Guide to managing the risks of rooftop solar installation work

Guidance material

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1. Introduction

Rooftop solar installation work has serious work health and safety (WHS) risks including working at height, falling objects, heat stress and working with electricity. This guide provides practical work health and safety information for duty holders, primarily for 'persons conducting a business or undertaking' (PCBUs), on:

- the duties and obligations under the model WHS laws
- identifying and assessing risks associated with installing solar panels on rooftops
- control measures to manage the risks, and
- how to plan and safely undertake rooftop solar installation work.

You are a PCBU if you:

- engage workers, or cause workers to be engaged, to undertake rooftop solar installation work
- influence or direct workers to undertake rooftop solar installation work
- have management or control of a workplace, or the fixtures, fittings or plant at a workplace, where rooftop solar installation work is undertaken.

1.1 What is rooftop solar installation work?

Rooftop solar installation work includes retailing, surveying, designing, installing, testing, commissioning, retrofitting, repairing, maintaining, decommissioning or removing rooftop solar systems on residential or commercial structures.

Rooftop solar systems include new or retrofitted solar panels, inverters, batteries (battery energy storage systems) and related equipment.

This guide only covers WHS requirements and is primarily focused on residential systems connected to the grid. There are a number of incentives, rebates and regulatory regimes associated with solar installation. For information on other regulatory regimes that may apply to solar installation, you will need to contact the relevant regulator.

1.2 Who should use this guide?

This guide assists duty holders, primarily PCBUs, to manage the risks to health and safety associated with rooftop solar installation work. All PCBUs have duties under work health and safety laws, regardless of the size of the business.

Duty holders include solar system retailers, surveyors, designers, manufacturers, importers and suppliers, electricians, installation contractors, installers, repairers, removers, commercial building owners and others involved in rooftop solar work.

Workers, elected health and safety representatives, homeowners, tenants and others, who may be impacted by rooftop solar installation work will find this guide useful.

More specific information on managing the risks from falls, machinery and other hazards associated with rooftop solar installation work is available on the Safe Work Australia website.

1.3 How to use this guide

This guide describes what a PCBU and workers must and should do for safe rooftop solar installation work.

In this guide, the word '**must'** indicates a legal requirement that must be complied with.

The word '**should'** indicates a recommended course of action.

Examples provided in this guide include the kinds of hazards, risks and control measures to assist duty holders to identify, assess and manage the specific risks of rooftop solar installation work in a range of situations.

To manage the risks, duty holders should also seek the advice of a competent person—for example, an accredited and experienced solar panel installer who is also a qualified electrician, to perform and supervise the planned rooftop solar installation work—and refer to relevant industry guidance material and standards. This will ensure you have the most comprehensive information about hazards and risks and the most effective control measures available for the particular workplace.

Conforming with this guide, and applying industry guidance, certification and standards assists duty holders to comply with the duties under the model WHS laws. The guide should be read in conjunction with the following:

- Model Code of Practice: How to manage work health and safety risks
- Model Code of Practice: Managing the work environment and facilities
- Model Code of Practice: Managing risks of plant in the workplace
- Model Code of Practice: Managing the risk of falls at workplaces
- Model Code of Practice: Managing the risk of falls in housing construction
- Model Code of Practice: Managing electrical risks in the workplace
- Model Code of Practice: Managing risks of hazardous chemicals in the workplace
- Model Code of Practice: Hazardous manual tasks
- Model Code of Practice: Managing psychosocial hazards at work
- Model Code of Practice: Confined spaces
- Model Code of Practice: How to manage and control asbestos in the workplace
- Model Code of Practice: Managing noise and preventing hearing loss at work
- Guide for managing the risks of working in heat

This guide references legal requirements under the WHS Act and WHS Regulations. These should not be relied on in place of the full text of the WHS Act and WHS Regulations in your jurisdiction. The guide covers many of the risks commonly encountered in rooftop solar installation work, but may not be exhaustive.

A range of other industry standards, legislative requirements and guidelines that may apply to the solar industry can be found in the 'Further resources' section at the end of the guide.

2. Who has health and safety duties?

Everyone connected with the work has work health and safety duties.

PCBUs have a primary duty to ensure the health and safety of workers while they are at work in the business or undertaking, and others who may be affected by the work, such as visitors.

A person can also have specific duties if they are:

- surveyors, designers, manufacturers, importers, suppliers, and installers of plant and structures – this includes solar retailers, installers and contractors
- persons with management or control of the workplace – this includes solar installers and contractors
- officers such as company directors, and
- workers – this includes electricians, trades apprentices, trades assistants and labourers.

2.1 The Primary Duty

PCBUs must ensure, so far as is reasonably practicable, that they:

- provide and maintain a safe work environment
- provide and maintain safe plant and structures
- provide and maintain safe systems of work
- ensure plant, structures, and substances are safely used, handled and stored
- provide accessible and adequate facilities (for example access to washrooms, lockers, and dining areas)
- provide sufficient instruction, training, information, and supervision
- monitor workers health and conditions at the workplace, and
- maintain any accommodation to ensure the health and safety of workers.

2.2 Main duty holders

As a duty holder, you must comply with your WHS duties, even if others have the same duty. If you do not take the required action yourself, you must ensure another duty holder is doing so. This requires duty holders to communicate with each other to identify hazards and risks, talk about health and safety concerns, and work together to minimise the risks.

Table 1 Duty holders in relation to rooftop solar installation work

Who	Duties
A person conducting a business or undertaking (PCBU)	Must ensure, so far as is reasonably practicable, the health and safety of workers, including workers the PCBU engages to carry out work, workers the PCBU directs or influences in carrying out work. Must ensure that the health and safety of other people is not put at risk from work carried out by the business or undertaking. The PCBU with management or control of fixtures, fittings or plant at a workplace must ensure, so far as is reasonably practicable, that the fixtures, fittings and plant are without risks to the health and safety of any person. The PCBU with management or control of a workplace must ensure, so far as is reasonably practicable, the workplace, the means of entering and exiting the workplace and anything arising from the workplace are without risks to health and safety. These duties require the PCBU to manage health and safety risks by eliminating them and if elimination is not reasonably practicable, by minimising those risks so far as is reasonably practicable. Rooftop solar installation work is considered construction work as it involves work carried out in connection with the construction, alteration, conversion, fitting-out, commissioning, renovation, repair, maintenance, refurbishment, demolition, decommissioning or dismantling of a structure (regulation 289). In the model WHS Regulations, PCBUs may have a range of other duties in relation to rooftop solar installations, including: • managing the risk of falls (regulations 78-80) • managing the risks of plant (regulation 203) • ensuring plant is maintained, inspected and tested (regulation 213) • ensuring the electrical installation is de-energised when rooftop solar installation requires entry into a roof space (regulation 155) • managing the risks of musculoskeletal disorders relating to hazardous manual tasks (regulation 60) • ensuring suitable and adequate information, training, and instruction are provided to workers (regulation 39) • maintaining a secure workplace from unauthorised access (regulation 298), and • ensuring there is a safe work method statement for high risk construction work (regulation 299).

Designers, manufacturers, importers and suppliers or installers of plant, substances or structures	Must ensure, so far as is reasonably practicable, the plant, substance or structure they design, manufacture, import, supply or install is without risks to health and safety. These duties may include carrying out analysis, testing or an examination, and providing specific information about the plant, substance or structure. Relevant information should be passed on from the designer through to the manufacturer and supplier to the end user.
Retailers of rooftop solar installations	Must ensure, so far as reasonably practicable, the plant, substance or structure they retail is without risks to health and safety. If the retailer is involved in planning the work or otherwise making decisions about how the work is carried out, they will have duties that are similar to other PCBUs (see above).
Officers	Must exercise due diligence to ensure the business or undertaking complies with the WHS Act and Regulations. This includes taking reasonable steps to ensure the business or undertaking has and uses appropriate resources and processes to eliminate or minimise risks to health and safety.
Workers and others, including third parties such as owners, tenants or visitors	Must take reasonable care for their own health and safety, comply with reasonable instructions, and not adversely affect the health and safety of other people. Workers must comply with any reasonable instructions, policies and procedures given by the PCBU, so far as is reasonably practicable.

Principles for WHS duties

There are four key principles that apply to all WHS duties in the model WHS Act which are outlined below.

A person can have more than one duty

A person can have more than one duty at the same time. For example, a person can be both a worker and an officer or a worker and a PCBU (if working as an individual contractor).

More than one person can have the same duty at the same time

Multiple duty holders who have the same duty must each meet their duty to the standard required. For example, a solar retailer, installer and contractor can have the same duty to ensure, as far as reasonably practicable, the work is without risks to health and safety.

Where more than one person has a duty in relation to the same matter, they each must discharge the duty to the extent to which they have influence or control over the matter. They must also consult coordinate and cooperate activities with each other.

WHS duties are not transferable

A duty holder cannot transfer their duties to another person. Any contractual term that seeks to transfer or reduce the duty holder's responsibility will be invalid.

Duty holders with duties in relation to the same matter can enter into reasonable arrangements or agreements with each other to make sure everyone's duties are met, while at the same time avoiding unnecessary duplication of effort.

Management of risks

A duty holder must manage risks to health and safety by eliminating risks, so far as is reasonably practicable. If it is not reasonably practicable to eliminate the risks, the duty holder must minimise the risks, so far as is reasonably practicable.

2.3 WHS laws in your state or territory

WHS laws differ in each jurisdiction. The Commonwealth and state and territory WHS regulators are responsible for enforcing WHS laws in their jurisdiction, investigating incidents and taking enforcement action.

If you need help understanding the WHS requirements in your jurisdiction, please contact your local WHS regulator.

2.4 Consultation

PCBUs must consult, so far as is reasonably practicable, with workers and their health and safety representatives to decide how to manage the risks of rooftop solar installation work. By drawing on the experience, knowledge and ideas of your workers you are more likely to identify hazards and choose effective control measures.

If there is more than one business or undertaking involved or if the workplace is managed or controlled by another PCBU, you must consult them to find out who is doing what and work together.

Duty holders must communicate clearly and regularly so that all hazards and risks are identified, continually assessed and controlled.

Further guidance on consultation can be found in the model Code of Practice: *Work health and safety consultation, cooperation and coordination*.

3. The risk management process

PCBUs must manage the health and safety risks associated with rooftop solar installation work.

Risk management requires you to think about what could go wrong at your workplace and what the consequences could be. Then you must do everything that is reasonably practicable to eliminate or minimise those risks. This process will be implemented in different ways depending on the size and nature of your business or undertaking.

Further information on the risk management process is in the model Code of Practice: *How to manage work health and safety risks*.

Risk management involves four steps. Following this step-by-step process can help you decide what is reasonably practicable, in particular situations so that you can meet your WHS duties.

- **Identify hazards**—find out what could cause harm.
- **Assess risks**—understand the nature of the harm that could be caused by the hazard, how serious the harm could be and the likelihood of it happening.

- **Control risks**—implement the most effective control measure that is reasonably practicable in the circumstances and ensure it remains effective over time.
- **Review hazards and control measures** to ensure they are working as planned.

To determine what control measures are reasonably practicable, you should consider the availability and suitability for each control measure. Costs may also be relevant, but you must only consider this after you have assessed the extent of the risk and the available ways to eliminate or minimise the risk.

Managing the risks of rooftop solar installation work requires a high level of competency. You should seek the advice of a competent person, for example, an accredited and experienced solar panel installer. Rooftop solar installation work also involves prescribed electrical work, which must be undertaken by an appropriately licensed electrical worker. The licensed electrical worker should be trained, accredited and experienced in the design and installation of solar photovoltaic (PV) and/or batteries. Refer to relevant industry guidance to ensure you have the most comprehensive information about hazards and risks and use the most effective control measures available for your workplace.

3.1 Identify the hazards

Identifying hazards associated with rooftop solar and battery installations involves finding what could potentially cause harm to people.

The following can help identify potential hazards:

- Observe the workplace to identify how work will be carried out. Consider the physical work environment – especially the condition of the roof; equipment; materials and substances used; work tasks and how they are performed; and work design and management.
- Ask workers and health and safety representatives whether they have identified any problems or potential problems. You are required to consult with workers and health and safety representatives when identifying hazards and assessing risks.
- Assess the workplace environment, including the requirement for work in a roof space, how to access and exit the roof as well as sunlight, wind, weather, and ground conditions.
- Consider the need for edge protection with mesh barriers and/or exclusion zones based on the potential for objects to fall from the roof like tools, debris, and equipment.
- Consider other work activities at the workplace, including those above, below, within or near the work area.
- Consider the work areas not located on the roof where inverters and batteries will be installed, including cabling, as there are specific installation requirements.
- Consider overhead utility infrastructure present at or near the site, such as powerlines or communications cabling.
- Consider the arc flash energy potential and determine suitable work practices and personal protective equipment (PPE), where the battery installation is a battery system installation or is battery equipment without suitable isolation of the internal energy source.

