

Solar Construction Safety



Oregon Solar Energy Industries Association

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Solar Safety Manual Feedback

Errors, omissions, and general feedback on solar safety and this manual are welcome.

If you see something that should be corrected, improved, or added please send an email with your suggestions to: safety@oseia.org and include the Subject line: Safety Manual Feedback.



Introduction

This introduction to solar construction safety provides information to help develop safe work practices for typical solar construction projects including both solar hot water and solar PV installations. In addition to this manual, attending ongoing OSHA and other safety courses can build proficiency in safe work practices.

This manual is intended to be useful to both employers and employees. Employers can use it to develop, deliver, and document training, and employees can use it as a basis for training.

Oregon OSHA requires employees to be trained for the work they do. Completing this course and the review sections at the end of each module tests employees' understanding of the material and the results can be entered into the employees' safety training records.

Employees who work safely and efficiently are more valuable to their employers. This manual helps employees learn the basics of construction safety. This is a good first step and it should be followed up with appropriate safety and first aid courses, such as the free courses offered by Oregon OSHA and other professionals.

Oregon OSHA covers a broad range of safety requirements such as employer emergency plans and first aid kits. This manual points to additional OSHA information to help develop policies to comply with some common OSHA requirements. To comply with Oregon OSHA requirements, business must follow all pertinent OSHA rules. Contact Oregon OSHA for more information on courses, services, and requirements that pertain to your business. See the OSHA contact information at the end of this manual or check: www.orosha.org.

Solar construction safety

Solar construction safety, like general construction safety, requires more than knowledge of safety rules; it requires the ability to evaluate unique situations to actively create safe work practices. This manual presents many common conditions found in typical solar work – both electrical and plumbing. These examples should be used as initial steps toward developing safe work habits for employees and to assist employers in developing appropriate safety policies.

Solar construction crews face many of the same conditions found in typical construction trades with notable exceptions that underscore the nature of both solar electric and solar hot water equipment: exposure to sunlight creates stored energy not present in other construction trades. Managing this energy safely is an important aspect of solar construction.

This manual prescribes the following process to minimize workplace hazards:

1. Evaluate and identify hazards.
2. Eliminate or remove hazards.
3. Control hazards that cannot be eliminated.
4. Recover from accidents

How to use this manual

This material is for training purposes only. Its purpose is to inform Oregon employers and employees of best practices in occupational safety and health and general Oregon OSHA compliance requirements. This material is not a substitute for any provision of the Oregon Safe Employment Act or any standards issued by Oregon OSHA.

Safety is the responsibility of both the employer and the employee. The employer is responsible for ensuring that employees are properly trained and equipped and that they follow the standard safety practices established by the business. The employee is responsible for following safety practices that protect themselves and fellow workers.

This manual provides useful information for both employers and employees:

- Employees can review each safety module and assess their knowledge by completing the review quizzes at the end of each module.
- Employers can use this manual to organize training for employees.
- Employers can use this manual to help document training by assuring that each employee who completes a module also signs and dates the review quiz page. The employer then retains the signed and dated review quiz in the employee's records. For review quiz answers, please see [Review quiz answers](#) on page 107.
- Employers are encouraged to use or modify the review sheets at the end of each module to fit their specific situations.

The safety topics in this manual are presented in task-oriented modules (chapters) associated with the solar industry. Modules can be used independently or grouped together in any way and are not necessarily meant to be used in the order they are presented here. The safety-training needs of each individual should determine which modules are completed.

Each module includes four main sections that cover specific areas associated with developing a proactive safety policy. Each section has a goal and associated symbol as described below. Notice how each section contributes to an overall understanding of safe work practices.



Section 1: Evaluate and identify potential safety hazards and injuries

Knowing how to identify potential safety hazards is critical to understanding potential injuries, preventing accidents, and recovering from accidents.



Section 2: Prevent accidents by using safe work practices

Knowing how to work in a safe manner is critical to preventing and recovering from accidents.



Section 3: Recover from accidents using preplanning

You must be prepared to recover from accidents if they occur. When an accident occurs, it's difficult to think clearly – this is the wrong time to start planning how to recover from the situation.



Section 4: Section review quiz with questions

The section review checks employees' understanding of the material and can be entered into the employee's safety training record to comply with Oregon OSHA training requirements. Review quiz answers are located at the end of the manual.

Oregon OSHA Information

Oregon OSHA information appears in this box.



Safety Tip: Safety tips appear in this box.

Employer information

Successful safety programs have safety policies that are followed. Failure to have policies affects a company's bottom line. Safety policies are ineffective unless they are enforced and reviewed consistently.

This section explains how employers can use this manual to train employees as a part of their effort to comply with OSHA requirements. To review all of the requirements for a specific business, contact Oregon OSHA or check requirements at: www.orosha.org.

Oregon OSHA Information

Oregon OSHA provides Consultation Services to help employers.

Oregon OSHA offers a service that has helped thousands of Oregon employers create safer workplaces and reduce their workers' compensation costs by as much as 60 percent.

