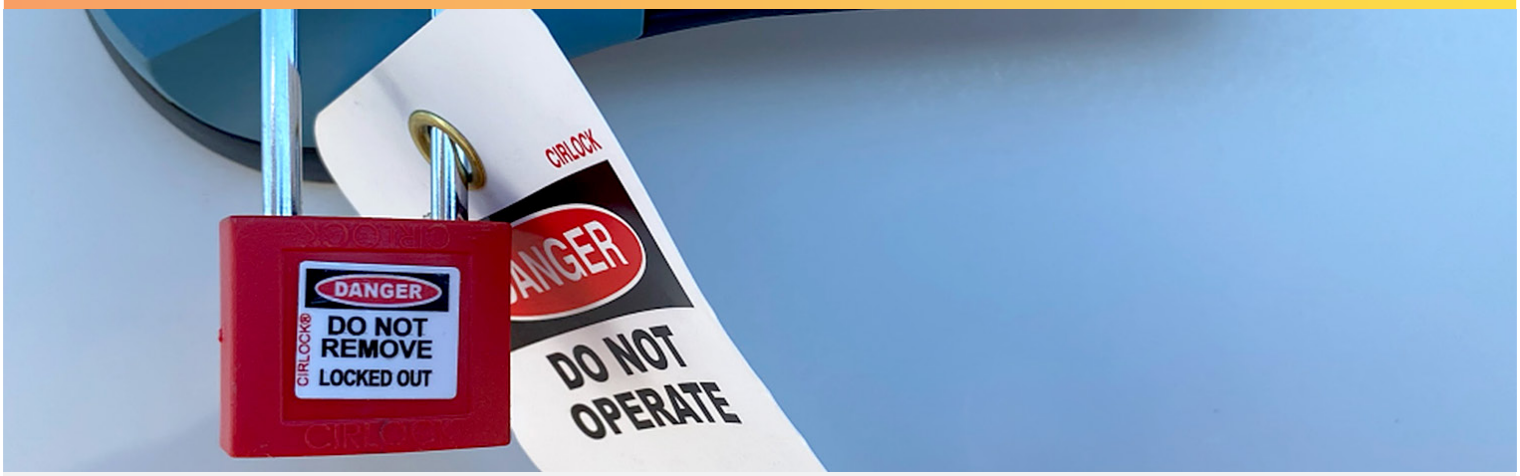
Solar Victoria

VICTORIA State Government

## Technical solution sheet 5.3

# Isolation of electrical equipment




### What is the legislation?

Electrical workers, including those working in the renewable energy sector, have responsibilities under the Victorian *Occupational Health and Safety Act 2004* and *Electricity Safety Act 1998* and associated regulations to ensure all electrical circuits or electrical equipment (including renewable energy systems handled in the course of that work) are:

- disconnected from the electricity supply, or
- adequate precautions taken to prevent electric shock or other injury while undertaking photovoltaic (PV) system installations, testing, commissioning, repairs or rectification work.

Guidance on the application of safe systems of work for PV systems and other electrical works are contained in the Australian and New Zealand Standard AS/NZS 4836 *Safe Working on or near low voltage and extra-low voltage electrical installations and equipment*.

The Standard provides a minimum set of guidelines, procedures, safety requirements and recommendations to safely manage the hazards associated with electricity, specifically arc blast, arc flash, electric shock and electrocution, which are all potential hazards when undertaking work on PV systems.

**This is part of a series developed with Energy Safe Victoria and TechSafe Australia to help Solar Homes Program installers work safely in the solar industry.**

Use this sheet and others in this series to plan and put in practice safe ways of working with electrical risks while installing solar systems.

**In series 5:**

| | |
|---|---|
| 5.1 | Working safely during solar installations – Electrical risk |
| 5.2 | Electric shock and electrocution |
| **5.3** | **Isolation of electrical equipment** ***(this sheet)*** |

See:
solar.vic.gov.au/safety-and-quality

# Hazards

## What are some of the hazards?

Electric shock or electrocution from energised electrical circuits or electrical equipment is a severe risk when working with renewable energy generation and storage systems. The possibility of electric shock, burns or electrocution are one of the most critical risks for electrical workers undertaking work on PV and Battery Energy Storage Systems (BESS).

Safe systems of work must be applied when undertaking installation, testing, commissioning, repairs or rectification work on PV and BESS.

Battery cells have the potential to deliver a severe electrical shock and or arc flash when interconnected as battery banks, reaching hazardous voltage levels.