- Consider the location of natural gas and/or liquid petroleum gas (LPG) and storage of other flammable liquids when identifying locations for inverters and batteries.
- Discuss the risks in carrying out rooftop solar installation work with the operators of machinery in use at the site.
- Securely transport and store solar panels, inverters and batteries and inspect that they are not damaged before they are installed. Assess the condition of any installed battery before commencing work.
- Refer to relevant industry guidance (see further resources in chapter 9.2), or other documentation that could assist in identifying hazards, such as the manufacturer's specifications for the solar panels, inverters and batteries being installed.
- Inspect plant and equipment, such as electric tools, ladders or elevating work platforms (EWPs), before and after use to ensure they are maintained in good working order, not damaged or excessively worn.
- Talk to manufacturers, industry associations, suppliers, health and safety specialists or any other competent person about the risks associated with the work.
- Review your incident and injury records including near misses.

3.2 Assess the risks

In many cases the risks and related control measures will be well known. In other cases, you may need to carry out a risk assessment to identify the likelihood of somebody being harmed by the hazard and how serious the harm could be.

A risk assessment can help you determine what action you should take to control the risk and how urgently the action needs to be taken.

For example, common risks associated with installing solar panels, inverters and batteries include:

- falls from height
- being struck by moving or falling objects
- being at risk of electrocution or electric shock by overhead electric lines
- being at risk of electrocution if work is required inside a roof space
- being at risk of electrocution or electric shock when connecting solar panels, inverters and batteries
- sustaining arc flash injuries
- exposure to asbestos and/or silica dust when drilling or cutting concrete, bricks, cladding or sheeting
- exposure to toxic fumes from any damaged batteries under fault conditions
- musculoskeletal disorders from manual tasks, such as moving and positioning solar panels, and lifting and carrying batteries and inverters, and
- heat-related illness such as heat stress while working on a hot roof, dehydration, fatigue

Examples of risk factors to consider may include:

- site conditions, for example, access to the rooftop, prevailing or unexpected winds and their strength and direction; vehicle traffic - or pedestrians that could interfere with the work
- environmental conditions, for example, storm activity or extreme heat
- the type of plant and machinery required for example, its dimensions, operating characteristics, ease of manoeuvrability
- the type of work activities required and the frequency of the work tasks
- the qualifications, licences, competency, skill and experience of the people supervising or doing the work
- lack of supervision
- condition of solar panels, inverters or batteries, including following transportation and storage, as well as after commissioning and during maintenance, replacement or removal
- location of existing utility services such as natural gas reticulation and stationary LPG bottles which may pose a fire and/or explosion risk
- setting up and packing up procedures, and
- work practices and procedures.

You should seek the most comprehensive information about risks from a competent person and refer to relevant industry guidance. To manage the risks, duty holders should engage a competent person, to perform and supervise the planned rooftop solar installation work and apply relevant industry guidance and standards. For further information, please refer to AS/NZS 5139:2019 *Electrical installations – Safety of battery systems for use with power conversion equipment*. For battery equipment, please refer to TS 5398 *Electrical Energy Storage Equipment – Safety Requirements*.

3.3 What is reasonably practicable?

Deciding what is ‘reasonably practicable’ to protect people from harm requires considering and weighing up all relevant matters, including:

- the likelihood of the hazard or risk occurring
- the degree of harm that might result from the hazard or risk
- knowledge about the hazard or risk, and ways of eliminating or minimising the risk
- the availability and suitability of ways to eliminate or minimise the risk, and
- after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated and whether this is grossly disproportionate to the risk.

The process for managing risks will help you decide what is reasonably practicable, including when using the hierarchy of controls, so that you can meet your duty of care under the WHS laws.

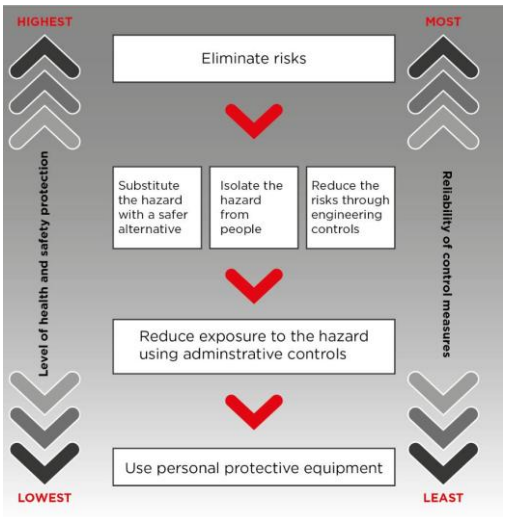
Further information on determining what is reasonably practicable is in the Interpretive guideline.

3.4 Control the risks

You must eliminate risks to health and safety so far as is reasonably practicable. If it is not reasonably practicable to eliminate the risks, you must minimise the risks so far as is reasonably practicable. You will most likely need to use a combination of control measures to protect your workers from the risks associated with rooftop solar installation work.

Controlling risks will be different at every workplace. You should consider the specific requirements of each workplace when managing risks (for example, the type of roof may impact on the risk of falls and the type of fall protections that can be used). The ways of controlling risks are ranked from the highest level of protection and reliability to the lowest. This ranking is known as the hierarchy of control measures.

Figure 1 The hierarchy of controls



You must work through this hierarchy and implement control measures which are reasonably practicable to manage health and safety risks associated with rooftop solar installation work.

You should seek advice from a competent person and refer to relevant industry guidance to ensure you use the most effective control measures available for your workplace.

Elimination controls

You must consider whether a risk can be completely removed from the workplace. For example, conducting work on the ground would eliminate the risk of a fall from height for that element of the work.

If it is not reasonably practicable to completely eliminate the risk, then risks must be minimised, so far as is reasonably practicable, by implementing one or more of the following controls:

- substituting the hazard for something safer
- isolating the hazard, and

- using engineering controls.

More than one control can be used for each risk. You must minimise the risks as much as is reasonably practicable.

Substitution controls

Substituting the hazard for something safer can be an effective control measure. For example, to reduce the risk of hazardous manual handling issues when moving the solar panels to the roof, use a panel lifting device, instead of relying on workers to carry them.

Isolation controls

Isolation involves physically separating the source of harm from people by distance or barriers. For example, use edge protection to prevent falling from roof edges and falls through fragile roof surfaces such as skylights.

Engineering controls

An engineering control is a control measure that is physical in nature, such as using a mechanical device or process. For example, use a panel lifter, or, if using a ladder, provide clamps that secure the ladder at the top and bottom to prevent the ladder from slipping.

Administrative controls

After you have applied all reasonably practicable substitution, isolation and engineering controls, consider if risks remain. If so, implement administrative control measures, so far as is reasonably practicable, for example:

- warning signs
- work methods or procedures
- supervising work to ensure safe work procedures are followed
- rotating jobs and varying tasks to minimise repetitive manual handling risks, and
- providing information, training and instruction needed to ensure workers can work safely.

Administrative controls do not control the hazard at the source and instead, rely on human behaviour and supervision. Administrative controls used *in addition to* substitution, isolation and engineering controls can be effective and may be applied as a short-term measure where no other practical control measures are available, for example using signs or no-go areas or lock-out tags on equipment.

Personal protective equipment

Personal protective equipment (PPE), in isolation, is the least effective method for controlling risks because PPE does not eliminate hazards. PPE used in conjunction with higher level controls may minimise residual risk by reducing the likelihood or severity of injuries.

If workers are required to use PPE at the workplace, you must provide it unless it has been provided by another PCBU. You must ensure it is selected to minimise risk to health and safety. This includes ensuring the PPE is:

- suitable for the nature of the work and any hazard associated with the work
- of suitable size and fit, and

- reasonably comfortable for the worker to use or wear.

PPE that may be appropriate for solar installation work includes:

- suitable gloves, for example, insulated gloves for electrical work
- slip-resistant footwear
- eye protection especially where drilling, cutting or percussion operations are being undertaken
- hearing protection where noise levels might risk of hearing damage
- safety helmet
- reflective high visibility clothing and arc flash rated clothing and other required PPE
- respiratory protective equipment where there is a risk of inhalation of harmful chemicals or dust, and
- sun protection.

A PCBU must ensure PPE is maintained, stored, repaired and replaced so it continues to minimise risk to the worker who uses it. The equipment must be clean and hygienic, and in good working order.

If you direct the workers, you must train them to properly use, wear, store, and maintain the PPE. A worker must, so far as they are reasonably able, use or wear the PPE as instructed. They must not intentionally misuse or damage the equipment and must inform the PCBU when the PPE needs repairing or replacing.

Combine control measures

If a single control measure is not sufficient to minimise the risk so far as is reasonably practicable, a combination of control measures should be used. In most cases, a combination of control measures will provide the best solution to minimise the risk to the reasonably practicable level.

Ensure control measures do not create new risks

You should consider the control measures you select to make sure new risks are not introduced. For example, using an EWP to access a roof may create the risk of rollover if the EWP is deployed on uneven ground. If any new hazards are created from implementing a control measure, you must review and as necessary revise the control measure, consult with workers and their health and safety representatives, and ensure the risks are effectively controlled.

3.5 Review hazards and control measures

Review your control measures regularly to review their effectiveness and take into consideration any changes that may have affected the work activities, like the nature and duration of the work and whether the system is working as planned.

If a safe work method statement (SWMS) has been prepared due to high risk construction work being done, the SWMS must also be reviewed and revised where necessary, especially after changes in conditions at the workplace.

3.6 High risk construction work and SWMS

Rooftop solar installation work, including the installation of inverters and batteries, is high risk construction work requiring a SWMS as it involves electrical risks and the risk of falls from heights over 2 metres.

A SWMS is a document that sets out in a readily accessible way, the high risk construction work activities to be carried out at a workplace, the hazards arising from these activities and the measures to control risks.

PCBUs must ensure high risk construction work is not carried out unless a SWMS is prepared for the work first; the SWMS is understood by those who will use it; the SWMS is regularly reviewed and as necessary revised; and principal contractors (if any) are given a copy of the SWMS.

Further guidance on SWMS is in the model Code of Practice: *Construction work*, SWMS information sheet and the Interactive SWMS tool.

4. Training and supervision

PCBUs must ensure workers are trained to perform the work safely. This includes providing information, training, instruction, and supervision to protect all persons from WHS risks. The information, training and instruction must cover the nature of the work, the associated risks, the control measures to be implemented and provided in a way that is readily understandable by the worker. Workers and supervisors must be trained in emergency procedures, including emergency procedures applicable to electrical risks and working at height.

4.1 Competent person

PCBUs must ensure that certain activities are undertaken by a competent person.

A competent person is a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task. Some work activities also require additional specific qualifications including for:

- confined spaces
- electrical work
- asbestos, and
- high risk work.

A licensed or registered electrician or a licensed electrical inspector is a competent person who can perform electrical inspections and testing for rooftop solar installations. Accreditation organisations, such as Solar Accreditation Australia (SAA), may accredit and maintain lists of installers and designers deemed competent under government incentive schemes.

Risks and hazards differ across workplaces, therefore WHS laws may not specify the training or qualifications a competent person needs. The PCBU has responsibility for determining and confirming the competent person's training, experience and qualifications.

For example, rooftop solar installation work involves a serious risk of falls and should only be carried out by people trained to work at heights. However, the type of working at heights

training provided may differ depending on the type of work being performed. It should include fall arrest and restraint technique training if this equipment is being used.

The WHS or electrical regulator in your state or territory should be contacted for information about the applicable electrical licensing or registration laws, or specific competency requirements related to electrical work.

PCBUs must ensure installers and workers obtain a General Construction Induction Card ('White Card') and should have had working at heights training, before they access a roof.

Depending on specific risks and hazards, other training for rooftop solar installation which may be required includes:

- emergency procedure training
- first aid training, and
- electrical rescue and resuscitation training.

4.2 Supervision requirements

A PCBU must provide suitable and adequate supervision to protect all persons from health and safety risks arising from work.

Lack of adequate supervision is a known risk that frequently contributes to WHS incidents during rooftop solar installation work.

High levels of supervision are necessary where workers are carrying out new procedures or difficult and critical tasks.

Supervisors of rooftop solar installation work, most notably qualified electricians, must have the necessary knowledge, skills, qualifications and experience to competently supervise the work of electrical apprentices and other workers. (The ratio of supervisors to apprentices vary by jurisdiction. It is important to be aware of these ratios and to and comply with them.) This includes competency in preparing work plans, inspecting and maintaining equipment, identifying risks to health and safety, and monitoring and reviewing the effectiveness of control measures. Government incentive schemes may require installers to be accredited by specific organisations (e.g. SAA) alongside having an appropriate electrical work licence.

Regardless of the experience of a senior electrical apprentice, a qualified electrician must be on site wherever electrical work is being carried out. Some WHS regulators provide specific guidance on the suitability of tasks for electrical apprentices at each stage of their apprenticeship. For information and advice, contact your local WHS regulator.

5. Before work starts

Eliminating hazards and controlling risks at the design or planning stage is often easier and more cost-effective than implementing risk controls during a work task.

Well-designed work can prevent work-related deaths, injuries and illnesses. Wherever reasonably practicable, hazards should be eliminated through safe work design. If eliminating hazards is not reasonably practicable, then tasks should be designed to minimise hazards and risks.

Example of safe work design – using temporary edge protection
Protecting from the risk of a fall is an important part of designing work tasks that occur on a roof. Some PCBUs direct workers to wear a harness and use restraint technique or a fall arrest system.
These can be effective in preventing falls, but can introduce other risks, such as tripping over ropes while carrying equipment. For this reason, temporary edge protection is the recommended control for preventing fall risks in solar installation work.
Many PCBUs find temporary edge protection increases the efficiency of solar installations overall, as it allows workers to move more freely on the roof.

