Solar Victoria

VICTORIA State Government

Technical solution sheet 5.2

Electric shock and electrocution

The principal electrical risk associated with the installation of photovoltaic (PV) systems is electric shock and electrocution. This can occur when a person makes contact with live electricity, causing a dangerous electrical current to pass through their body.

Solar panels exposed to solar radiation produce voltage at their output terminals – a person working near solar panels during daylight hours or under strong sources of artificial light is always engaging with live electrical equipment.

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

Use this sheet and others in this series to plan 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** ***(this sheet)***
5.3	Isolation of electrical equipment

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

What is electric shock and electrocution?

Electric shock occurs when a person becomes part of an electrical circuit, causing current to flow through their body.

Electrocution specifically refers to a fatal electric shock caused by severe damage to internal organs or fibrillation of the heart muscle. A current of 30mA can cause fibrillation of the heart muscle and result in death.

The effects of electric shock can range from minor to severe, depending on the intensity and path of the current passing through the human body. At Low Voltage (LV), an electric shock may cause entry and exit burns, muscle contraction and other serious issues such as cardiac arrest resulting in death.

Note: At High Voltage (HV), electric shock can cause severe life threatening internal and external burns.

A person displaying any of the following symptoms may be the victim of electric shock:

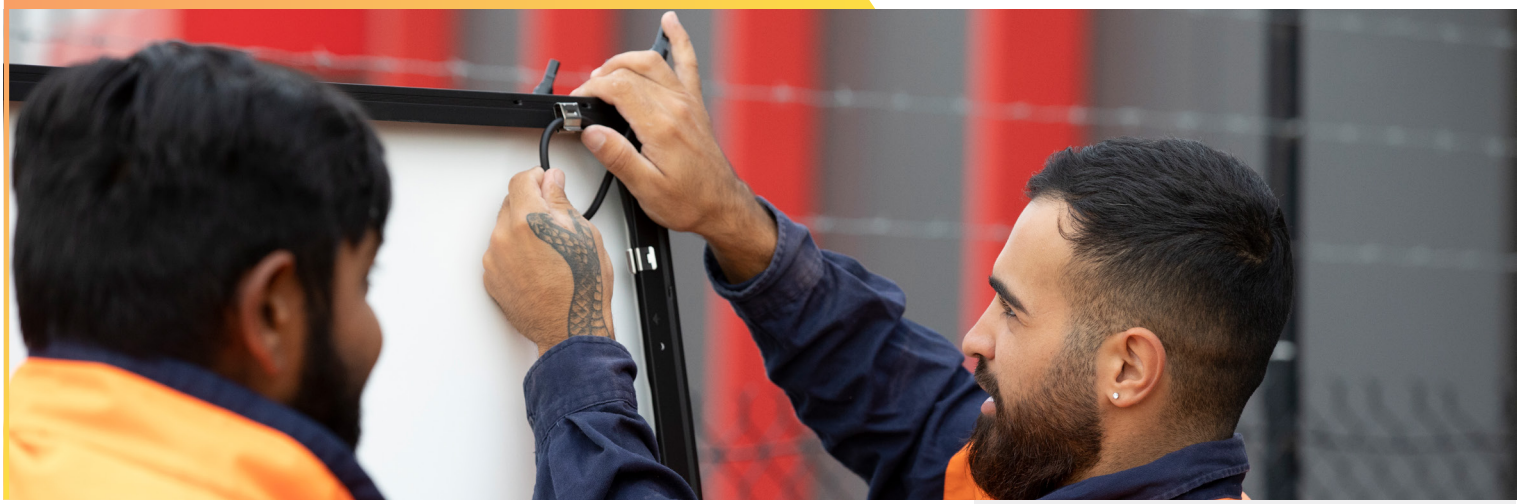
- Weak or erratic pulse.
- Difficulty breathing or breathing stopped.
- Unconsciousness.
- Cardiac arrest.
- Involuntary muscle reaction.
- Entry and exit burns.
- Bone fractures caused by muscle spasm.

Planning a safe approach to working with electrical risk

Follow this four-step risk management process to ensure hazards are identified, risks are assessed and controlled, and that employers fulfil their duty to monitor, review and revise controls when required.

Figure 1: The four-step risk management process.

Note: Electrical installation work must only be carried out by a Licensed Electrical Worker (LEW) and all electrical apprentices must be provided with effective supervision. See the Energy Safe Victoria website for guidance: Requirements for the effective supervision of apprentice electricians.



Step 1: Identify hazards

The first step in the electrical risk management process is to identify electrical hazards. Many electrical hazards arise due to:

- Design, installation, construction, maintenance and testing of electrical equipment.
- Lack of training and supervision.
- Design changes or modification of equipment.
- Operating environment and conditions.
- Inadequate work practices.
- Complacency due to repetition of work.
- Lack of concentration due to distraction or other factors.

Electrical hazards may be identified in a number of ways, including:

- Consulting with workers.
- Inspection and testing of equipment.
- Consulting instruction manuals.
- Consulting manufacturers and suppliers.
- Reviewing incident reports.

Note: An **arc flash** is a serious electrical hazard that has the potential to cause death or serious injury. An arc flash could be considered as an unexpected and violent, electrical short circuit in the air that produces an arc and associated explosions of gases and molten metal.