Other parts and components of renewable energy systems, such as chargers and inverters, also have hazardous voltages which must also be considered prior to undertaking any work on these systems.

A risk management process is essential to identify any potential electrical or other hazards, in addition to considering and implementing appropriate risk controls when working with energised renewable energy systems or at heights.

Prior to commencing any work on a PV system, a competent person must determine it is safe to do so by applying a risk management process, where the work is planned and organised to eliminate or minimise the risk associated with the work.

If a risk assessment indicates that risks associated with the work to be undertaken on the PV system cannot be sufficiently controlled to enable the work to be performed safely, the work should not proceed.


*1. Testing the earth continuity back the main earth bar, while wearing PPE (testing).*

**Figure 1: The four-step risk management process.**


**The principles of risk management comprise:**

1. identifying the hazard
2. assessing and prioritising the risks
3. applying control measures to the identified risks
4. monitoring and review.

## Identifying hazards

The first step in the risk management process is to identify any potential electrical or other hazards associated with the PV system work that could cause harm.

There are many potential sources of electrical hazards including:

» Electric shock or electrocution caused by direct contact with energised electrical circuits or equipment.

» Electric shock caused by step and touch potential, induced voltages, incorrect connections, faulty electrical wiring and or equipment, disconnected conductors and static electricity.

» Electric shock caused by contact with extraneous conductive materials.

» Arc flash and burns from arcing faults, fire, explosion and incorrect or accidental circuit connections.

» Toxic fumes or gas from burning or arcing solar cells containing noxious chemicals.

Some typical hazards associated with undertaking work on PV systems include:

» Incorrect Panel-to-panel connections and disconnections.

» Faulty or damaged PV system wiring and components.

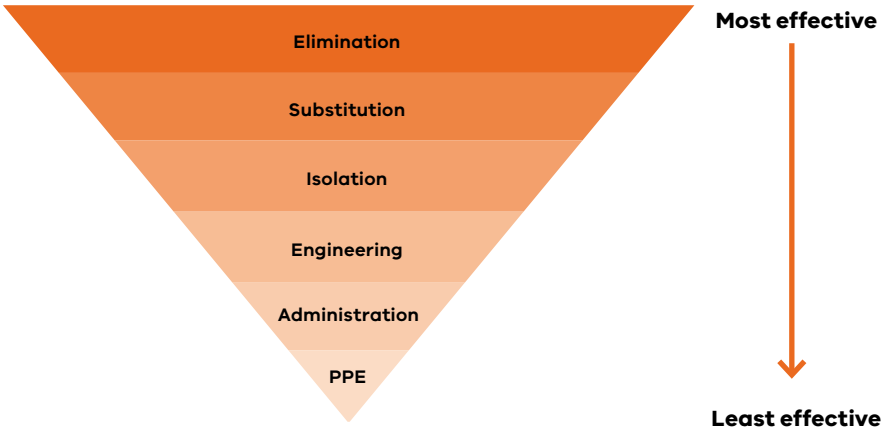
» Penetration of equipment and components by the ingress of water.

» Damaged solar PV array panels.

## Removing or treating hazards

Prior to any work commencing on a PV system, a risk assessment must be undertaken to assess the level of risk associated with the identified hazards.

Where hazards are identified, the risks must be prioritised and control measures implemented in accordance with the hierarchy of risk and hazard controls relevant to the PV system work to be undertaken.




## Eliminating or controlling hazards

PV system workers should always seek to eliminate any potential electrical hazards as the primary risk control method. This is effectively achieved in most cases by utilising a secure electrical isolation method of the energy source at its origin by a suitably qualified person.

To help keep PV system workers safe, it is essential to isolate, de-energise, lockout and tagout the relevant electrical components of a PV system before commencing any installation, repair or maintenance work, in addition to implementing a method to prevent the inadvertent energisation of isolated electrical circuits, equipment or components for work in progress on a PV system.

PV system workers must also ensure the correct personal protective equipment (PPE) is worn and that electrical equipment is safe to approach before undertaking any work.

Work on PV systems must always be planned where practical to maximise electrical safety outcomes relevant to the work to be undertaken, in addition to always maintaining safe systems of work.

Installation or maintenance of any electricity generation system (other than a battery energy system), which has a nominal operating voltage or open circuit voltage exceeding 50 volts d.c, and an individual or combined rated generation capacity equal to or greater than 240 watts, is electrical installation work and must only be carried out by licensed electrical workers.

Installation or maintenance of any battery or battery energy storage system, which has a nominal operating voltage exceeding 12 volts d.c, and an individual or combined rated storage capacity equal to or greater than 1kWh, is electrical installation work and must only be carried out by licensed electrical workers.