For further information see:

- Handbook – Principles of good work design
- Model Code of Practice: *Safe design of structures*

5.1 Role of solar retailers

Solar retailers commonly make early decisions that directly impact the safety of solar installation work. A common commercial arrangement in the solar industry involves retailers being the customer contact and responsible for contracting out installation services. Under this arrangement, the retailer may be responsible for:

- providing solar panels, inverters, batteries and related equipment that meet Australian Standards and are appropriate for the solar system being installed
- conducting a preliminary assessment of the customer's roof, primarily to determine the number of panels to be installed
- conducting a preliminary assessment of where inverters, batteries and their cabling will be installed at the work site
- ensuring secure transportation and storage of solar panels, inverters and batteries
- receiving quotes from installers to install the solar panels, inverters and batteries, and
- offering the customer a quote for the 'whole package' of a solar system and installation.

As they have influence over how the work ultimately occurs, a retailer must eliminate or minimise risks to WHS so far as is reasonably practicable. They must not leave WHS solely to the installer.

For example, if a retailer selects the installer with the cheapest quote without consideration of WHS, the retailer would not be fulfilling their WHS duties. Quotes for installation work should reflect the outcomes of the roof and work site inspections and the use of controls to eliminate or minimise WHS risks so far as is reasonably practicable.

Solar retailers should consider:

- designing arrays which avoid, or limit the need for workers to work near roof edges or other fall hazards
- placing inverters, batteries and related equipment at ground level or wall mounting where practical, to avoid the need to access rooftops for maintenance

- placing inverters, batteries and related equipment a safe distance away from existing utility services such as flammable liquids storage, LPG bottles and/or natural gas supply piping and regulators, and
- installing or not impeding the operation of existing roof access or rooftop safety system equipment like permanent ladders, walkways, handrails and anchor points that will enable safe future access for maintenance.

5.2 Designing and importing solar equipment

Rooftop solar designers, manufacturers, importers and suppliers must ensure, so far as is reasonably practicable, that the systems they design, manufacture, import, supply or install are without risks to health and safety.

Designers, manufacturers, importers and suppliers have WHS duties to provide information about the solar panels, inverters and batteries they provide. This information should enable other duty holders (for example, installers) to manage risks. Information must be passed on from the designer through to the manufacturer and supplier to the end user. This information includes:

- the purpose for which plant was designed or manufactured
- compliance with relevant Australian Standards and electrical safety legislative requirements
- the results of calculations, analysis, testing or examination
- conditions necessary for the safe use of the plant, and
- manufacturer instructions and maintenance requirements.

Please note there may also need to be approval or listing by an agency contracted by governments (e.g. Clean Energy Council) providing rebates for solar or battery installation.

Case study
Naoko is a solar retailer arranging a customer's solar panel installation. She approaches two local installers – Safest Solar and Dodgy Solar to quote for the job. Naoko selects Dodgy Solar's quote, because it is cheaper than Safest Solar, and she includes it in the customer's price.
Unfortunately, Dodgy Solar's price was lower because they failed to allow for any fall protection equipment in the price. Safest Solar's quote had included the use of temporary edge protection, which involves around 30 minutes work to set up and around 30 minutes to pack down at the end of the day.
Naoko, incorrectly thinking that fall protection was 'the installer's problem', did not factor in the risk of a fall. Dodgy Solar's quote involved illegal work practices that put workers' lives at risk. Unfortunately, a worker was injured in a fall on the job and both Naoko's company and Dodgy Solar were prosecuted for breaches of WHS legislation.

5.4 Roof inspections

The integrity of a roof is critical to the safety of those working on, under and around it.

Before beginning work on a roof, the roof should be inspected by a competent person to identify all risks associated with accessing and working on the roof.

To determine if a roof is safe to access and to develop control measures for the identified risks, the roof inspection should consider:

- the structural integrity of the roof, for example can the structure withstand the weight of the installation
- the material, height, and pitch of the roof
- the roof's general condition, for example, moss or other vegetation
- the presence of materials that may require additional safety measures, such as asbestos or respiratory crystalline silica
- whether the roof has unprotected edges, skylights or voids
- the access for workers, their equipment and the materials to be installed
- public access, or adjacent areas requiring exclusion zones, such as public footpaths, and
- emergency access or evacuation procedures, and
- weather conditions which may make working on a roof unsafe at a particular time.

Assessing the roof should be done at the site. Geospatial mapping software, such as Google Earth, are not capable of adequately assessing WHS risks.

Before commencing rooftop installation work, it is important to consider that the location of solar panels and any other system component will not obstruct the operation of any existing rooftop safety system (e.g. anchor points, static lines, guardrails, etc).

5.5 Steep roofs

Steep roofs increase risks of worker slips or falls. Where a roof is very steep, that is greater than 26 degrees, or 10 degrees where surface moisture, oil or other conditions make the roof slippery, additional controls measures are required to work safely.

The combination of control measures will depend on the specific circumstances and two or more of the following control measures are recommended:

- a work positioning system
- a scaffold platform, located at the roof edge, and
- a roof ladder.

5.6 Fragile roofs

Falling through fragile roofs, fragile roof sections or through fragile sheeted roofing cause work-related fatalities in Australia. Roofs cannot be relied on to bear the weight of a person and the equipment without thorough inspection. The inspection should include the fragility of the roof ridge, purlins, battens and rafters. The inspection should also include the availability

of suitable anchor points and the roof's ability to withstand loads applied by restraint systems if these systems are to be used. A competent person should carry out the inspection.

Where an otherwise stable roof has sections of fragile material, fall prevention must be used to prevent a worker from falling through the fragile section. The fall prevention is required to be to the same standard that is used to protect against falls at roof edges and voids. Please refer to section 6.1 for more information.

Roofs are likely to be fragile if they are constructed of the following materials:

- asbestos roofing sheets
- polycarbonate or plastic commonly used in skylights
- roof lights, particularly those in the roof plane that can be difficult to see in certain light conditions or when hidden by paint
- fibre cement sheets
- liner panels on built-up sheeted roofs
- metal sheets and fasteners where corroded
- glass, including wired glass
- chipboard or similar material where rotted
- wood slabs, slates and tiles.

5.7 Work site inspections

Before commencing installation or maintenance work at locations other than a rooftop, a work site inspection should be conducted by a competent person to identify all associated risks.

The work site inspection should consider risks associated with:

- the access for workers, their equipment and the materials to be installed
- places for secure storage and inspection of solar panels, inverters and batteries before installation, including decommissioning, repair and removal
- the installation site for inverters and batteries and evaluate the need for physical barriers and weather protection. Consider environmental factors, particularly the effects of extreme heatwaves, on system performance, hazardous chemicals and safety
- the cabling route and the presence of harmful substances and materials, like asbestos and crystalline silica.
- inverter and battery proximity to mains power or other energised equipment, including how these can be de-energised
- how the inverter and battery will be commissioned (or decommissioned)
- proximity of batteries, inverters and associated equipment to any hazardous zones such as gas cylinders, natural gas, LPG installations, any flammable liquid storage areas, pressure regulators and vents
- specific control measures relating to fire and explosion risks such as, elimination ignition sources, fire detection and monitoring, fire alerting, fire suppression – temporary mitigations prior to final site configuration

- traffic management and impact to public safety including exclusion zones, safety nets and barricading requirements
- emergency response planning such as access, signage and labelling or evacuation procedures.

6. Rooftop solar installation work risks

The following section sets out some of the most common risks in the industry and provides examples of how these can be managed.

Every workplace is different, with hazards and risks varying from workplace to workplace. It is important that a PCBU completes an individual risk assessment and updates the risk controls for every rooftop solar installation site.

6.1 Falls from height

PCBUs must carry out work on the ground or on a solid construction to eliminate the risk of a fall from height. If it is not reasonably practicable to do this, PCBUs must provide and maintain a safe system of work to minimise the risk of falls from height.

A safe system of work involves using the following process to determine the type of fall protection to use.

- Provide a fall prevention device, such as scaffolding, an elevated work platform (EWP), temporary edge protection, and skylight or void covers, if reasonably practicable.
- If a fall prevention device is not reasonably practicable, provide a work positioning system, such as a system using restraint technique, or
- if neither of these are reasonably practicable, provide a fall arrest system such as a backup line, safety net or catch platform, so far as is reasonably practicable.

Temporary edge protection should be used to protect against the risk of falling from a roof. It provides better protection than the use of a restraint, which can introduce trip hazards.

A restraint system should only be used in rare situations where it is not reasonably practicable to use temporary edge protection such as when a worker steps outside of the area protected by the temporary edge protection. If used, it must be installed and operated correctly by a competent person and in accordance with manufacturer's instructions.

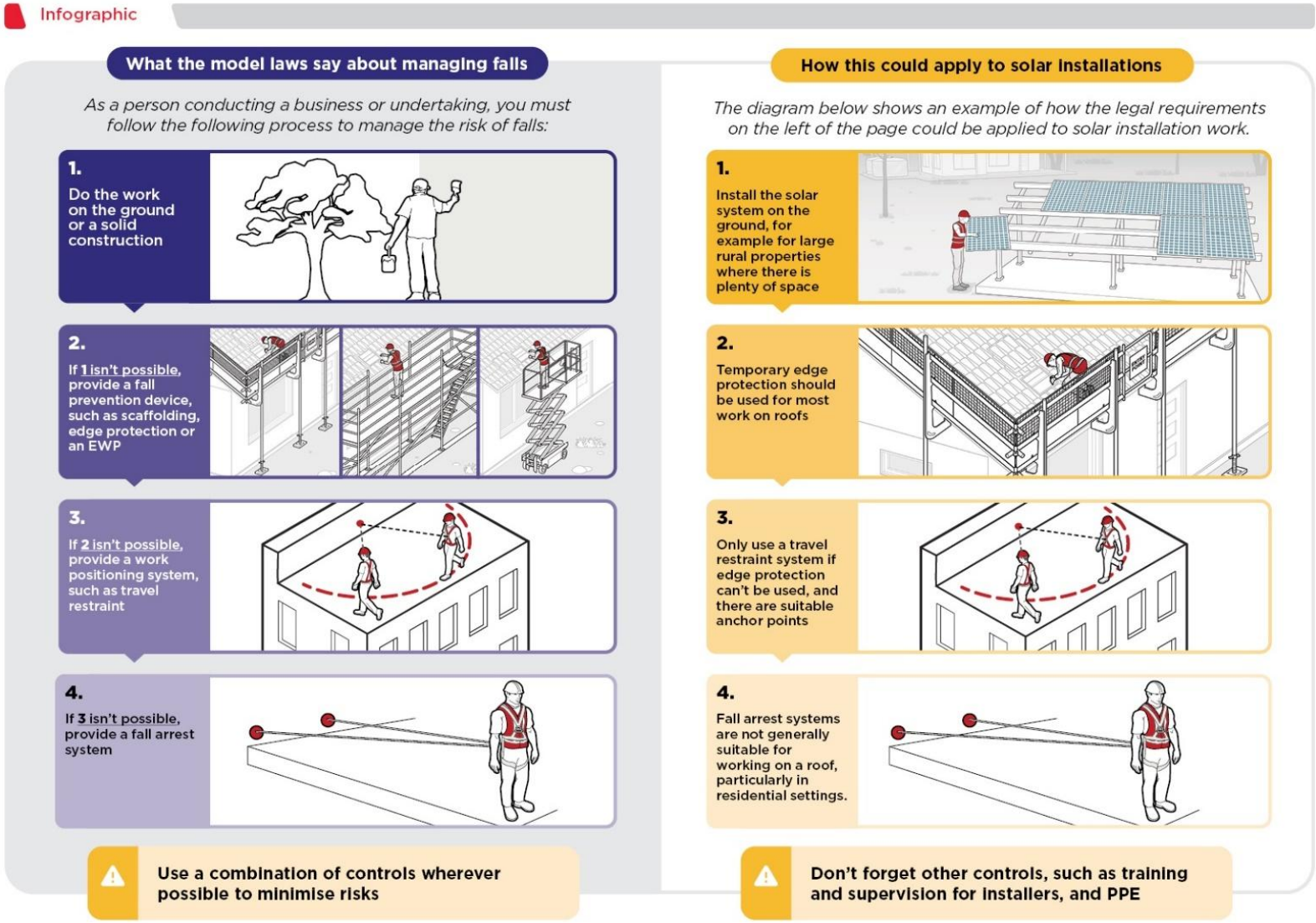
Fall arrest systems should never be used for single storey residential solar installations as they will not 'brake' before the operator hits the ground. They may be suitable for taller buildings where edge protection or restraint are unable to be used. If used there is also a potential hazard of the fall arrest failing if it makes contact with the roof edge.

If you are working above 2 metres, a PCBU must provide one of the controls described above – no one should ever work on a roof without fall protection in place.

For more detailed information on managing the risk of a fall, please refer to the:

- Model Code of Practice: *Managing the risk of falls at workplaces*
- Model Code of Practice: *Managing the risk of falls in housing construction*, and
- Guide to managing risks of industrial rope access systems.