Arc flash incidents occur when low impedance paths are inadvertently made across phases, phase to neutral or from phase to earth. These connections can occur at any time:

- by accidental contact across terminals from tools or equipment
- due to a breakdown in insulation
- from a build-up of contaminants such as carbon or dust.

It is commonly assumed that substantial arc flash incidents only occur in HV situations, however, it is important to understand that these incidents can and do occur in LV installations due to the potential for high fault currents. ESV have also investigated incidents of arc flash involving PV arrays of solar installations.

See the ESV website for Arc flash hazard management (guideline and self-audit tool).

Step 2: Assess risks

The *Occupational Health and Safety Act 2004* requires employers to, so far as is reasonably practicable, provide and maintain a working environment for their employees that is safe and without risks to health.

As a solar worker, you will need to prepare a safe work method statement (SWMS) when undertaking high-risk construction work (HRCW). A SWMS is a safety planning tool that identifies the hazards and risks and documents the control measures necessary to manage those risks.

The SWMS should describe to workers in clear terms how risks from the work will be effectively controlled to enable the work to be completed safely.

Once the hazards have been identified, assess the risks they pose and determine the appropriate control measures to suit each task.

The risk of electrocution while undertaking PV system installations can be assessed by determining the:

- likelihood of an electrical incident happening
- severity of harm that a person could receive in the event of an electrical incident.

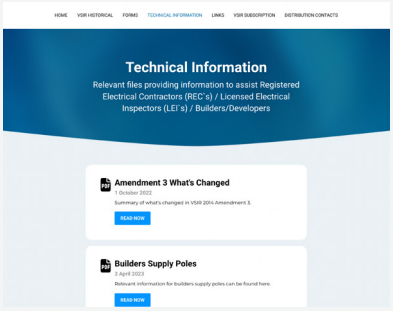
See the WorkSafe website for more information on when and how to complete a SWMS for construction activities: worksafe.vic.gov.au/resources/safe-work-method-statements-swms

Step 3: Control risks

After assessing the risks, and prior to commencing the installation, control measures need to be implemented to eliminate, substitute, or minimise the risks associated with any tasks where electricity may be an issue.

Note: Installation and maintenance of PV systems is 'electrical installation work' and must be carried out by licensed electrical workers. The licensing requirements to conduct work on solar and battery systems are detailed in the Electricity Safety (Registration and Licensing) Regulations 2020.

Electricians can control the risk of electrocution during solar installations by:

Control	Description	
Removing the service fuse	Removal and replacement of the service fuse should be done in accordance with ESV guidelines. It is important to take steps to prevent the electricity from being turned back on while work is in progress, known as lock-out/tag-out (LOTO). Electricians should refer to the Victorian Electricity Supply Industry Code of Practice for low voltage service fuse removal and reinsertion by Licensed Electricians and L and G Class inspectors available at victoriansir.com.au/technical-information.	
Using appropriate signage	Once the service fuse is removed and the main switches or isolation devices are locked off, a sign should be placed at the main switchboard or device location warning against turning the power on. To be an effective control, the main switch or isolation devices must also be locked out so that the installation cannot be re-energised while working.	 
Verifying the installation is de-energised	Once isolated, determine that the electrical equipment is de-energised, also known as 'testing for dead.' The electrical installation should be treated as energised until testing confirms that de-energisation has been achieved. Note: By switching off the power at the property's main switch, supply from the distribution network to the switchboard will remain live, including the service conductor and the consumer's mains into the main switchboard.	
Using safe systems of work	Safe systems of work should be developed, documented, and followed.	

To reduce the risk of electric shock and electrocution, solar workers must:

- Never work live.
- Identify and confirm all sources of electricity to the property. There may be more than one power source, such as solar, batteries, wind or back-up generator, or there may be multiple properties powered from the same meter box.
- Identify hazards that may be introduced as a result of isolating the power to the affected property.
- Switch OFF all power at the switchboard and place a lock on the MAIN SWITCH or on the meter box to prevent inadvertent re-energisation. If it is not reasonably practicable to use a lock, use a Lock Out Tag Out (LOTO) kit.
- Even with electricity disconnected, avoid contact with electrical cables and equipment.
- Be aware of hazards that may be present in the ceiling space, such as split metal conduits, cloth covered cabling, deteriorated rubber sheath cabling, or even unterminated electrical wiring systems. It is recommended to turn off the power to the property before entering the ceiling space.

Above: Employers must provide workers with appropriate personal protective equipment (PPE) e.g. insulated gloves, eye protection, safety footwear, suitable clothing, hard hats.

Note: Any damaged electrical cables or equipment identified will need to be notified to the property owner and repaired by a licensed electrical installation worker.

Step 4: Review and revise controls

Controls to eliminate or reduce electrical risk must be constantly monitored and reviewed so that they remain fit for purpose, suitable for the nature and duration of work, and are used correctly by employees.

Common review methods include workplace inspection, employee consultation, equipment testing, and analysing historical records and data. If control measures are found to be inadequate, review the available information and make the necessary changes to the guidance.

To assist in the review process, employers should keep effective records of scheduled electrical safety maintenance activities, including any equipment test and tag programs.

Review should always take place:

- before any alteration to plant or system of work that is likely to result in an electrical hazard
- after any notifiable incident
- if a new hazard is identified or consultation necessitates a review
- if the control measures are deemed to be inadequate for their intended purpose
- at the request of a health and safety representative (HSR).

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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