Electrical safety is inversely proportional to the level of risk and depends on:

a. appropriate job planning by a competent person;

b. correct isolation and testing procedures and techniques;

c. use of safety equipment and tools, test instruments and PPE that are fit for purpose;

d. work being carried out by appropriately licensed and competent persons;

e. display of warning notices to reduce the risk of personal injury or death; and

f. use of barriers to prevent inadvertent contact with energised parts.

# Isolating Electrical Equipment

## How to safely isolate electrical equipment

PV system workers must not undertake any work on or near de-energised exposed conductors or parts until a licensed electrical worker (LEW) who is competent in the task has:

a. positively identified the relevant PV system equipment and conductors, all energy sources and isolation points;
b. isolated all relevant PV electrical equipment and conductors from all energy sources;
c. secured the isolation points of all relevant PV electrical equipment and conductors;
d. discharged any stored energy of PV system equipment where necessary;
e. proven the de-energisation of all relevant PV electrical equipment and conductors by test;
f. identified the limits of the PV system safe area of work; and
g. displayed warning notices in the PV work area to reduce the risk of injury or death.

## Identify the correct circuit and equipment

The correct identification of relevant PV system electrical circuits, equipment and components is essential to ensure electrical equipment and circuits in the work area are de-energised, isolated and secured prior to commencing any work. PV system line diagrams, labelling and circuit ID numbering provide visual means to identify system components which must always be confirmed by test.

These PV system components must be positively identified to enable the correct isolation of electrical equipment and circuits prior to commencing any work:

a. PV electrical equipment and circuits comprising the work or required to maintain a safe system of work for the designated work area;
b. Points of isolation for relevant PV electrical equipment and circuits; and
c. All energy sources, including battery energy storage and standby generation systems.

## Identify the correct isolation device

Having identified the relevant PV electrical circuits and or equipment to be de-energised, an appropriate means of electrical isolation must be considered that provides a secure method of isolation preventing inadvertent energisation of the isolated electrical circuits or equipment prior to completion of the work. The relevant PV electrical equipment and circuits to be worked on must be isolated and secured from all sources of electrical supply either by opening switches, removing fuses or links, opening circuit breakers or removing circuit connections.

Alternative sources of supply such as UPS systems, standby generators, auxiliary power supplies, neutral back feed from intermixed circuits, battery energy storage systems and other extraneous sources of supply all pose a significant risk of electric shock or electrocution if not correctly identified, isolated and secured prior to commencing work on PV systems.

Isolation devices should be locked in the OFF position and Tagged OUT to eliminate the risk of inadvertent energisation of the isolated electrical circuits or equipment. Refer to *AS/NZS 4836* for detailed Lock OFF and Tag OUT (LOTO) electrical safety guidelines.

## Ensure the safety of others

PV system workers must also consider other workers and the general public when assessing the risk associated with a designated work area prior to commencing any work. Risk control measures may necessitate the installation of barriers, screens and signage to warn and protect other trades persons working on site. Risk control measures such as temporary barriers and warning signage to identify the immediate work area and exclusion zone are generally an effective means to control these risks.

Additional control measures such as a Safety Observer may also be required to control risks associated with high pedestrian or vehicular traffic or lifting operations at a work site.

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*2. The main switch or isolation devices must be locked out so that the installation cannot be re-energised while working.*

*3. Controlling the site to ensure the safety of others.*

## Isolate, test and confirm

Having positively identified all components of the electrical circuits and or equipment to be de-energised for work to be undertaken, isolation of the appropriate electrical circuits and or equipment to be de-energised can proceed.

LEWs must ensure correct and serviceable PPE is worn prior to undertaking the following test procedure to prove de-energisation of all relevant PV electrical circuits and or equipment:

1. Visually inspect and check test equipment for any signs of damage.
2. Check suitability of the test equipment for the voltage present;
3. Test the voltage tester on a known voltage source for correct operation;
4. Test between all conductors or electrical equipment terminals and a known earth;
5. Test between all conductors or electrical equipment terminals;
6. Retest the voltage tester on a known voltage source for correct operation.

Where a voltage tester is used to prove de-energisation, LEWs must always test the voltage tester immediately before and immediately after use to confirm correct operation of the tester.

## Fit LOTO devices

Following the correct circuit identification, de-energisation and isolation of the relevant PV electrical circuits and or equipment, a securing device such as a Personal Lock system and Danger Tag (LOTO) must be fitted to the isolation device/s to prevent inadvertent operation of the device. Securing devices should be selected that require a deliberate action to engage and disengage, such as a third-party Pad Lock system.