Figure 2 What the model WHS laws say about managing falls and how this could apply to solar installations



Fall prevention devices

A ‘fall prevention device’ includes a secure fence, edge protection, working platforms such as scaffolds or EWPs, or covers used to prevent a worker from falling. Fall prevention devices must only be used if it is not reasonably practicable to prevent falls by carrying out work on the ground or on a solid construction.

Scaffolds

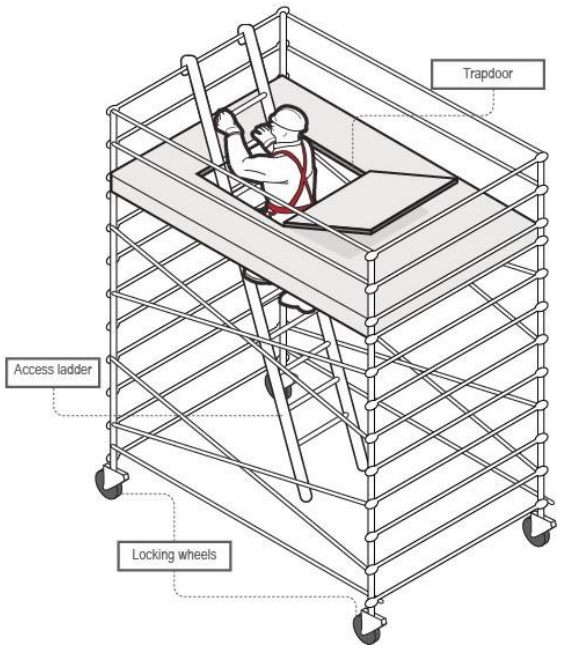
Scaffolds provide a platform for working at height and accessing a roof. A wide variety of scaffold systems are available. Specific requirements apply to some types of scaffolds under the model WHS Regulations. For more information on requirements related to scaffolding, please refer to the General guide for scaffolds and scaffolding work.

Scaffolds may be a suitable method of roof access and fall prevention for commercial solar installations, or larger residential projects. They are generally not used on smaller residential solar installations.

A person with management or control of a scaffold must not allow the use of a scaffold unless a competent person who holds the appropriate scaffolding high risk work license, who has inspected the scaffold, provides written confirmation that the scaffold has been completed.

Where mobile scaffolds are used, workers should be trained in their use. Trestle scaffolds are generally unsuitable for working at heights of 2 metres or above. If they are used at heights greater than 2 metres, guard-railing and toe-boards should be used to prevent people and material from falling off the open side or end of the work platform.

Figure 3 Mobile scaffold with access ladder and trapdoor



EWPs

EWPs are powered mobile plant designed to lift or lower people and equipment by a telescopic, hinged or articulated device, or any combination of these, from a base support.

EWPs can move over a supporting surface without the need for fixed runways. Types of EWPs commonly used to access roofs for work include:

- trailer mounted EWPs (see Figure 4)
- self-propelled EWPs with telescoping boom, including knuckle boom (see Figure 5)
- vehicle mounted EWPs (see Figure 6), and
- scissor lifts (see Figure 7).

EWPs can be used for a range of tasks related to solar installation work, such as loading and unloading solar panels, tools and other equipment.

When using an EWP for solar installation work, PCBUs should consider:

- Ground conditions: Is the EWP stable with adequate control, stabilisers or dunnage to maintain stability in operation? Is the ground level, uneven, sloping, firm or loose and could this lead to the EWP overturning? Are there underground services present, like water, gas, telephone, or electricity that may restrict access or set up locations?
- Overhead hazards: Are there obstacles, such as parts of a building or trees above the EWP that could strike a worker when the EWP is being used? Are overhead electrical or other utility lines present?
- Suitability: Can the EWP safely reach the height necessary to access the roof? Does the worker need to lean outside the structure of the EWP? Can solar panels and other equipment be loaded and unloaded from the EWP easily and safely?
- Fall protection: workers on the platform should wear a harness that is attached to the EWP's designated anchor point.
- Emergency exit: If workers access a roof using an EWP, is it available to quickly move them off the roof if there is an emergency?

Figure 4 Trailer mounted EWP

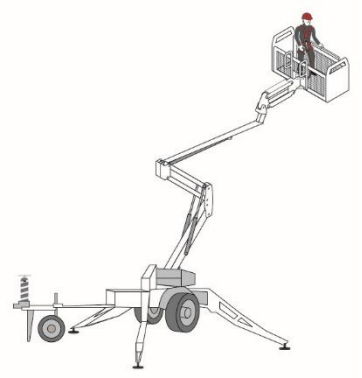


Figure 5 Self propelled EWP

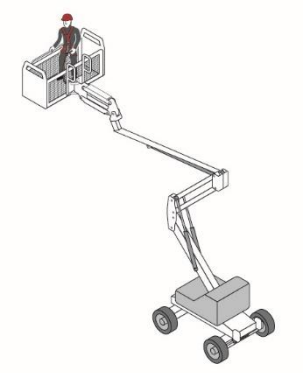
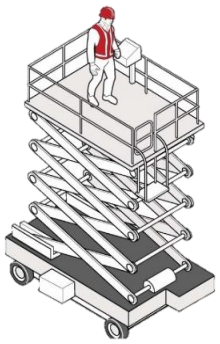


Figure 6 Vehicle mounted EWP

Figure 7 Scissor lift EWP



EWPs should only be considered for rooftop access if permanent fixtures are not available, and if the following conditions can be met:

- Ground conditions: Is the EWP stable with adequate control, stabilisers or dunnage to maintain stability in operation? Is the ground level, uneven, sloping, firm or loose and could this lead to the EWP overturning? Are there underground services present, like water, gas, telephone, electricity that may restrict access or locations to set up temporary platforms?
- Exclusion zone: Can access to the EWP be barricaded and secured at ground level? Can access to the EWP landing be barricaded when the platform is lowered?
- Positioning: Can the EWP be positioned safely against the roof, for example, flush against the roof landing? Can the platform be extended onto the roof? Is the platform fitted with a gate and can a worker gain safe access onto the roof without the platform moving away?
- Fall protection: Can edge protection be installed at the landing point to eliminate risk of fall? Can a safe ‘step-down’ be constructed onto the roof where there is a parapet wall at the roof edge?

More detailed information about using an EWP, including selecting the right EWP, registration, training, licencing and pre-use safety checks can be found in the *Guide to managing the risks of elevating work platforms*.

Temporary edge protection

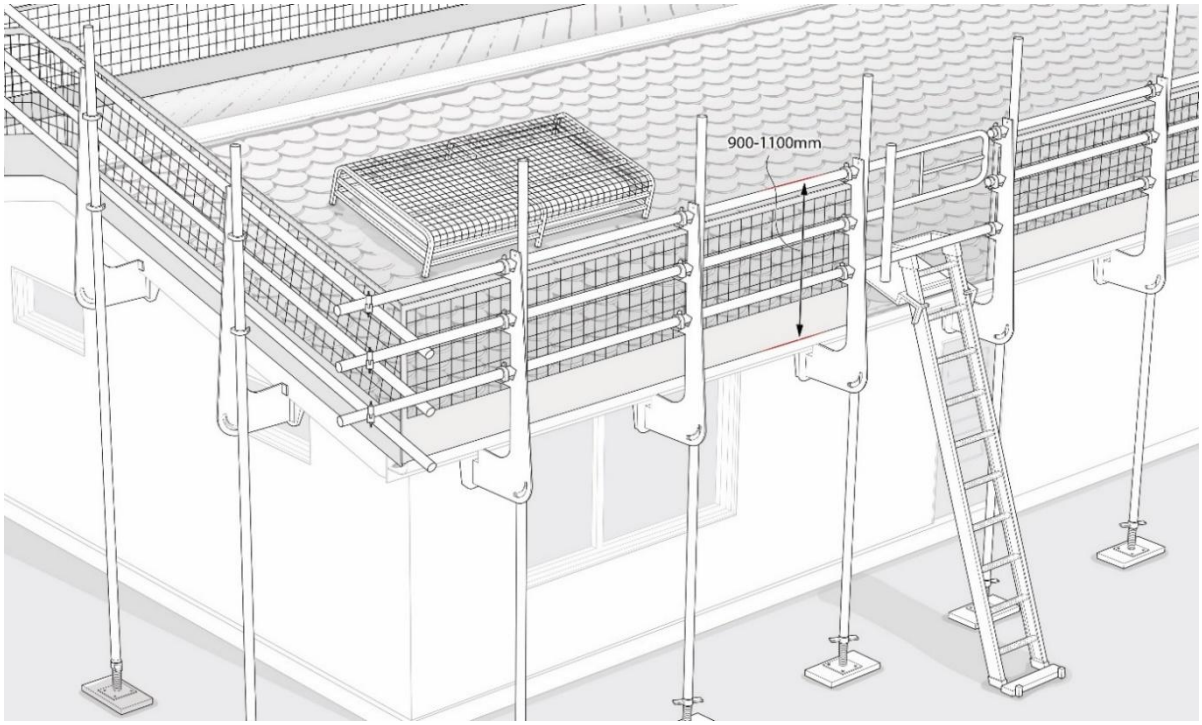
Temporary edge protection, perimeter guardrails and skylight or void covers should be used to provide effective protection from the risk of falling at:

- edges of roofs
- perimeters of buildings or other structures
- perimeters of skylights or other fragile roof materials, and
- openings in floor or roof structures.

Temporary edge protection, skylight or void covers and exclusion zones are recommended as minimum fall controls and can be cost effective, easy to install (even from the ground) and allow the work to be done without the constraints of harnesses.

Guardrails should incorporate a top rail 900 mm to 1100 mm above the working surface, a mid-rail and a toe-board or bottom rail to prevent workers or other objects sliding off the roof. The guardrail system, method of attachment and the supporting structure should be capable of withstanding any loads that will be applied.

Figure 8 Temporary edge protection



Exclusion zones on large roofs

Based on the risk assessment, edge protection should only be omitted on roofs below a 7 degree pitch where a 3 metre exclusion zone can be maintained. The exclusion zone should be a minimum of 3 metres from the roof edge or void (or 2 metres for a flat roof) and be delineated with a barricade. Safe access should be provided to the exclusion zone, for example elevated work platform, mobile scaffold or delineated walkway with secure ladder.

Work positioning systems

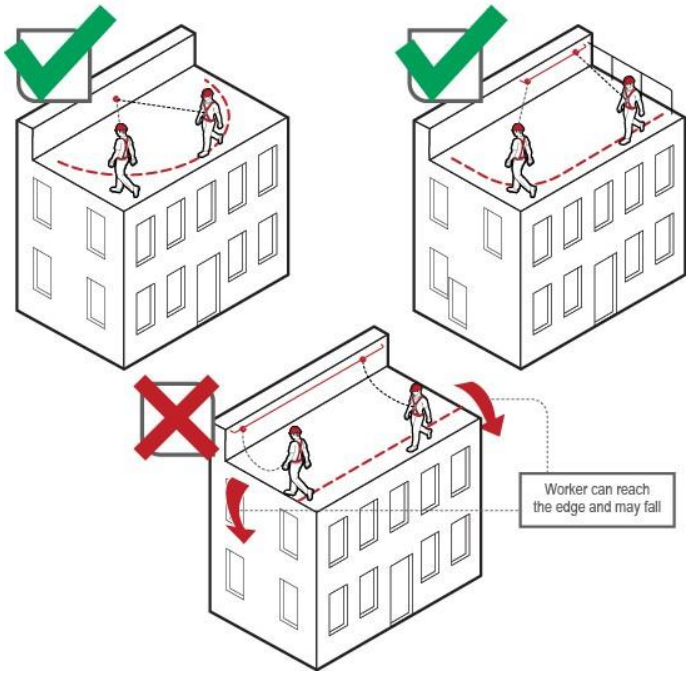
A ‘work positioning system’ includes any plant or structure, other than a temporary work platform, that enables a person to be positioned and safely supported on a roof while work is being carried out.

Restraint technique

A restraint technique controls a person’s movement by physically preventing the person from reaching a position at which there is a risk of a fall. It consists of a harness connected by a lanyard to a suitable anchorage point or static line. For restraint technique, the anchorage point and/or static line must be designed, manufactured, selected and used in compliance with the appropriate Australian Standards and installed by a competent person. This

equipment must be set up to prevent the worker from reaching an unprotected edge from where a fall may occur.

Figure 9 restraint technique options



Inertia reels and retractable lanyards may be used as part of the restraint technique provided the restraint technique is maintained with them in their fully extended condition.

Restraint techniques must only be used if it is not reasonably practicable to prevent falls by carrying out work on the ground or on a solid construction, or minimise the risk using a fall prevention device, such as edge protection.

A restraint system should be installed by a competent person in accordance with the manufacturer's instructions. Restraint anchorage should be designed for fall arrest loading.

A purpose-designed roof anchor, when used in accordance with the designer's or manufacturer's/supplier's instructions, may form part of the restraint technique on metal deck or tiled roofs. These should only be used in accordance with manufacturer's instructions, and may require advice from an engineer or other competent person on the structural adequacy of the roof and method of attachment.

Training and supervision for restraint systems

Restraint systems require a high level of safety competency on the part of workers and supervisors. PCBUs must ensure the workers and supervisors are trained and competent.