Free work site safety, health, and ergonomic consultations, by a trained professional, are available to Oregon employers. Oregon OSHA safety and health professionals across the state provide free consultations at more than 2,000 work sites each year in Oregon. Consultations, conducted at the request of an employer, evaluate any or all aspects of work site occupational safety and health. The employer determines the scope of the evaluation.

Employers receiving a consultation are provided a report summarizing the visit, including recommendations for improvement. Consultations are kept confidential from Oregon OSHA's enforcement program. Check the web at: www.orosha.org/consultation.html for more information.

Training your employees

Oregon employers are required to properly train and supervise workers in the safe operation of any machinery, tools, equipment, processes, or practices which they are authorized to use or apply. Employers are also required to document training (see OAR 437-001-0760 for more information).

Providing sufficient training takes time and effort but it pays off quickly. Avoiding delays and costly accidents are immediate benefits.

There are several ways to train employees:

- Perform the training within the business.
- Send employees to professional training courses such as free classroom training offered by OSHA or first aid training offered by the Red Cross.
- Add to training by requiring that employees complete manuals such as this one.

A combination of training that includes study and both in-house and external courses is recommended to provide a more robust safety policy at your workplace.

When providing safety training in-house, use these guidelines to help employees internalize safety into everyday work habits:

- Conduct training in a non-threatening and controlled environment. For example, don't take a new employee up to a roof top to learn roof safety.
- Conduct training in a safe environment where employees are encouraged to ask questions and they can make mistakes without hurting themselves.
- Assure that in-house training is provided by a competent person as defined by OSHA.

Oregon OSHA Information

Employers must ensure that employees are trained by a competent person to recognize hazards and instruct them to minimize these hazards.

A competent person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

A qualified person means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project.

Proactive safety policies

**The following information is excerpted from Oregon OSHA online course 100. All employers are encouraged to take this online course to learn more about setting up safety policies for business.*

According to the OSEAct, every employer has a legal obligation to provide and maintain a safe and healthful workplace for employees.

Taking risks is part of running a business. You take risks in product development, marketing, and advertising in order to stay competitive. But there are some risks that should never be taken. One of these risks is the safety and health of the employees in the company.

A proactive strategy means taking action to make sure accidents do not happen in the workplace. A proactive response to safety and health in the workplace must occur before an accident can be prevented.

The proactive improvement process first identifies a hazard and anticipates the possible injury. The hazard is analyzed, recommendations proposed, and corrective actions and system improvements are implemented. The proactive improvement process *predicts* in

order to *prevent*. Proactive strategies look forward. By emphasizing accident prevention, management sends a message of caring to all employees. The safety professional attempts to identify and analyze hazardous conditions and unsafe behaviors in order to predict future accidents. Proactive strategies are always less expensive than reactive strategies. Remember, proactive programs are implemented to prevent future injuries and illnesses.

Consider some of the costs associated with accidents and you will quickly find that having a proactive safety policy in place is a smart investment and better for everyone involved. Here are some potential costs associated with accidents:

Consider what one lost workday injury might cost your company in terms of:

- ◆ Production down-time.
- ◆ Productive time lost by an injured employee.
- ◆ Productive time lost by employees and supervisors helping the accident victim.
- ◆ Cleanup and start-up of operations interrupted by an accident.
- ◆ Time to hire or train a worker to replace the injured worker until they return to work.
- ◆ Time and cost for repair or replacement of damaged equipment or materials.
- ◆ Cost of continuing all or part of the employee's wages, plus compensation.
- ◆ Reduced morale among your employees and perhaps lower efficiency.
- ◆ Cost of completing paperwork generated by the accident.
- ◆ OSHA penalties.

According to the National Safety Council, which considers all industries nationally, in 2000 the average direct and indirect cost of a lost time injury was over \$28,000, and a fatality averaged \$980,000. In Oregon, the direct costs to close a disabling injury claim is around \$10,000 and it will cost an average of \$300,000 to close a fatality claim.

Additional safety planning information

A good reference guide for developing sound safety practices for your workplace is available at Oregon OSHA: *A Foundation for a Safe Workplace*; Oregon OSHA. This manual presents an overview of setting up the foundation for safety policies at your workplace and provides sample checklists and forms that you can use for your business. The manual is available for free at the website below:

www.cbs.state.or.us/osha/publications/safetymanagepubs.html



Module 1:

General jobsite safety

This general jobsite safety module presents the starting point for on-the-job safety – developing a proactive approach to safety.

This module introduces the proactive approach that continues throughout this solar construction safety manual. The underlying premise of proactive jobsite safety is that it is ALWAYS safer and less expensive to eliminate and prevent safety hazards.

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Learning objectives

The general jobsite safety module provides:

- ◆ Basic attributes of a proactive safety program.
- ◆ How to create a proactive safety policy in your workplace.
- ◆ General jobsite safety regarding:
 - Personal protective equipment (PPE).
 - Developing a safety plan.
 - Recovering from jobsite accidents.