## Test again prior to working on the equipment

Once the planned work is ready to proceed and all isolation points have been secured and tagged, retest the relevant PV electrical circuits and or equipment using the correct PPE and test equipment to ensure all system components remain isolated prior to commencing any work.

Ensure all workers are advised of the isolation points and the extent of the work to be undertaken which should be referenced back to the Safe Work Method Statement (SWMS) for the work activity, in addition to recording the risks and control measures in the JSEA relevant to the site and work to be undertaken.

## Carry out required works

Following retesting to confirm de-energisation of the relevant PV electrical circuits and equipment and a visual inspection of the work area to ensure all isolation points are secured, Locked Out and Tagged Out (LOTO), work can proceed as planned.

Monitor progress of work and any changed working or site conditions to ensure the ongoing safety of the PV installation work or repairs.

## Test all installation work

Following completion of the PV system installation, LEWs must conduct a thorough visual inspection of the completed work to ensure all components of the electrical work have been completed as planned and in accordance with the statutory requirements.

LEWs must also ensure all relevant installation tests have been completed in accordance with AS/NZS 3000:2018 *The Wiring Rules section 8 Verification,* as well as any additional relevant Australian Standards specific to the work being carried out.

## Remove LOTO devices

On completion of satisfactory test results, advise all PV system workers and other relevant site persons that the PV system installation, maintenance or repairs are complete and is ready to commence commissioning.

Conduct a visual inspection to ensure the installation is complete and all wiring and equipment covers have been replaced. Upon receipt of authority to proceed from the site controller, commencement of the removal of LOTO isolation devices may be carried out.

## Commission electrical equipment

Following removal of LOTO devices at all isolation points, the LEW shall complete the commissioning checks and testing in accordance with the relevant Australian Standard. For example:

- PV Systems refer to AS/NZS 5033:2021 Section 6.3 Commissioning and AS/NZS 4777.1:2016 Section 7 System Documentation and Commissioning.
- BESS refer to AS/NZS 5139:2019 Section 6.4 System documentation, verification and commissioning.
- Ensure the PV system installation, maintenance or repairs complies with all statutory and manufacturers technical and performance requirements prior to completion and handover to the client.

*4. Testing the rail, earth continuity back to the main earth bar.*

*5. Ensure all SWMS are planned and prepared as per WorkSafe Victoria requirements.*

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## Important resources

See the Energy Safe Victoria website for legislation and regulations: esv.vic.gov.au/about-esv/energy_regulatory_framework/legislation-and-regulations including:

- *Electricity Safety Act 1998*
- Electricity Safety (General) Regulations 2019.
- Electricity Safety (Registration and Licencing) Regulations 2020.

See also:

- *Occupational Health and Safety Act 2004*: legislation.vic.gov.au/in-force/acts/occupational-health-and-safety-act-2004
- Occupational Health and Safety Regulations 2017 (OHS Regulations): legislation.vic.gov.au/in-force/statutory-rules/occupational-health-and-safety-regulations-2017

Standards:

- AS/NZS 3000:2018 *The Australian/New Zealand Wiring Rules*.
- AS/NZS 3760:2022 *In-service safety inspection and testing of electrical equipment and RCD's*.
- AS/NZS 3017:2022 *Electrical installations – Verification by inspection and testing*.
- AS 4509.1:2009 *Stand-alone power systems Safety and installation*.
- AS/NZS 5033:2021 *Installation and safety requirements for photovoltaic (PV) arrays*.
- AS/NZS 5139:2019 *Electrical installations – Safety of battery systems for use with power conversion equipment*.
- AS/NZS 4777.1:2016 *Grid connection of energy systems via inverters installation requirements*.
- AS/NZS 4836:2011 *Safe working on or near low-voltage electrical installations and equipment*.

## More information

Call Energy Safe Victoria on 03 9203 9700 (option 2) or 1800 800 158 or email info@energysafe.vic.gov.au

energysafe.vic.gov.au

Call WorkSafe on 1800 136 089 or email info@worksafe.vic.gov.au

worksafe.vic.gov.au

Call TechSafe Australia on 03 8558 0100 or email techsafe@techsafe.com.au

techsafe.com.au

For more information about Solar Victoria's commitment to safety and quality, including training and workforce development, see: solar.vic.gov.au/industry

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Developed with Energy Safe Victoria and TechSafe Australia

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SOL239 Version 1.1. Published July 2024