The level of supervision required depends on the level of risk and the experience of the workers involved. High levels of supervision are necessary where inexperienced workers are expected to follow new procedures or carry out difficult and critical tasks. Work supervisors should have competency in preparing and carrying out work plans, inspecting and maintaining equipment, and monitoring and reviewing the safe effectiveness of rope access systems.

Fall arrest systems

Fall arrest systems such as catch platforms, safety nets and individual fall arrest systems including anchorage lines or rails, are intended to safely stop a worker falling an uncontrolled distance and reduce the impact of the fall. They are not recommended controls for rooftop solar installation work.

These systems must only be used if it is not reasonably practicable to use a fall prevention device or work positioning system or if higher level controls are not fully effective in preventing a fall.

If used, fall arrest systems should be designed, manufactured, selected and used in compliance with the appropriate Australian Standards for industrial fall arrest systems and devices.

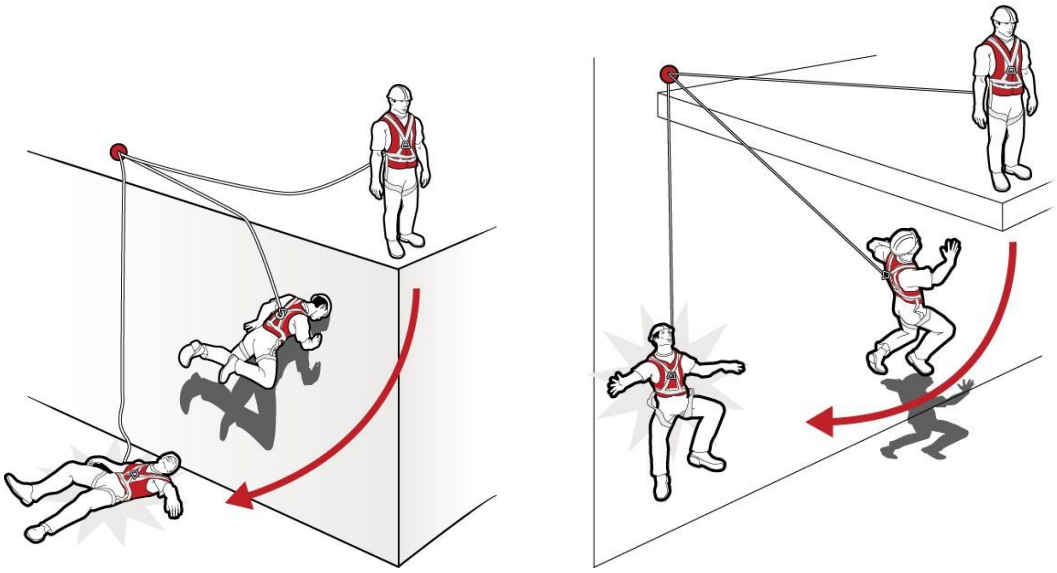
Individual fall arrest systems are intended to arrest a falling person safely and reduce the impact of the fall from a roof. If using an individual fall arrest system, training and supervision is essential.

The safe and correct use of individual fall arrest systems relies on several factors, including the design and availability of anchorage points that comply with relevant Australian Standards.

Individual fall arrest systems have limited application in typical residential housing construction because of ‘swing down’ or ‘swing back’ hazards.

A ‘swing down’ hazard is where the distance it takes for a person’s fall to be fully arrested is greater than the distance to the ground. In most cases, individual fall arrest systems need time to ‘brake’ a person’s fall, over which time the person will fall for several metres. For this reason, fall arrest systems are not recommended, even as a backup control, for residential solar installations where building heights are usually between 1 and 2 stories.

Figures 10 and 11 Swing down’ (left) and ‘swing back’ (right) hazards where a fall may result in contact with the ground, a wall or an object



A ‘swing back’ hazard is where the swing in the rope allows a person to hit another obstruction during their fall, such as an adjacent wall.

When using fall arrest systems, the following key safety measures are recommended:

- A fall arrest system should never be used where there is not adequate fall distance to account for ‘swing down’ or ‘swing back’ hazards.
- Fall arrest equipment should be selected, installed and used correctly.
- All anchor points should be designed, manufactured and installed to be capable of withstanding the force applied to them as a result of a person’s fall.
- Workers must be competent in the use of fall arrest equipment.
- The system should be designed and installed so that the person travels the shortest possible distance before having the fall stopped.
- Rope protection should be used to prevent rope damage by the roof edge or other contact points.
- An emergency plan must be developed and maintained to ensure it remains effective. Relevant workers must be trained in emergency procedures, including rope rescue techniques.

Catch platforms and safety nets are used to arrest a fall from a roof. They are often constructed on larger constructions sites alongside scaffolding systems and are positioned below a roof edge to catch a worker if they fall. They are recommended only as a ‘backup’ control as they work after a worker has fallen some distance before being caught. Safety nets should not be utilised to enter or exit a work area or as a working platform.

An internal safety net can be effectively used over stairwell openings and between stud walls during the erection of roof trusses.

Load restraint

When transporting equipment from one place to another, there are risks of injury due to vehicle rollaways, inadequate load restraint, etc. For more information on how to manage the risks associated with lifting and suspending loads, refer to the model Code of Practice: *Managing risks of plant in the workplace* and the Prevention of vehicle roll-aways and safe immobilisation: Fact sheet.

6.2 Falling objects

PCBUs must provide and maintain a safe system of work to prevent an object from falling freely, so far as is reasonably practicable, or to arrest the fall if the object cannot be prevented from falling.

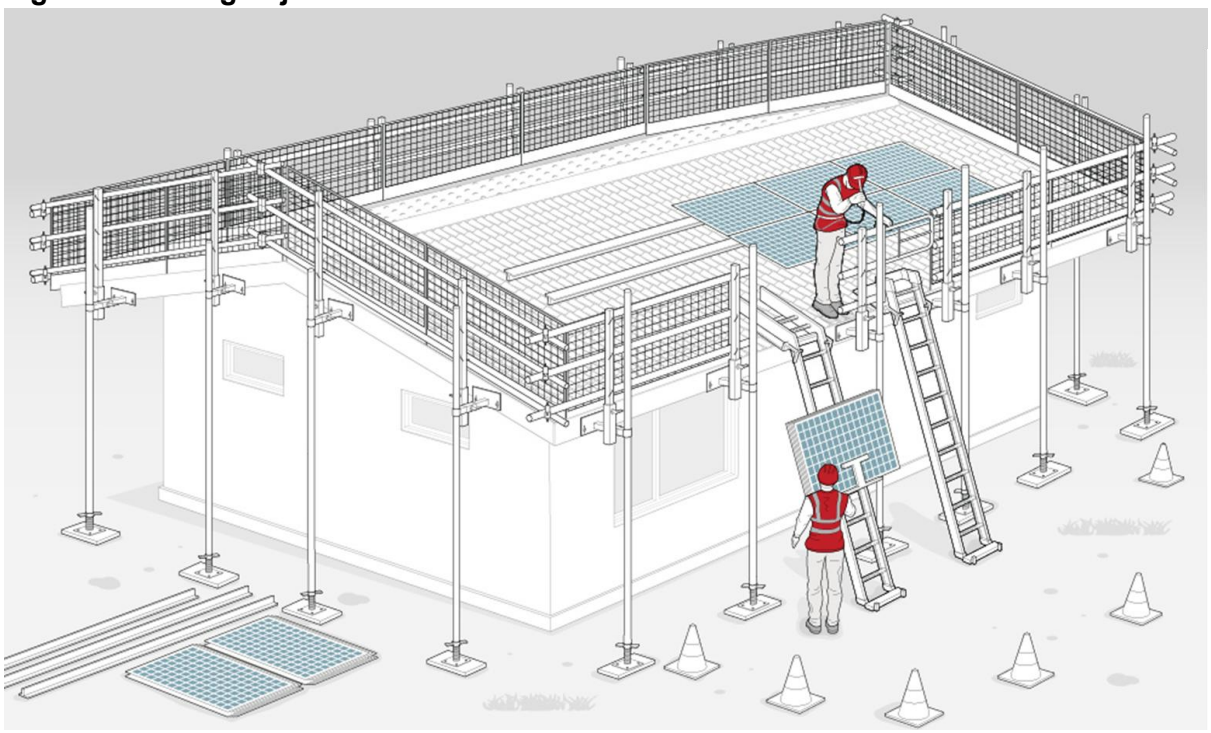
While undertaking rooftop solar installations, objects can fall on or hit people at the worksite or surrounding area if they fall from the roof. This includes material, debris, tools or equipment falling off the roof or a platform, scaffold or ladder.

Controls for falling objects include:

- Fitting physical barriers to stop objects falling from the roof or work platform.
- Installing screens, overhead protection, and protected walkways.
- Not taking an object onto a roof unless it is needed for the work.

- Setting up exclusion zones to limit access to overhead work and prevent falling objects from hitting other workers or pedestrians.
- Using hoists or panel lifters to securely raise and lower solar panels.
- Using lanyards on tools and hands-free bags for tools and mobile phones.
- Regularly cleaning floors and access ways to avoid slips and trips.

Figure 12 Falling objects



Further guidance on managing the risk of falling objects is in the *Falling objects fact sheet*.

6.3 Establishing exclusion zones

An exclusion or ‘no go’ zone can be used to prevent people from entering an area at risk of falling objects. Generally, the zone includes measures such as clear signs, physical barriers, and supervised access to the exclusion zone.

As a PCBU, you should consider an exclusion zone where there is a risk of a person entering an area and being injured. Examples of when to use an exclusion zone include where there is a risk of objects falling from a roof, or where cranes or EWPs are being used. Sometimes exclusion zones are useful at other locations, such as balconies, that are within or near a roof that is being accessed.

Information and instruction should be provided about exclusion zones, with supervision to ensure that no unauthorised worker or third party enters the area. The less secure the perimeter identification is, the greater the level of supervision required.

Hazards should be discussed with the customer, so the customer understands the need for the PCBU to have certain control measures in place such as exclusion zones.

6.4 Electrical risks

Electrical risks are risks of death, shock, burns or other injury caused directly or indirectly by electricity. Even the briefest contact with electricity can have serious consequences for a person's health and safety. Electric shocks may cause falls from ladders or EWPs.

Electrical work must only be carried out by licensed or registered electrical workers. For information about the applicable electrical licensing or registration laws, contact the local regulator in your jurisdiction.

A PCBU must manage electrical risks at the workplace and has a range of relevant duties under the model WHS laws. For more information on managing electrical risks refer to the model Code of Practice: *Managing electrical risks in the workplace*.

Key risk controls for managing electrical risks associated with solar power installations include:

- de-energising equipment, including removal of service fuses, and testing that it is de-energised, before work starts
- ensuring de-energised equipment is not inadvertently re-energised during work (for example, by isolating, locking off and tagging control mechanisms)
- turning off the main switch in the electrical installation's switchboard before accessing roof spaces, particularly during PV system cabling
- installing batteries in locations that have a safe distance away from existing utilities such as natural gas, LPG installations and flammable liquids storage areas
- sourcing battery equipment with inbuilt isolation devices to remove arc flash energy risk, or if not appropriate installation design, work practices and PPE to reduce arc flash risk
- using residual current devices to protect workers and equipment
- inspecting and testing all electrical equipment before use
- using insulated tools and equipment, including battery-powered tools where possible and using DC surge protection devices
- establishing a commissioning system to ensure the new electrical installation is safe
- establishing a system for safe decommissioning, repair, maintenance and removal of panels, inverters and batteries
- considering environmental conditions, which may affect electrical resistance (for example, rain or high humidity can make a person wet and increase the risk of electric shock), and
- wearing appropriate PPE such as cotton or fire-retardant long sleeve clothing, rated insulated electrical gloves, protective non-slip safety boots and a safety helmet.

Solar panels can create electricity when the sun is shining on them, so may continue to pose serious risks of electric shock even when mains power at a location is turned off. If not isolated properly, solar panels can cause arc flashes and electrocute workers, even at low

voltages. Electric shock can also occur from batteries. It is important to follow manufacturer's instructions.

With more people working from home, some installers are reluctant to turn off electricity supply to avoid disturbing the client. This is an unsafe practice and places workers at risk of electrocution during installation. PCBUs must ensure worker safety, as far as reasonably practicable, and prioritise the health and safety of workers before customer convenience.

Case study: extra low voltage electrocution
A worker died as a result of working on an off-grid solar system and was found with significant burns to their hands and fingers.
The investigation revealed:

- the solar system had been operating at an extra low voltage (not exceeding 50VAC or 120V ripple-free DC)
- environmental conditions had increased the risk of electrocution, with very high humidity decreasing electricity resistance between the solar system and the person.

De-energising solar panels

Solar panels generate electricity even with small amounts of sun exposure. They may not always be effectively de-energised, particularly on the DC side of the installation. In some cases, regulators may require that solar installations be tested while energised. In these circumstances, standard methods of preventing electrical risks which involve de-energising equipment cannot be used. For this reason, solar installation work must only be performed by a competent person. Please refer to the model Code of Practice: *Managing electrical risks in the workplace* for specific requirements to follow when carrying out electrical work on energised solar panels.