Safety is an integral part of work done in the solar industry. Working safely is as important as the skills and techniques used with typical construction tools. More valuable employees consider good safety practices to be a skill.

Safe installations are more efficient and cost effective. Using equipment properly and working safely results in less time lost to injuries and the delays they cause, and can prevent fines being assessed from agencies responsible for enforcing workplace regulations.

A proactive approach is the first step on the road to developing safety policies that could save your life or the life of a co-worker.



Safety Tip: Use the following process to minimize workplace hazards:

1. Evaluate and identify hazards.
2. Eliminate or remove hazards.
3. Control hazards that cannot be eliminated.
4. Plan for your recovery from accidents.



Evaluate and identify potential safety hazards and injuries

Learning to evaluate and identify potential safety hazards is a critical first step to eliminating risks and potential injuries. A good understanding of workplace hazards enables you to prevent accidents and recover more quickly if one occurs.

Each workplace presents its own unique set of occupational hazards. Conducting an analysis of your unique hazards:

- Leads to properly identifying safety training needs.
- Helps identify the measures necessary to ensure the workplace is a safe one, such as the need for additional equipment and personal protective gear.
- Helps determine how to eliminate or control hazards before they cause injuries.

To take the first step in identifying hazards, learn the specifics about the work you are going to do, along with when and where it takes place. Following are some examples of questions to consider when evaluating each job and jobsite:

- Are employees trained to perform the job with which they are tasked?
- Are safety policies and procedures in place and enforced?
- Are employees trained on company safety policies and procedures?
- Are you the general contractor or a subcontractor at the jobsite? What safety responsibilities are assigned to each?
- Is required personal protective equipment available and in good condition?
- What prep-work is required prior to the job?
- What are the general jobsite tasks and conditions?
- Are employees working from ladders or roof tops? Is fall protection required?
- What tools are being used to complete the job?
- Are severe conditions such as wet, windy, high heat, or cold weather involved?
- What post-job cleanup and work is required?

Evaluate the specific work situation

It's important to evaluate each specific situation to develop a list of the hazards and the potential injuries that could occur. Understanding the hazards and potential injuries, and the likelihood of an accident occurring, enables you to set up a suitable safety policy for each specific situation.

Use the questions included in the previous section and develop additional questions to help evaluate a typical workday and identify potential hazards. With this information, you can set up safety policies and procedures that reduce the risks associated with identified hazards.

The following examples demonstrate work conditions that construction crews face. Additional situations in your job may need to be addressed. Use these common examples, but analyze your specific situation as well.

Typical construction work situations include:

- Using power tools.
- Working with ladders to access equipment and rooftops.
- Working in very hot or very cold conditions.
- Working with solar hot water collector panels.
- Working with solar electric PV panels.

After evaluating your work situations, identify the hazards and risks associated with those situations. Then select the appropriate action to address the hazard.

The following example identifies hazards and the appropriate actions to address them. Be sure to evaluate your specific situation and identify actions to eliminate and control hazards in each case.

1. Using power tools:

- a. Working conditions include: using many different power tools and power cords on the jobsite.
- b. Hazards include: worn or frayed power cords and power lines (electric shock hazards), objects thrown from equipment such as saw blades (eye injury, laceration, puncture wound, and bleeding hazards), sharp tools (laceration, puncture wound, and bleeding hazards).

⇒ Action: Develop company personal protective equipment policy.

⇒ Action: Eliminate extension cord hazards by using battery operated tools.

⇒ Action: Develop procedures for using power tools and extension cords.

2. Working with ladders to access equipment and rooftops:

- a. Working conditions include: carrying and positioning ladders on walls and rooftops, climbing and working from both step ladders and extension ladders.
- b. Hazards include: lifting hazards from carrying ladders, fall hazards from accidents on ladders, electrical hazards from contact with electrical power lines.

⇒ Action: Develop proper lifting and carrying procedures for ladders.

⇒ Action: Develop proper ladder use policies.

3. Working in very hot weather conditions:

- a. Working conditions include: working in summer on hot rooftops or in hot attic spaces.
- b. Hazards include: dehydration, potential of passing out, heat exhaustion, heatstroke, or death.

⇒ Action: Reduce heat exhaustion risk hazards by working during cooler hours of the day.

⇒ Action: Develop hydration and safe practices while working in hot weather conditions.

4. Working with solar hot water collector panels:

- a. Working conditions include: lifting and moving, installing and performing maintenance on large flat plate collectors and evacuated tube collectors.
- b. Hazards include: lifting heavy and awkward flat plate collectors (lifting hazards), handling collectors that are hot from sitting in the sun (burn hazards).

- ⇒ Action: Eliminate hot collector hazards by covering the collector area with an opaque object.
 - ⇒ Action: Develop policies and procedures for working with solar hot water collectors.
5. Working with solar electric PV panels:
- a. Working conditions include: installing and performing maintenance on solar electric PV panels.
 - b. Hazards include: handling solar electric PV panels in the sun resulting in electric shock.
- ⇒ Action: Develop policies and procedures for working with solar electric PV panels.

