral conductors. Earth conductors (including PEN conductors) should be disconnected last.

Non-electrical energy sources may require the insertion of safety pins, locking of valves or the controlled release of energy in springs to isolate the risk.

4.4. Bonding conductors

Differences in potential may develop in local earths with respect to the general mass of earth due to the presence of earth fault currents.

For guidance on bonding conductors if electrical equipment is isolated at a remote location or there is a risk of induced voltage being present, see AS/NZS 4836 Safe working on or near low-voltage electrical installations and equipment, clause 3.1.6.

5. Testing

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

All electrical conductors, including earthing conductors, shall be treated as energised until proven deenergised.

Under section 15 of the *Electrical Safety Regulation 2013*, testing to ensure the equipment is de-energised is considered 'energised electrical work' and must be carried out in accordance with the requirements for such work. Refer to the *Electrical safety code of practice - Managing electrical risks in the workplace*, the *Guide for safe working on or near energised electrical equipment* and AS/NZS

3017 Electrical Installations-Verification by inspection and testing, section 4.3 for additional guidance.

Testing process

- Test the test instrument for correct operation, on a known voltage source to ensure the test instrument is working and the correct function is selected.
- Test between all supply conductors including any alternate supplies and a known earth. Confirm de-energised.

Note: the known earth should be verified by a voltage test or an earth continuity test.

- Test between all supply conductors. Confirm de-energised.
- Retest the test instrument on a known voltage source for correct operation, to ensure that the test instrument is still working correctly.

Note: After isolation has been completed, a voltage source may not be available. In this situation a voltage proving unit may be used to confirm the correct operation of the test instrument. In the case of d.c supply, an insulation test instrument could be used as a d.c. voltage source.

6. Securing the isolation

In all circumstances where the worker performing the work does not have the device used for isolation under their sole effective control at all times, the isolation device must be fitted with a warning sign and a device to prevent inadvertent operation (e.g. a danger tag and locking device).

6.1. Locking off

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

This may include switches with a built-in lock and lockouts for switches, circuit breakers, fuses and safety lockout jaws (sometimes called 'hasps').

All circuit breakers, switches and combined fuse switch units should be locked off to secure the isolation. Where it is not possible to lock off the device, alternative controls may include an additional component, for example a clip, screw, bolt or pin that can be inserted to prevent a switch from being operated.

Where a locking device is not available for the isolation device, alternate means such as removal of the load conductor from a fuse carrier or locking an enclosure door may be used as a method for securing the isolation. Where a fuse wedge is removed, measures must include ensuring that live parts are not left exposed in the fuse carrier. Measures may include removing the fuse element and refitting the wedge.

If more than one person is working on the same de-energised electrical installation, individuals should ensure their own personal lock is applied to the isolation point. This includes all persons affected by the isolation, including apprentices and/or persons who may be performing work on

the equipment whether it is electrical work or not (e.g. a person replacing belts on an evaporator fan).

If the fitment of multiple lockout devices to an isolation point has the potential to affect the isolation installed (e.g. due to the weight of the lockout devices) or multiple lockout devices cannot be installed due to the location of the isolation point, alternative methods such as the use of a lock box may be required.

No-one shall operate an isolator or knowingly use equipment where the isolator has a control mechanism attached (e.g. tag, lock).

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



Figure 1 – Examples of locking methods incorporating danger tags.

6.2. Danger tags

A danger tag must be attached to the isolation device whenever the worker performing the work does not have the device used for isolation, under their sole effective control at all times.

The personal danger tag is red and black on a white background and is used for tagging electrical and non-electrical equipment. It is attached to the means of isolation to prevent unauthorised or inadvertent operation of equipment being repaired or installed.

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

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

The danger tag should:

- be durable and securely fixed to the isolator
- clearly state the warning, including any warning about specific hazards relating to the isolation (for example, multiple points of supply)

- be dated and signed by the worker or workers involved in carrying out the work or, where appropriate, by the supervisor in charge of the workers
- be attached in a prominent position on each isolation point (i.e. the point or one of many points used to isolate electrical parts) or device
- only be removed by the signatories to the tag—if unavailable and unable to return, measures should be put in place to manage risks associated with removing the lock or tag (e.g. thorough investigation to ensure all workers and others at the workplace are safe).