Overhead electrical lines

Electric lines have significant risks, including electrocution, arcing, explosion, fire, burns, unpredictable cable whiplash and electrifying other objects including signs, poles, trees or branches. Whether carrying voltage of 400,000V or 230V, contact with electric lines can be fatal. It is not necessary to touch an electric line to be electrocuted. A 'flashover' or 'arc flash' can electrocute a person close to a line conductor.

PCBUs must ensure, so far as is reasonably practicable, that no person, plant or thing at the workplace comes within an unsafe distance of an overhead electrical line. Exclusion zones are designed to ensure distance between persons and plant and electric lines. Approach distances and work zones vary across each state and territory. PCBUs should be familiar with the regulations in the specific state or territory, and should contact the relevant Electrical Supply entity for further information. Where overhead electrical lines are present and there is any risk of entering the exclusion zone, the PCBU should ensure documented consultation occurs with the relevant electrical distributor and all recommendations from the electrical distributor are followed.

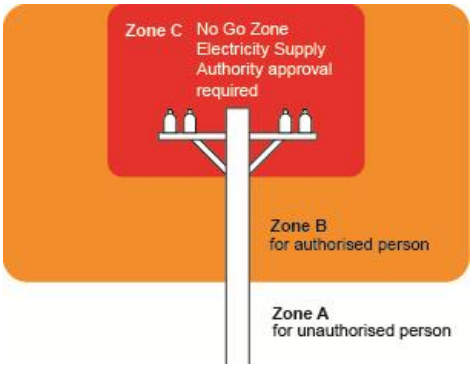
PCBUs should consider the distance required to avoid electrical flashover, allow for the inadvertent movement of a person or plant (such as an EWP), and allow for the sag and sway of conductors.

Solar installers use equipment that contains metal and it is crucial to keep the equipment a safe distance from overhead electrical lines. If it is not reasonably practicable to ensure a safe distance, a PCBU must conduct a risk assessment for the proposed work and

implement control measures, including control measures consistent with any requirements of the relevant Electrical Supply authority in their jurisdiction.

A competent safety observer should be used when using a crane or EWP as part of solar installation work, and where there are risks from approaching overhead power lines. Safety observers should not carry out other tasks, such as dogging duties, at the time of observing plant operations. All workers should be able to clearly identify the person carrying out safety observer duties. This ensures that safety observers are not distracted while carrying out the role.

Figure 13 Overhead power line zones



6.5 Batteries (battery energy storage systems)

Battery installation must only be carried out by licensed or registered electrical workers. For information about the applicable electrical licensing or registration laws, contact the local regulator in your jurisdiction. PCBUs should consider additional risk controls for managing risks associated with battery installations, including:

- ensuring batteries are installed in compliance with relevant Australian Standards such as the AS/NZS 5139 *Electrical installations – Safety of battery systems for use with power conversion equipment*
- ensuring battery equipment compiles with TS 5398 *Electrical Energy Storage Equipment – Safety Requirements* (and preferably has internal isolation devices to isolate the internal battery energy source)
- only installing batteries that are appropriate for the system being installed
- ensuring safe distance from exits, windows and other openings
- ensuring that it does not block access points or emergency exits
- ensuring that it is not installed in a habitable room where people live and sleep, such as a living room or bedroom and away from ignition sources, such as hot water units, gas meters and vehicle exhaust points
- ensuring there is adequate ventilation if the battery will be installed indoors, such as a garage
- ensuring secure transportation and storage to avoid damage. Batteries such as lithium-ion (Li-ion) are transported with a low charge (typically 30%) to reduce risk during transport. Even at these lower charge levels, the batteries are a high-density energy source and can deliver an electric shock.

- inspecting and testing batteries for damage before installation
    - This includes before repairing, maintaining, decommissioning or removing.
- using mechanical lifting aids to reduce the risk of sustaining musculoskeletal disorders from hazardous manual handling
- following the manufacturer's and designer's instructions for safe installation
- considering putting up warning signs and labels, including 'No smoking' signs and emergency shutdown procedures near the battery, and
- establishing a commissioning (or decommissioning) system to ensure the battery installation is safe.

Please refer to the model Code of Practice: *Managing electrical risks in the workplace* for specific requirements to follow when carrying out electrical work.

Retrofitting batteries

Batteries can also be retrofitted to existing solar systems. It is important that the electrical risk management process is conducted in full when retrofitting a battery. In particular, it is critical to ensure:

- the battery selected is appropriate and compatible for the existing solar system,
- the location of the existing inverter is appropriate for a battery, or if the inverter can be relocated to an appropriate location
- following the manufacturer's instructions for the existing solar system and the new battery that is being installed.

Lithium-ion batteries

All battery types used in solar energy storage systems, including lithium-ion and non-lithium batteries (e.g. lead-acid, nickel-based) present serious safety risks and must be managed accordingly. Both can pose significant risks to WHS if improperly installed, used, stored or disposed of.

Lithium-ion (Li-ion) batteries are the most common battery installed in new or retrofitted solar systems. However, older systems may use lead-acid batteries. If damaged, defective or not installed, used, charged, or stored correctly, Li-ion batteries can pose serious risks to health and safety. This includes risks of:

- electrical shocks causing injury or death through direct or indirect contact with the battery
- arc flash injury or death from inadvertent release of internal storage battery energy
- thermal runway
- electrical fires or explosions, and
- exposure to hazardous chemicals and toxic gas release, particularly when damaged, overheated or short-circuited. Inhaling non-flammable gases may cause a risk of inhaling noxious gases similar to a natural gas leak if there is no ventilation.

Always check the battery before installation – fires and explosions can be caused by damage, or improper handling or usage of Li-ion batteries, including:

- physical damage caused by crushing, dropping, puncturing, etc.
- overheating caused by exposure to direct sunlight or extreme heat
- overcharging
- use of incompatible or faulty equipment in existing installation, and
- short circuiting caused by electrical faults within the battery or device containing the battery.

Li-ion batteries contain chemicals which are hazardous and may pose a significant risk if they are disturbed or leak out of the battery.

If a Li-ion battery is exposed to extreme heat or internally heats up to high temperatures (e.g. by overcharging), the battery can release hazardous gases, fumes and electrolytes. Some of these gases, fumes and leaked electrolytes may be:

- toxic if inhaled
- corrosive to the respiratory tract
- cause severe skin irritation or burns and eye damage, or
- cause environmental contamination if not handled properly.

Appropriate PPE, including respiratory protective equipment, should be used where there is a risk of inhalation of hazardous chemicals.

Further guidance on managing risks of chemical exposure is available in the model Code of Practice: Managing risks of hazardous chemicals in the workplace.

Non-lithium batteries

Non-lithium batteries such as lead-acid, nickel-cadmium and alkaline types, may also explode, leak corrosive or toxic substances, emit flammable gases, and cause chemical burns or heavy metal exposure. Due to these risks, all batteries must be treated as hazardous, with appropriate controls in place to prevent injury, property damage, and environmental harm. Always follow manufacturer instructions, safety data sheets (SDS) and relevant regulations for safe use, storage and disposal.

Emergencies associated with batteries

A damaged or ruptured battery can result in the release of hazardous chemicals, release non-flammable gases and/or cause chemical leakage. The release of hazardous chemicals can also cause the battery to explode or catch fire, which can trigger the release of more hazardous chemicals. In some cases, chemical reactions and/or heat generated by the battery can become self-sustaining (thermal runaway) and the resulting fire can be difficult to extinguish.

If a battery shows signs of failure (bulging, swelling or leaking) during system installation or maintenance:

- cease all work immediately
- isolate the battery system and switch off power – only if it is safe to do so
- make the area safe by restricting access and removing ignition sources

- notify the battery supplier or manufacturer as soon as practicable for further instruction and safe handling

If a battery emits smoke or catches fire:

- stop work immediately and assess the situation
- isolate and switch off the battery – only if it is safe to do so
- evacuate the area if required and prevent unauthorised access
- contact emergency services (000) without delay
- only trained personnel with appropriate firefighting equipment should attempt to suppress the fire

Safe disposal of Li-on batteries

Li-ion batteries must not be disposed of in general waste or standard recycling bins as they pose a risk of fire, explosion and can cause environmental harm and may also breach environmental regulations.

Always refer to the manufacturer's instructions and the SDS for specific guidance on handling and disposal requirements.

After reviewing the manufacturer's instructions and SDS, contact your local recycling authority or an authorised battery recycling service for advice on safe and compliant disposal options.

6.6 Hazardous manual tasks

A hazardous manual task is where a person has to lift, lower, push, pull, carry or otherwise move, hold or restrain something repeatedly, use high or sudden force, undertake repetitive movement, have sustained or awkward posture, or be exposed to vibration. Inverters and batteries are typically very heavy and carrying this type of equipment is an example of a hazardous manual task. Hazardous manual tasks are one of the most common causes of musculoskeletal injuries in solar installation work.

A PCBU must manage risks to health and safety relating to musculoskeletal injuries and disorders associated with a hazardous manual task.

Handling solar equipment and other materials exposes workers to fatigue, musculoskeletal injuries, and falls risks where workers are required to carry equipment in unsafe conditions. For example, carrying solar panels in windy conditions can cause the panel to act like a 'sail' and may cause injury, or cause the worker to fall.

Risk control measures for managing the risks of hazardous manual tasks include:

- completing work on the ground wherever possible, so unnecessary equipment does not need to be carried onto a roof, or to minimise time spent inside a roof cavity
- using a scaffold to access the roof instead of a ladder
- using a crane or panel lifter to lift solar panels onto the section of the roof on which they will be installed
- using mechanical aids, such as pulleys to lift tools and equipment

- installing permanent or temporary walkways on the roof, particularly on roofs with uneven surfaces
- rotating and sharing lifting and positioning tasks between multiple workers
- using lightweight tools and equipment, and
- providing regular rest breaks for workers.

In determining control measures, PCBUs must consider the duration and frequency of the task, environmental conditions, the design and layout of the workplace and the systems of work used.

Further guidance is available in the model Code of Practice: *Hazardous manual tasks*.

6.7 Asbestos

PCBUs must not carry out, direct, or allow a worker to carry out work that involves handling or disturbing asbestos or asbestos-containing materials (ACM).

Examples of where solar installers are likely to encounter asbestos or ACM include:

- roofs made of corrugated cement sheeting
- ceiling cavities containing friable asbestos,
- any residential building built or renovated before 1990
- any commercial building built before 2004, or
- older electrical switchboards.

While the risk decreases for buildings constructed after those dates, a person with management or control of a workplace must ensure, so far as is reasonably practicable, that all asbestos or ACM at the workplace is identified by a competent person.

Managing the risks of asbestos includes:

- recording identified material in an asbestos register
- assessing the risk of exposure to airborne asbestos
- eliminating or minimising the risks of asbestos by using control measures, such as:
    - ensuring asbestos is not disturbed
    - encapsulating or labelling asbestos, and
    - providing workers with PPE including respiratory protection.

For more information on managing the risk of asbestos, please refer to the model Code of Practice: *How to manage and control asbestos in the workplace* and the model Code of Practice: *How to safely remove asbestos*.

6.8 Respirable crystalline silica

Rooftop solar installation activities involve the risk of exposing workers and others at the workplace to respirable crystalline silica (RCS). This includes activities involving the processing of rooftop materials containing at least 1% crystalline silica (i.e., any crystalline silica substance or ‘CSS’), such as:

- cutting brick, concrete or stone roof tiles, and
- angle grinding, jack hammering and chiselling of concrete or masonry.

Workers and others at the workplace are also at risk of exposure to RCS during clean-up activities such as sweeping of dust.

The model WHS Regulations set out specific duties in relation to the management of risks associated with the generation of RCS from processing a CSS.

Where solar installers need to cut or drill or otherwise process a CSS (e.g. roof tiles) to install solar panels, the PCBU must first assess whether the processing of the CSS is high risk and, therefore, reasonably likely to result in a risk to the health of a person at the workplace. Any processing assessed as high risk is subject to additional duties including requirements to have a silica risk control plan in place and to provide crystalline silica training to workers.

> For more information about how to complete the assessment, (including the mandatory matters to which the PCBU must have regard) and the additional duties relating to any processing assessed as high risk, refer to Parts 2.5 and 3 of the model Code of Practice: *Managing risks of respirable crystalline silica in the workplace*.

Solar installers are prohibited from processing a CSS such as a roof tile unless they implement:

- isolation control/s (such as removing as many workers as possible from the area), and
- engineering control/s (such as an effective on-tool dust extraction system).

If a worker is still at risk of exposure to RCS after implementing isolation and engineering controls, the worker must be provided with, and wear, appropriate respiratory protective equipment while the work is being carried out.

The use of respiratory protective equipment by itself is only permitted if the above isolation or engineering controls are not reasonably practicable to implement as part of the installation.

For more information on what you must do to keep workers safe from the risks of RCS, and your duties in relation to the processing a CSS, please refer to the model Code of Practice: *Managing risks of respirable crystalline silica in the workplace*. Parts 2.3 and 2.4 of the Code address the requirements for controlled processing of a CSS and the implementation of control measures to manage RCS risks.

6.9 Heat

Working on roofs, or inside roof spaces during solar installation work increases the risk of heat-related injuries and illnesses, such as burns from contacting hot surfaces like roof tiles, heat stroke and dehydration.