The actions listed above will be addressed in the 'Work Safely' section that follows the understanding injuries section below.

Understanding potential injuries from identified hazards

Understanding potential injuries from identified hazards provides you with information to evaluate the risks you are taking.

Serious injuries, including death, result from jobsite accidents. Just a few of the potential injuries from jobsite hazards include:

- Death
- Severe/traumatic/massive head/brain/skull injuries
- Broken/fractured/shattered bones
- Spinal injuries
- Punctured lungs
- Internal organ injuries
- Electrocutation
- Burns
- Heatstroke
- Severe cuts or lacerations
- Serious back or neck injuries
- Puncture injuries from falling onto items
- Eye injuries
- Strains and sprains

Once the jobsite evaluation is complete identifying where and how work is being performed, develop safety strategies to remove or reduce accident risks. The next section discusses how to reduce the risks associated with the identified hazards by eliminating and controlling the hazard situation.



General jobsite safe practices

The previous section describes how to identify jobsite hazards using an example to evaluate potential risk areas for typical construction crew work. With that information, you can begin to develop a strategy to reduce the risks associated with construction crew work.

This section helps you develop strategies to either eliminate or control hazards. Since many construction hazards are difficult to eliminate altogether, most of the suggestions deal with controlling the hazard by developing safe work practices and habits. However, always be on the lookout for ways to eliminate hazards altogether.

The following actions were identified in the previous section:

- ⇒ Action 1: Develop company personal protective equipment policy.
- ⇒ Action 2: Eliminate extension cord hazards by using battery operated tools.
- ⇒ Action 3: Develop procedures for using power tools and extension cords.
- ⇒ Action 4: Develop proper lifting and carrying procedures for ladders.
- ⇒ Action 5: Develop proper ladder use policies.
- ⇒ Action 6: Reduce heat exhaustion risk hazards by working during cooler hours of the day.
- ⇒ Action 7: Develop hydration and safe practices while working in hot weather conditions.
- ⇒ Action 8: Eliminate hot collector hazards by covering the collector area with an opaque object.
- ⇒ Action 9: Develop policies and procedures for working with solar hot water collectors.
- ⇒ Action 10: Develop policies and procedures for working with solar electric PV panels.

Actions 2, 6, and 8 are self explanatory and the smartest way to avoid hazards – by eliminating them altogether.

Actions 4 and 5 are addressed in Module 2 [Lifting safety](#) on page 27 and Module 3 [Ladder safety](#) on page 41. See those modules for methods of controlling lifting and ladder-related hazards.

This section deals with the following actions:

- ⇒ Action 1: Develop a company personal protective equipment policy.
- ⇒ Action 3: Develop procedures for using power tools and extension cords.
- ⇒ Action 7: Develop hydration and safe practices while working in hot sun conditions.
- ⇒ Action 9: Develop policies and procedures working with solar hot water collectors.
- ⇒ Action 10: Develop policies and procedures for working with solar electric PV panels.



Safety Tip: You are the most important factor in preventing accidents from happening! Make sure you understand all the potential safety hazards and the injuries that can result from accidents to ensure that you find ways to keep yourself and others healthy and alive.

Develop a company personal protective equipment policy

Oregon requires employers to provide and to pay for personal protective equipment (PPE) required for the worker to do his or her job safely and in compliance with OR-OSHA standards. The employer must also ensure employees use and maintain PPE in a sanitary and reliable condition.

When employees choose not to comply with PPE rules it usually indicates a failure of the safety management system. Any of the following root causes may result in general non-compliance and potential OSHA fines:

1. Employer does not provide quality PPE.
2. Employer does not properly supervise the use of PPE.
3. Employer fails to enforce the use of PPE.
4. Employer does not properly train employees on the use of PPE.

Oregon OSHA Information

Oregon OSHA standards require employers to furnish and require employees to use suitable protective equipment where there is a “reasonable probability” that injury can be prevented by such equipment. The standards also set provisions for specific equipment.

Employers are required to develop a written PPE program that covers selection, use, maintenance and effectiveness of PPE.

The objective of the Personal Protective Equipment Program is to protect employees from the risk of injury by creating a barrier against workplace hazards. Personal protective equipment is not a substitute for good engineering or administrative controls or good work practices, but should be used in conjunction with these controls to ensure the safety and health of employees.

PPE policies and procedures should be reviewed if an employee appears to need retraining or when introducing new PPE into the workplace. PPE can include the following:

- Eye and face protection (e.g., safety goggles, glasses, face shield, visor).
- Head protection (e.g., hard hats, helmets, hats). Hard hats are required if there is a risk of objects falling onto a person or a risk of hitting your head on an object. For example, if someone is working on the roof above you, you need to wear a hardhat.
- Protection of extremities (e.g., steel-toed shoes, other protective footwear, safety gloves, latex gloves, kneepads).
- Respiratory devices (e.g., respirator, dust mask). These are especially important if you are working around lead paint or asbestos. Masks may be warranted in attic spaces around insulation.
- Hearing protection (e.g., ear plugs, canal caps, ear muffs).
- Protective clothing.