Figure 2 – Danger tags.

6.3. Altering isolation for testing, fault finding and re-energising

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

Any testing or fault finding on energised parts must be carried out in accordance with requirements for working on or near energised electrical equipment.

All persons directly affected by the isolation must be informed prior to altering the isolation.

6.4. Restoring power

All reasonable steps should be taken to ensure that restoring electricity supply following isolation does not pose risks to health and safety at the place. For example, immediately prior to re-energisation:

- all relevant persons shall be notified that the electricity supply is about to be connected

- carry out a visual inspection to ensure that all tools, surplus material, and waste have been removed
- carry out an inspection to ensure all conductors have been appropriately terminated
- carry out appropriate testing on any new, altered or repaired electrical equipment, for example tests for insulation resistance, earth continuity, polarity, correct connection, and functional testing—refer to AS/NZS 3000 Electrical installations “Wiring rules”, section 8 for mandatory testing
- ensure all guards, covers, etc. are reinstated
- remove temporary bonds and short-circuiting devices and ensure all devices are accounted for
- take precautions as appropriate to ensure that other electrical equipment is not inadvertently energised
- follow procedures for removing any locks (or other control mechanisms), tags, notices, and safety signs ensure all guards, covers, etc. are reinstated—applicable personal tags and locks shall be removed by the person who fitted them.

When restoring electricity after electrical work has been performed, visual inspection and testing must be carried out to ensure that the electrical installation to the extent it is affected by the electrical work complies with the wiring rules.

6.5. Leaving unfinished work

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

- terminating any exposed conductors (ensure all conductors which can become energised if basic insulation fails are terminated and enclosed)
- physically securing any exposed conductors or surrounding metal work to ensure any exposed conductors or conductive parts are enclosed and any surrounding metalwork not separated by double insulation is earthed
- tagging, taping off the electrical equipment and the workplace area
- informing affected persons at the workplace the work is not complete and advising of potential hazards
- taking any necessary precautions to ensure that electrical equipment cannot become inadvertently re-energised
- ensuring that the status of switchboards and electrical equipment are clearly and correctly labelled
- handing over adequate information to workers taking up the unfinished work to allow them to continue the work safely.

6.6. Out of service tags

Out of service or caution tags are used to identify electrical equipment that is not safe to use or fit for purpose. The equipment should be isolated using a suitable isolation point and an out of service or caution tag should:

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



Figure 3 – Example of out of service tag



Figure 4 – Examples of locking methods incorporating out of service tags.

7. Simple example of isolation and lockout process

7.1. Task

Replacement of 15A socket outlet. Work to be performed by an apprentice supervised by a licensed electrical worker.

7.2. Step-by-step process

Step 1: Consulted with person in control and they are aware that the compressor supplied by the socket outlet will not be available for approximately 30 minutes.

Step 2: Identified the RCBO supplying the socket outlet and determined that it is a safe isolation point. This socket outlet is supplied from the non-essential busbar, it is the only equipment supplied by the circuit and no alternate supplies are relevant.

Step 3: Test the voltage indicator.

Tested active – earth.

Result 245.8Va.c.



Step 4: The RCBO for the circuit has been correctly identified and switched off.

A Locking device, hasp, lock and danger tag installed by electrical worker.

The apprentice has also installed his personal lock onto the hasp so as the circuit cannot be re-energised until both the licensed electrical worker and apprentice have removed their respective locks.



Step 5: Voltage tests are performed

Active – Neutral

Active – Earth

Neutral – Earth

All voltage measurements consistent with a small amount of induced voltage. (e.g. 0.4Va.c.)



Step 6: Voltage test performed on a known source to confirm test instrument still operational.

Active – Earth

Result 246.8Va.c.



Step 7: A proximity tester may be used as a secondary confirmation test only.

The proximity tester is tested prior to and after testing.



Step 8: The circuit is now confirmed as de-energised, isolated, and locked out. The electrical work may now proceed.

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Document approval process

Version	Action	Date of Action	Approval date
1.0	Created		

Review date

1 February 2027

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