PCBUs must manage the risks associated with working in heat, including providing workers with access to drinking water. PCBUs should not schedule work on or inside a roof during very hot temperatures. Instead, schedule rooftop tasks for cooler parts of the day.

Other controls to reduce the risk of heat-related injuries and illnesses include:

- using mechanical lifting aids to reduce physical exertion
- providing fans or mechanical ventilation when working in roof cavities

- reducing time spent working in heat, for example through rotating workers between tasks
- providing rest breaks in a shaded, cool area (air conditioned where possible), and
- providing PPE such as long-sleeved clothing, gloves, a hat, sunglasses and sunscreen to protect from UV radiation.

Further guidance on managing risks from working in heat is in the model Code of Practice: *Managing the work environment and facilities* and Guide for managing the risks of working in heat.

6.10 UV radiation

Work on roofs expose workers to the risk of skin cancers through direct ultraviolet radiation (UVR) from sunlight and reflected UVR from surfaces such as concrete, metal and glass.

Controls to reduce solar UVR exposure include:

- carrying out roof work earlier in the morning or later in the day
- rotating tasks so individual workers spend less time outside
- working in the shade, under overhead protection or away from nearby reflective surfaces and
- providing workers with PPE, such as loose-weave fabric shirts with a collar and long sleeves, long trousers and hats with broad brims or caps with 'legionnaire' style peak and flap at the back, sunglasses and 50+ SPF sunscreen on any exposed skin.

6.11 Working inside a roof

Solar installation work commonly involves entering roof spaces. Working inside a roof has a range of WHS risks to workers including:

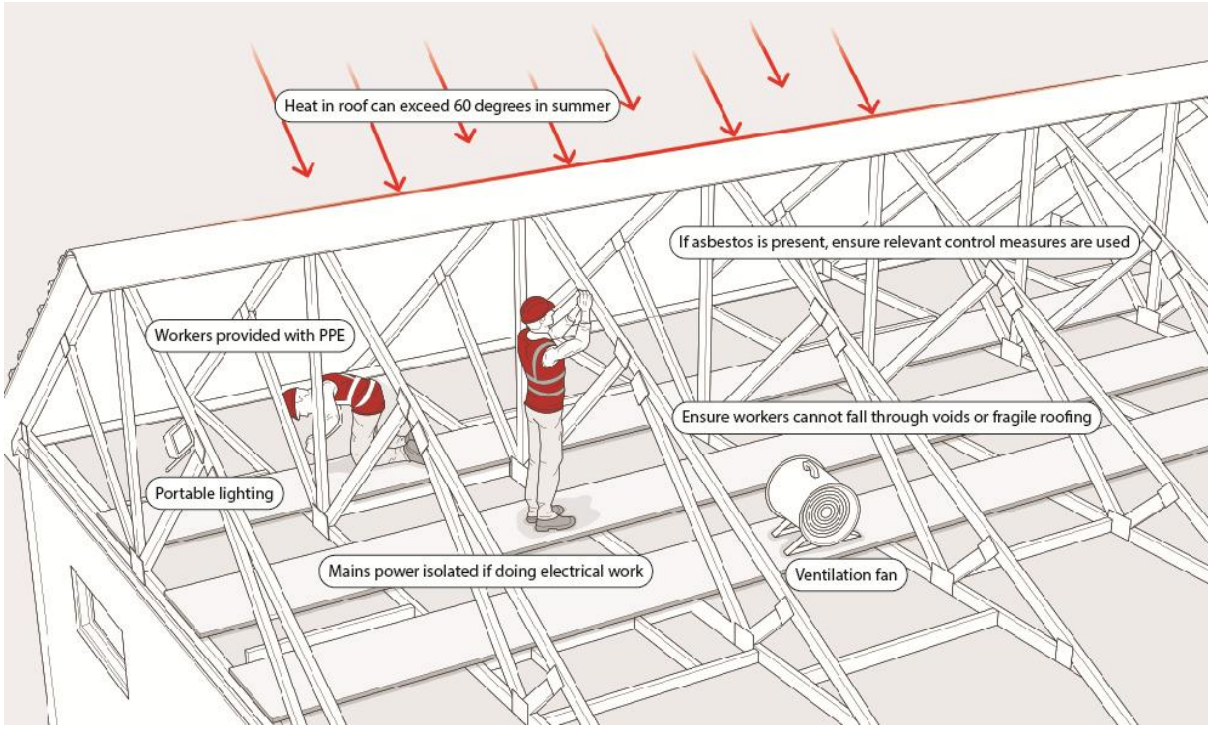
- exposure to heat-related illnesses
- electric shock
- musculoskeletal disorders
- exposure to asbestos
- exposure to dust
- falls from height, and
- difficulty rescuing and treating an injured or unconscious person.

Control measures to reduce the risks of working in roofs include:

- inspecting the roof space before entry to determine any hazards that may be present, including a weakened or deteriorated roof structure, high temperatures, evidence of vermin, sharp objects, asbestos, unlit areas, accessibility, the locations of electrical wiring, water or gas piping
- ensuring workers do not enter the roof if there are friable or disturbed asbestos or ACM present
- de-energising the electrical installation before entering the roof
- carrying out the work outside the roof space where possible

- reducing the time spent in the roof, and the number of people working inside the roof at the same time
- providing fans or mechanical ventilation to reduce the risk of heat-related illnesses
- providing lighting, such as battery-powered headband lighting, if there is poor visibility
- ensuring ceiling joists or other beams can be safely navigated, and providing adequate fall protection where required
- ensuring the worker can still be heard from outside the space or that there is always a means of communication with the worker
- providing PPE such as gloves and non-slip shoes
- monitoring conditions within the roof, and
- having an emergency rescue plan.

Figure 14 Example control measures for working in a roof



6.12 Remote or isolated work

Workers accessing a roof may sometimes be isolated from assistance, including rescue, medical assistance, or attendance by emergency service officers. If PCBUs cannot eliminate the risks of remote or isolated work, they must minimise the risks by providing a safe system of work, including effective communication with the worker.

Controls to reduce remote or isolated work risks include:

- arrange work so workers do not work alone
- provide effective communication between workers, and others, at all times

- agree worksite communication methods before workers start work – the way workers communicate will depend on the size of the workplace, the tasks being carried out, the equipment being used, noise and weather implications and the location of workers at the worksite
- use a safety observer, who works from the ground and communicates with a worker on the roof to inform them of the proximity to surrounding hazards like electric lines, and can promptly seek assistance if it is required. A safety observer should have a designated role without carrying out other tasks or being distracted
- develop an emergency response plan, and communicate to employees, and
- ensure employees working alone have adequate first aid training and an adequate first aid kit.

Expert advice and local knowledge may help select an effective communication system.

Further guidance is in the model Code of Practice: *Managing the work environment and facilities*.

6.13 Psychosocial hazards

Psychosocial hazards cause risks to worker's mental health. To assess the risk, consider the duration, frequency and severity of exposure to psychosocial hazards. Psychological harm may include anxiety, depression, post-traumatic stress disorder and sleep disorders.

Common psychosocial hazards include:

- job demands
- low job control, for example, workers having little say over break times
- poor support, for example inadequate training
- remote or isolated work
- poor physical environment, for example when working long hours in hot conditions
- violence and aggression
- bullying
- harassment, including sexual harassment, and
- conflict or poor workplace relationships and interactions.

PCBUs must eliminate, or if not possible, minimise, psychosocial risks so far as is reasonably practicable.

Controls to reduce psychosocial risks may include:

- providing regular breaks
- providing the appropriate level of supervision based on the level of risk and the worker's experience
- staying in regular contact with workers in remote or isolated locations
- giving workers the equipment and training needed to do the work safely
- clearly describing key tasks, responsibilities and expectations
- regularly consulting to keep workers informed

- controlling physical WHS risks
- being active to promote cooperative work cultures, prevent workplace violence and aggression, bullying and harassment, and controlling harmful behaviours, and
- engaging third parties such as owners, tenants or neighbours so that they understand what is required of them to ensure a safe workplace.

In determining control measures to implement, PCBUs must consider things like:

- the duration, frequency and severity of the exposure to psychosocial hazards
- how psychosocial hazards may interact or combine
- the design of work including job demands and tasks
- the systems of work including how work is managed, organised and supported
- the design and layout, and environmental conditions, of the workplace (including safe entries and exits, and facilities for workers' welfare)
- the design and layout, and environmental conditions, of workers' accommodation (if any)
- the plant, substances and structures at the workplace
- workplace interactions or behaviours, and
- information, training, instruction and supervision provided to workers.

Further guidance on managing the risks of psychosocial hazards is in the model Code of Practice: *Managing psychosocial hazards at work*.

6.14 Other environmental hazards

Common environmental hazards include:

- Wind – Strong winds can damage roofs, impact the stability of plant or workers on a roof and dislodge solar panels or other equipment that has not been properly secured, or hanging branches.
- Wet – Some plant and equipment may perform differently when wet or may be more easily damaged. Water can cause slippery conditions on the roof and also increase electrical risks.
- Cold – Hypothermia and frostbite can occur when working in cold conditions.
- Lightning.

To ensure that environmental conditions remain safe for workers, and prior to roof access, seek regular local weather forecasts and updated site information. Where working in potentially hazardous conditions, have a cease work plan if environmental conditions change, use appropriate equipment, clothing, PPE and provide facilities to manage the risks.

Further guidance on managing the risks associated with the work environment and facilities is in the model Code of Practice: *Managing the work environment and facilities*.

6.15 Emergency procedures and first aid

PCBUs must prepare an emergency plan for the workplace. It must be tailored to each work environment and be regularly updated. The emergency plan must contain:

- emergency procedures (including evacuations, notifying emergency services, medical treatment, and effective communications)
- details of testing the emergency procedures, and
- information, training and instruction to workers to implement emergency procedures.

The PCBU should regularly test the emergency plan's procedures and provide workers with information, training and instruction, including rescue techniques, so they may carry out emergency procedures.

A rescue plan should be prepared where installers are accessing and working in or on a roof. The plan should contain procedures for accessing and rescuing a worker from the roof or confined space and bringing them to ground. If a fall arrest device is being used as a control measure, specific emergency and rescue procedures must also be included. At least one worker on site should be trained and competent to carry out the rescue plan. Simply relying on dialling 000 is not an adequate emergency plan for working on a roof. An emergency plan and emergency and rescue procedures can also greatly assist emergency services that may be called to respond.

You must maintain the emergency plan so it remains effective. Check that rescue equipment is present and ready for immediate use. This equipment should be sufficient to carry out a rescue from any situation on the site, so far as is reasonably practicable. The rescue plan should include contact details for emergency services and the electricity supply entity.

Rescues may be too complex or too hazardous for workers to attempt, for example if there are electric lines involved in the incident. A rescuer must not attempt a rescue that is beyond their skill level and must take reasonable care for their own health and safety during the rescue.

PCBUs must ensure workers have access to first aid equipment, and facilities for the administration of first aid. For example, a first aid kit may be available on the roof where solar installation is taking place. An adequate number of workers must be trained to administer first aid and/or workers must have access to people trained in first aid. Further guidance is in the:

- Model Code of Practice: *Managing the risk of falls at workplaces*
- Model Code of Practice: *Managing the risk of falls in housing construction*
- Model Code of Practice: *First aid in the workplace*
- Model Code of Practice: *Managing the work environment and facilities*.
- Model Code of Practice: *Managing risks of hazardous chemicals in the workplace*.

For more information on emergencies associated with batteries, please refer to section 6.5 *Emergencies associated with batteries.*

7. Safely accessing and exiting a roof

PCBUs must eliminate or minimise risks to health and safety when accessing and exiting a roof, so far as is reasonably practicable. PCBUs must also provide a safe means of access to and exit from the workplace and other areas.

7.1 The safest way to access and exit a roof

Careful planning, applying the correct safe working method and having suitable equipment to access and exit roofs will reduce the risk of falls and injuries.

The safest methods for providing roof access include:

- scaffold access towers
- stair towers
- industrial grade secured ladders, and
- roof access hatches.

Where there is no permanent access to a roof, the next safest measure is to provide properly constructed temporary access with clearly signposted access points. Ensure that stepping onto the roof can be done safely and that the landing place is firm, stable and free of obstructions.

7.2 Entry and exiting a roof using a ladder

Accessing a roof using a ladder involves WHS risks. Falls from ladders often result in serious injuries that may cause fatality, even when working at relatively low heights. A portable ladder should only be used to access and exit a roof if it is not reasonably practicable to use the methods listed at 7.1.