For more information on PPE see the Oregon OSHA online course 203 at <http://www.cbs.state.or.us/osha/educate/training/pages/203outline.html>

Develop procedures for using power tools and extension cords

A power tool used on the job must be maintained in a safe working condition. Employers must designate one or more competent persons to oversee the proper use and maintenance of tools used on the job. In general, equipment, including electrical cords, must be inspected prior to use to ensure it is in safe condition.

Employees must be trained in the proper and safe use of all power tools they use. If maintenance is required, employees must be trained to safely perform that maintenance.

Ground Fault Circuit Interrupter rules apply to construction sites to 125-volt, single-phase, 15-, 20-, and 30-ampere receptacles that are not part of the permanent wiring of a building or structure, this includes use of extension cords. See rules and fact sheet noted below for more detailed information.

See Module 6 [Solar electrical safety](#) on page 91 for more information on electrical safety issues.

See OR OSHA rules: Division 3 subdivision I (tools) and K (electrical) for more details.

See OR OSHA GFCI fact sheet at: www.orosha.org/pdf/pubs/fs14.pdf

Develop hydration and safe practices while working in hot sun conditions

Working in hot conditions can contribute to dehydration, the excessive loss of water from your body. Fluid loss can become severe enough to be life threatening.

Available potable water must be on the jobsite. OR OSHA rule in Division 3 Subdivision D 1926.51 lists detailed information on jobsite potable water requirements.

Water at the jobsite can be provided using a large water thermos such as the one at right.



Develop policies and procedures working with solar hot water collectors

Solar panels become very hot when bright sunlight shines on them. Caution should be used when handling collectors that have been exposed to sunlight. It is difficult to see how hot the collector manifold is until you touch it.

There are several items to keep in mind when handling solar hot water collectors:

- Cover the panels with part of the shipping carton or with an opaque sheet to prevent heat build up.
- Wear gloves.
- Use caution when working with solar panels in the middle of the day.

See Module 5 [Solar plumbing safety](#) on page 81 for more information on working with solar hot water collectors.

Develop policies and procedures for working with solar electric PV panels

Solar electric panels produce electricity when exposed to sunlight. Even overcast days can present enough light to create an electric potential in solar panels. The only method of ‘turning the panel off’ is to remove the energy source: sunlight.

Caution should always be used when handling solar electric panels. Even a mild shock delivered at the wrong time can be dangerous.

See Module 6 [Solar electrical safety](#) on page 91 for more information on working with solar electric PV panels.

Working smart

- **Remain aware while at work.**

Stay actively aware of your work surroundings. If you see unsafe conditions or people working in an unsafe manner; stop and correct the conditions before an accident happens.

- **Know the safety policies at large developments or jobsites.**

If you are working on a large construction site, such as a new development or large commercial job where the solar contractor is a sub-contractor, it is important to meet with the jobsite general contractor to check in and ask about safety policies in place.

- **Working with other contractors?**

Make sure you are fully aware of any work that other contractors are performing at your jobsite. Talk with them and identify any potential safety hazards created by their work.

- **Working in proximity to mobile equipment?**

If there is mobile equipment on the jobsite, make sure you know where the equipment is and when it is being used. For example, if you are working on a ladder and there is a forklift operating nearby, make sure the forklift operator is aware of your ladder location.



Safety Tip:

Whenever you are roping extra equipment or gear onto a roof top the person on the roof pulling the gear up must be tied off properly using appropriate fall restraint gear and practices to prevent a fall.

- **Use a proper tool belt.**

A proper tool belt can save many trips up and down the ladder. A tool belt leaves your hands free to hold onto the ladder and can reduce one jobsite trip hazard (tools lying on walking surfaces). Extra tools and equipment should be safely lifted to work areas such as rooftops using a hoist or rope.

Maintain a clean and safe jobsite

Floors and walkways should be cleared of obstructions and kept dry in order to prevent slips, trips and falls.

Covers and/or guardrails must be used to protect employees from the hazards of open pits, tanks, vats, ditches, etc.



Safety Tip: A cluttered and messy jobsite with lumber remnants, extension cords, tools, and equipment randomly scattered not only looks bad to clients and prospective clients but it also presents severe fall and trip hazards. Clean up your jobsite and keep it as clean as possible throughout the day. An organized jobsite is safer and makes a positive impact on clients.



Recovering from accidents

Emergency planning protects lives, equipment, and property. By planning for emergencies you can increase your ability to act properly to avoid further injury. Do not wait for an emergency to start thinking about how to respond. It is difficult to think clearly during an emergency; training can increase the chances of a proper response.

The future of your business and even the lives of your employees may depend on having an effective plan for emergencies; for small businesses that typically sends only one or two people to a remote jobsite, the importance is even greater.

Preparing a safety-and-health policy

Does your company have a written safety-and-health policy? It should. A written policy reflects commitment to a safe, healthful workplace, summarizes management and employee responsibilities, and emphasizes the program's role in achieving that goal. Keep the policy brief, commit to it, and enforce it.

For more information on preparing a safety-and-health policy, see *Expecting the Unexpected: What to consider in planning for workplace emergencies*, an OR-OSHA Standards and Technical Resources Section publication. This document is available online at <http://www.orosha.org/pdf/pubs/3356.pdf>.

Developing an emergency-response plan

Follow these guidelines to develop a plan for responding promptly to emergencies.

- **Effective plans don't need to be elaborate.**

The plan should show that you've thought about how to eliminate and control hazards, and show workers how to respond promptly if something goes wrong.

- **Get others involved in planning.**

When workers participate in developing the plan, they contribute valuable information, take the plan seriously, and are more likely to respond effectively during an emergency. Key planning objectives include:

- **Identify the emergencies that could affect your site.**

See [Evaluate and identify potential safety hazards and injuries](#) on page 14.

- **Establish procedures for responding to the emergencies.**

Procedures are instructions for accomplishing specific tasks. Emergency procedures are important; they tell workers what to do to ensure their safety during an emergency. The emergency-response plan should include the following procedures—preferably in writing—that describe what people must know and do to ensure that an injured worker receives prompt attention:

- ♦ Reporting an emergency.
- ♦ Rescuing a worker.
- ♦ Providing first aid.

Oregon employers with more than 10 employees must have their plan in writing.

After an emergency, review your procedures; determine if they should be changed to prevent similar events, and revise them accordingly.

See [Safety planning checklist](#) on page 24 for items to consider while developing procedures for responding to emergencies.

- **Identify critical resources and rescue equipment.**

A prompt rescue won't happen without trained responders, appropriate medical supplies, and the right equipment for the emergency.

First-aid supplies: Every jobsite needs medical supplies for common injuries. Does your site have a first-aid kit for injuries that are likely to occur? Store the supplies in clearly marked, protective containers and make them available.

- ♦ Employers should have employees on hand who are trained in basic first aid and CPR even if a hospital or clinic is in near proximity.
- ♦ Adequate first aid supplies should be readily available.
- ♦ The contents of the first aid kit should be placed in a weatherproof container with individual sealed packages and should be checked weekly to ensure that missing items are replaced.
- ♦ In areas where 911 is not available, the telephone numbers of physicians, hospitals or ambulances must be known.

Rescue equipment: Identify on-site equipment that responders can use to rescue workers. Extension ladders and mobile lifts are useful. Determine where and how each type of equipment would be most effective during a rescue.

- **Train on-site responders.**

Those who work at a remote site might need a higher level of emergency training than those who work near a trauma center or a fire department. It is important that someone on-site have training in first aid and CPR.

When an emergency occurs

- **Employee rescues.**

Improperly prepared or trained rescuers can endanger themselves and those they are trying to rescue. Leave rescue work to trained professional responders who are equipped for emergency situations unless it is absolutely necessary to do otherwise.

- **Prompt rescue required.**

“Prompt” means without delay. For example, if a worker is suspended in a personal fall-arrest system, you must provide for a prompt response. A worker suspended in a harness after a fall can lose consciousness if the harness puts too much pressure on arteries. A worker suspended in a body harness must be rescued in time to prevent serious injury.

If a fall-related emergency could happen at your jobsite, have a plan for immediately responding. Workers who use personal fall-arrest systems must know how to promptly rescue themselves after a fall, or they must be promptly rescued.

- **What to do.**

- ♦ Call 911. Tell the dispatcher the workplace location and the nature of the emergency. Know that most 911 responders are not trained to rescue a worker suspended in a personal fall-arrest system. Make sure only trained responders attempt a technical rescue.
- ♦ If you can reach the victim, administer proper first aid if required and you are trained. If you are not trained, now is the time to get training before an accident happens.
- ♦ First responders should clear a path to the victim. Others should direct emergency personnel to the scene.
- ♦ Assist professional medical responders when they arrive.
- ♦ Inform the victim’s supervisor.

After an emergency

- Report fatalities and catastrophes to OR-OSHA within eight hours.
- Report injuries requiring overnight hospitalization and medical treatment (other than first aid) to OR-OSHA within 24 hours.
- Identify equipment that may have contributed to the emergency and put it out of service. Have a competent person examine the equipment. If the equipment is damaged, repair or replace it. If the equipment caused the accident, determine how and why.
- Document in detail the cause of the emergency.
- Review emergency procedures. Determine how the procedures could be changed to prevent similar events; revise the procedures accordingly.