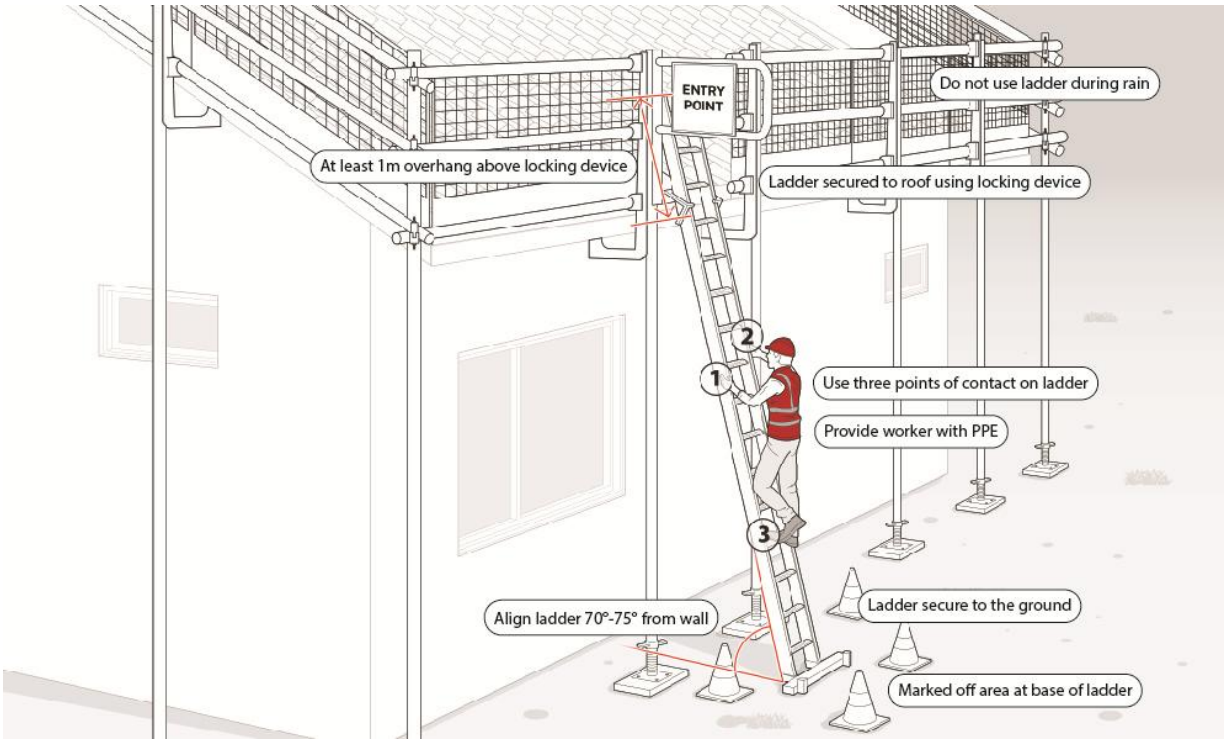
If a portable ladder is used to access a roof, PCBUs should ensure that:

- the ladder is inspected before use in accordance with manufacturer's instructions and to ensure it complies with the relevant Australian Standard
- the ladder is placed at a 70-75 degrees (approximately 1:4) angle to the wall
- the ladder is securely fixed at both the base and top
- the ladder extends at least 1 metre above the stepping-off point on the working platform
- there is a firm, stable work platform, free from obstructions, to step onto from the ladder
- fall protection is provided at the stepping-off point where people access the working platform
- the base of the ladder is clear of obstructions with a clearly marked exclusion zone
- workers use three points of contact at all times when on the ladder. Workers should not carry solar panels or other equipment up a ladder
- workers are provided with appropriate PPE including non-slip shoes, and
- the ladder is not used in the rain, during strong winds, and when otherwise wet.

Depending on the temporary edge protection being used on the roof, PCBUs should make sure that:

- workers can access the roof through the edge protection without having to climb over the top rail or mid-rail
- where a platform is located more than 500 mm below the roof edge, additional means of access to the roof is provided, and
- where an elevator, hoist or similar equipment is used it is installed so materials can be safely received at the roof level.

Figure 15 Example control measures for safe ladder use



Further information on the safe use of ladders, including selecting the right ladder and using it and maintaining it for roof work is provided in:

- Model Code of Practice: *Managing the risk of falls at workplaces*.
- Model Code of Practice: *Managing the risk of falls in housing construction*.

7.3 Use of tools and other work equipment

Tools and work equipment for rooftop work should:

- be in good condition
- be suitable for the intended work
- be secured from falls from height, and
- not introduce additional risks to WHS without adequate risk controls.

Using some tools can introduce additional WHS risks which must be managed in the workplace. For example, cutting or grinding tools can accidentally cut through safety lines used to manage the risk of a fall.

Where the use of a tool creates an additional WHS risk, a PCBU must eliminate or minimise the risk so far as is reasonably practicable (for example, by providing rope protectors).

8. Rooftop solar system maintenance, replacement and removal

Maintaining, replacing, retrofitting and removing solar systems pose WHS risks that are similar to the initial installation. PCBUs must eliminate or minimise WHS risks associated with this work so far as is reasonably practicable.

The controls used to manage WHS risks during solar system maintenance, replacement or removal will be similar to the installation phase.

However:

- some risks may be reduced, for example some equipment used in installation may not be required
- other risks may be increased, for example the condition of the roof may have degraded, requiring additional fall protections, the worker may be alone, or there may be damage to solar panels, inverters and batteries, and
- new risks may be introduced, for example, disconnecting solar panels, inverters and batteries may involve risks of electrical shock from arc flash if each panel is not adequately isolated.

Damaged panels or other parts of the rooftop solar system must be disconnected or isolated before they are repaired, replaced or cleaned by a licensed electrician or qualified installer. When undertaking maintenance work on solar panels, consideration should be given to physically isolating all sources of energisation (e.g. batteries, inverters and mains power) to prevent backfeeding to the switchboard. Rooftop solar system maintenance should also be performed by an appropriately licensed electrical worker, who may also be an accredited installer under a government incentive scheme (e.g. SAA).

Demolition work involves significant hazards and requires specific skills, training and a licence. Further information can be found in the model Code of Practice: *Demolition work*.

9. Glossary and further resources

9.1 Glossary

commercial structure is a large-scale building, generally of multiple storeys.

construction work is any work carried out in connection with the construction, alteration, conversion, fitting-out, commissioning, renovation, repair, maintenance, refurbishment, demolition, decommissioning or dismantling of a structure.

competent person is a person who has acquired through training, qualification or experience the knowledge and skills to carry out the task.

duty holder is any person who owes a work health and safety duty under the WHS Act or Regulations including a PCBU, a designer, manufacturer, importer, supplier, installer of products or plant used at work (upstream duty holder), officer or a worker.

fall means a fall by a person from one level to another.

fall arrest system means plant or material designed to safely stop a worker falling an uncontrolled distance and to reduce the impact of the fall. This includes a safety net, a catch platform, or a safety harness system.

fall prevention device is material or equipment—or a combination of both—designed to prevent a fall for temporary work at heights, that once in place after initial installation does not require any ongoing adjustment, alteration or operation by any person to ensure its integrity. This includes secure fencing, edge protection, working platforms and covers.

high risk construction work is construction work that:

a) involves a risk of a person falling more than 2 metres; or
b) is carried out on a telecommunication tower; or
c) involves demolition of an element of a structure that is load bearing or otherwise related to the physical integrity of the structure; or
d) involves, or is likely to involve, the disturbance of asbestos; or
e) involves structural alterations or repairs that require temporary support to prevent collapse; or
f) is carried out in or near a confined space; or
g) is carried out in or near: (i) a shaft or trench with an excavated depth greater than 1·5 metres; or (ii) a tunnel; or
h) involves the use of explosives; or
i) is carried out on or near pressurised gas distribution mains or piping; or
j) is carried out on or near chemical, fuel or refrigerant lines; or
k) is carried out on or near energised electrical installations or services; or
l) is carried out in an area that may have a contaminated or flammable atmosphere; or
m) involves tilt-up or precast concrete; or
n) is carried out on, in or adjacent to a road, railway, shipping lane or other traffic corridor that is in use by traffic other than pedestrians; or

o) is carried out in an area at a workplace in which there is any movement of powered mobile plant; or

p) is carried out in an area in which there are artificial extremes of temperature; or

q) is carried out in or near water or other liquid that involves a risk of drowning; or

r) involves diving work.

may indicates an optional course of action.

must indicates a legal requirement exists that must be complied with.

person conducting a business or undertaking (PCBU) is an umbrella concept which intends to capture all types of working arrangements or relationships. A PCBU includes a:

- company
- partnership
- unincorporated body or association
- sole trader or self-employed person.

person with management or control of plant at a workplace means a PCBU to the extent that the business or undertaking involves the management or control of fixtures, fittings or plant, in whole or in part, at a workplace.

plant includes any machinery, equipment, appliance, container, implement and tool; and any components of or anything fitted or connected to those things. Plant includes items as diverse as rope access systems, lifts, cranes, computers, machinery, conveyors, forklifts, vehicles, power tools, quad bikes, mobile plant and amusement devices.

restraint technique is a work positioning system used to control a person's movement by physically preventing them from reaching a position at which there is a risk of a fall, for example an unprotected edge. It consists of a harness that is connected by a lanyard to an anchorage or horizontal line.

risk of a fall is a circumstance that exposes a worker while at work, or other person while at or in the vicinity of a workplace, to a risk of a fall that is reasonably likely to cause injury to the worker or other person. This includes circumstances in which the worker or other person is:

- in or on plant or a structure that is at an elevated level
- in or on plant that is being used to gain access to an elevated level
- in the vicinity of an opening through which a person could fall
- in the vicinity of an edge over which a person could fall
- on or in the vicinity of a surface through which a person could fall
- on or near the vicinity of a slippery, sloping or unstable surface.

a safe work method statement, or SWMS is a document that sets out the high risk construction work activities to be carried out at a workplace, the hazards arising from these activities and the measures to be put in place to control the risks.

should indicates a recommended course of action.

a solid construction is an area that has:

- a surface that is structurally capable of supporting all people and things that may be located or placed on it
- barriers around its perimeter and any openings to prevent a fall
- an even and readily negotiable surface and gradient, and
- a safe means of entry and exit.

worker is any person who carries out work for a PCBU, including work as an employee, contractor or subcontractor (or their employee), self-employed person, outworker, apprentice or trainee, work experience student, employee of a labour hire company placed with a 'host employer' or a volunteer.

workplace is any place where work is carried out for a business or undertaking and includes any place where a worker goes, or is likely to be, while at work. This may include offices, factories, shops, construction sites, vehicles, ships, aircraft or other mobile structures on land or water.

work positioning system means any plant or structure, other than a temporary work platform, that enables a person to be positioned and safely supported at a location for the duration of the relevant work being carried out. This includes restraint technique or a rope access system.

9.2 Further resources

Table 2 Further resources

Who	Resources
Training.gov.au	For information about recognised qualifications for the solar industry and registered training organisations that are approved to deliver the training throughout Australia. • Australian register of vocational education and training
Solar Accreditation Australia	Installers are required to install rooftop solar and batteries in accordance with Solar Accreditation Australia (SAA) Installation Guidelines for Accredited Installers and Supervisors. These guidelines are updated regularly to reflect current industry best practice. They may also help explain legislative requirements of installing to AS/NZS 3000 *Electrical installations* (known as the Australian/New Zealand Wiring Rules), AS/NZS 5033 *Installation and safety requirements for photovoltaic (PV) arrays* and AS/NZS 5139 *Electrical installations – Safety of battery systems for use with power conversion equipment*, but cannot override them. • Solar Accreditation Australia
Clean Energy Regulator	The Clean Energy Regulator lists approved solar modules and inverters and sets installation requirements for designers and installers of small-scale solar installations. • Clean Energy Regulator
SafeWork NSW	• Guide to safe solar panel installation I SafeWork NSW • Solar panel retail and installation I SafeWork NSW • Solar Installers Checklist I SafeWork NSW
WorkSafe Queensland	• Construction and operation of solar farms code of practice I WorkSafe QLD • Battery energy storage systems (BESS) | WorkSafe.qld.gov.au.
WorkSafe Victoria	• Working safely at heights during solar installations | WorkSafe Victoria • Working safely when installing PV systems
SafeWork SA	• Managing risk of falls for solar panel installations | SafeWork SA
WorkSafe NT	• Work health and safety requirements for Solar PV installers | NT WorkSafe • Solar PV Batteries – Information for home and business owners | NT WorkSafe
WorkSafe ACT	• Installation of solar panels I WorkSafe ACT • Residential photovoltaic and battery storage inspection process
Industry sponsored guidance	• TS 5398 *Electrical energy storage equipment – Safety requirements* • Advancing Safety Standards in Battery Storage: Launch of Preliminary Tech Spec TS 5398 - Standards Australia

Electrical Regulatory Authorities Council	• Installations resources – ERAC
Clean Energy Council	• Approved batteries | Clean Energy Council. And battery-storage-guide-for-consumers.pdf
Australian Standards	• 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

Table 3 Further advice from jurisdictional fire safety authorities

Who	Resources
NSW Fire and Rescue	• Residential Battery Energy Storage Systems - Fire and Rescue NSW
Fire Rescue Victoria	• Battery safety for industry | Fire Rescue Victoria • Battery safety for consumers | Fire Rescue Victoria
Country Fire Authority	• Renewable Energy Fire Safety | CFA (Country Fire Authority)
Queensland Fire and Emergency Services	• Lithium-ion battery safety | Queensland Fire Department
Western Australia Department of Fire and Emergency Services	• Lithium-ion-batteries | DFES
South Australian Metropolitan Fire Service	• Photovoltaic (PV) Array and Battery Energy Storage Systems | Metropolitan Fire Service
ACT Emergency Services Agency	• Lithium-ion Batteries | ACT Emergency Services Agency
NT Fire and Rescue Service	• Battery energy storage systems | NT Police, Fire & Emergency Services