Where to find more information

Following are links to more information on planning for workplace emergencies:

- *Emergency management guide for business and industry*; Federal Emergency Management Agency (FEMA); www.fema.gov/library/bizindex.htm
- *How to Plan for Workplace Emergencies and Evacuations*; U.S. Department of Labor Occupational Safety and Health Administration; www.osha.gov
- Oregon Emergency Management; www.osp.state.or.us/oem
- *Expecting the unexpected – What to consider in planning for workplace emergencies*, an OR-OSHA Standards and Technical Resources Section publication; <http://www.orosha.org/pdf/pubs/3356.pdf>
- *A Foundation for a Safe Workplace*; an OR-OSHA Standards and Technical Resources Section publication; www.cbs.state.or.us/osha/publications/safetymanagepubs.html

Safety planning checklist

While most construction jobs are within easy access to medical care, some construction jobs are in more remote areas. The following items should be considered when you develop procedures for responding to emergencies. Someone who is **not** on the jobsite should know the following:

- How many people are on the jobsite?
- Who knows they are on the jobsite?
- Are they expected to return at a specific time?
- Do they have access to phone service ?
- Are they expected to call in at a specific time?
- Do employees have the proper safety training they need for the work they are doing?
- Do employees have first-aid and CPR training?
- Do they carry a first-aid kit?
- Is there a nearby hospital or clinic?
- Do employees have proper safety gear in good working condition (such as fall protection and other personal protective equipment)?
- Is employee emergency-contact information such as phone number, person to contact, and any pertinent medical information up-to-date and accessible?
- Does 911 work in the jobsite area? If not, do you have another number to call?
- Is this a large construction site where employees must check in with the jobsite manager? What is their emergency plan?



Review quiz: General jobsite safety

The following questions and true or false statements help ensure that you understand the material presented in this module. When you finish, please print your name, sign, and date the quiz.

1. Oregon OSHA requires employees to be trained in the work that they do?
2. Why is it important to identify potential safety hazards at a jobsite?
3. Why is it important to use a proper tool belt?
4. It is important to plan for workplace accidents to increase your ability to act properly to avoid further injury. (T or F)
5. Effective emergency-response plans need to be elaborate. (T or F)
6. 911 is available in all areas. (T or F)
7. Not every jobsite needs first-aid supplies. (T or F)
8. Employers must have employees on hand who are trained in basic first aid and CPR unless a hospital or clinic is in near proximity. (T or F)
9. If 911 is not available in the jobsite area, what should be done before on-site work begins?

Demonstrate the following to the trainer:

- An employee is injured on the job (a fall or other injury). What are the steps taken to address the injury?
- Describe personal protective equipment and provide examples of when it would apply to the work you are doing.

Training subject	Date	Location
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Trainee certification: I have received training on the above subject and completed the Review quiz. This training has provided me adequate opportunity to ask questions and learn safety guidelines to determine and correct skill deficiencies. I understand that using these guidelines and procedures safely is a condition of employment. I fully intend to comply with all safety and operational guidelines discussed. I understand that failure to comply with these guidelines may result in progressive discipline (or corrective actions) up to and including termination.

Employee name	Signature	Date
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Trainer certification: I have conducted training to the employee listed above. I have explained related procedures, practices, and policies. The employee was given the opportunity to ask questions and practice procedures taught under my supervision. Based on the employee's performance, I have determined that the employee has adequate knowledge and skills to safely perform these procedures and practices.

Trainer name	Signature	Date
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Module 2:

Lifting safety

Lifting is one of the most common tasks, and unfortunately it is often performed incorrectly. Although lifting objects can cause various injuries, back injuries are the most common. Lifting hazards are a serious problem when you consider how debilitating a back injury can be. Back injuries do not heal quickly and can last a lifetime.

Fortunately, risks associated with lifting can be dramatically reduced with knowledge, training, and proper lifting technique.

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Learning objectives

The lifting safety module presents:

- ◆ The hazards associated with lifting.
- ◆ Effective lifting techniques.
- ◆ Recovering from lifting-related accidents.

Prevention of back injuries is a major workplace safety challenge. According to the Bureau of Labor Statistics (BLS), more than one million workers suffer back injuries each year, and back injuries account for one of every five workplace injuries or illnesses. One-fourth of all compensation indemnity claims involve back injuries, costing industry billions of dollars on top of the pain and suffering borne by employees.

Lifting, placing, carrying, holding, and lowering are all involved in manual materials handling (the principal cause of compensable work injuries). The BLS survey shows that four out of five of these injuries were to the lower back, and that three out of four occurred while the employee was lifting.

In Oregon, sprains or strains of the back are still the most common injury accounting for more than 5,000 claims of the more than 25,000 claims accepted as disabling.

The average cost of a claim that results from a lifting injury is approximately \$8,000 in direct cost. The estimated direct and indirect cost for these injuries ranges from \$16,000 to \$80,000 per claim.

The direct cost to Oregon employers for sprains or strains of the back could easily cost \$40,000,000 per year (5000 x \$8,000). The indirect cost (between 1 and 10 times the direct cost) could reach as much as \$400,000,000 per year.



Safety Tip: As with other workplace hazards, use this process to minimize lifting hazards:

1. Evaluate and identify lifting hazards.
2. Eliminate or remove lifting hazards.
3. Control lifting hazards that cannot be eliminated.
4. Recover from accidents.



Evaluate and identify lifting-related safety hazards

When you understand how and why lifting injuries occur, you can better analyze your unique work situations and develop risk-reduction strategies.

This section covers basic causes of lifting injuries with a focus on back injuries. This is not meant to be an exhaustive list of causes or potential hazards. You are encouraged to take courses offered by OSHA to learn more about proper lifting technique.

This section presents an example evaluation to identify some lifting hazards for construction crews followed by a review of back injuries.

Evaluate your lifting-related hazards

To establish safe lifting policies and procedures that reduce the risks associated with lifting, it's important to review your work tasks and identify where and how you move objects on the job. This section helps identify example action items that are addressed later in the section [Procedures for lifting safely](#) on page 30. You may come up with additional situations that need to be addressed. Use these common examples, but also analyze your unique situation thoroughly.

Typical lifting issues for solar contractors include:

- Carrying and moving heavy tools and equipment.
- Loading and unloading equipment and tools from truck.
- Lifting tools and equipment onto a roof.

After identifying where, when, and how you lift objects, determine what actions can reduce the hazards associated with lifting.

1. Carrying and moving tools and equipment.
 - a. Working conditions include: carrying large equipment and tools around the jobsite.
 - b. Hazards include: using improper lifting techniques or carrying awkward and heavy objects causing cumulative trauma or strains and sprains.⇒ Action: Develop proper procedures for lifting and carrying.

2. Loading and unloading equipment and tools from the truck.
 - a. Working conditions include: loading and unloading ladders, tools, solar equipment.
 - b. Hazards include: using improper lifting techniques causing cumulative trauma or strains and sprains.⇒ Action: Develop procedures for loading and unloading vehicles.

3. Lifting tools and equipment onto a roof.
 - a. Working conditions include: lifting tools and equipment onto roofs.
 - b. Hazards include: using improper lifting techniques causing cumulative trauma or strains and sprains.⇒ Action: Eliminate lifting by using a crane to hoist equipment onto the roof.
⇒ Action: Develop safe lifting policies for moving items onto roofs.

The actions listed above will be addressed in the 'Work Safely' section that follows the understanding injuries section below.

Understanding potential lifting-related injuries

Lifting-related injuries can be serious and debilitating. They include sprains, strains, muscle pulls, hernias, bone-related injuries, and back injuries. While all of these can and do happen, back injuries make up the vast majority of injuries related to lifting.

Two primary back injuries are associated with more common lifting risks:

- **Cumulative trauma injuries:** Although cumulative trauma can be associated with repetitive stress, the focus here is on cumulative trauma injuries caused by lifting in awkward positions or using improper lifting technique over a period of time. Unhealthy lifting technique over time can weaken or injure backs.

Cumulative trauma lifting injuries caused by awkward and improper lifting techniques are related to your posture. Lifting objects with poor posture can increase the stresses on your back bones (spine), tendons, and muscles. Additional stresses are placed on your spinal discs when twisting while lifting instead of lifting with a straight back. Working frequently above shoulder height can be particularly stressful.

- **Strains and sprains:** Strains and sprains are sudden injuries caused by improperly lifting or lifting too heavy an object. Lifting improperly by jerking the object (a sign that you are lifting something too heavy) is a major cause of sprains and strains.

Leading lifting injury factors

Major factors in lift-related injuries include:

- Your physical conditioning.
- Exceeding your physical capacity.
- Improper lifting techniques.

Address these three factors by staying healthy, knowing your limits, and lifting properly to reduce your risks associated with lifting.



Procedures for lifting safely

The previous section describes lifting related safety hazards and how they occur with an example of evaluating potential risk areas for solar contractors. This section develops a strategy to reduce the risks associated with lifting hazards. It continues the example from the previous section, reviewing the action items and developing strategies to either eliminate the hazard or control it. Since many of these construction hazards are difficult to eliminate altogether, most of the suggestions deal with controlling the hazard by developing safe work practices and habits. However, you should always be on the lookout for creative ways of eliminating hazards altogether.

The following actions were identified in the previous section:

- ⇒ Action 1: Develop procedures for proper lifting and carrying.
- ⇒ Action 2: Develop procedures for loading and unloading vehicles.
- ⇒ Action 3: Eliminate lifting by using a crane to hoist equipment onto the roof.
- ⇒ Action 4: Develop safe lifting policies for moving equipment onto roofs.

To address these actions, this section provides details on the following topics:

1. Preventing back injuries.
2. Eliminate and control lifting hazards when possible.
3. Develop safe lifting procedures.
4. Procedures for loading and unloading vehicles.
5. Lifting and rooftops.
6. Working smart.

Lifting safely means doing the right things at the right time; gauging limits based on physical health and using proper lifting technique. Staying in shape and maintaining a healthy weight both affect your ability to reduce risks associated with lifting injuries.

Although exceeding limits is a personal issue, companies can help by setting general company lifting guidelines and policies. However, guidelines can't replace intuition and experience with what an individual is capable of lifting. Asking for help lifting is often the safest bet, and company policy should encourage employees to help each other with lifting.

Preventing back injuries

Since lifting puts your back at risk, it makes sense to use your back properly and take steps to protect it.

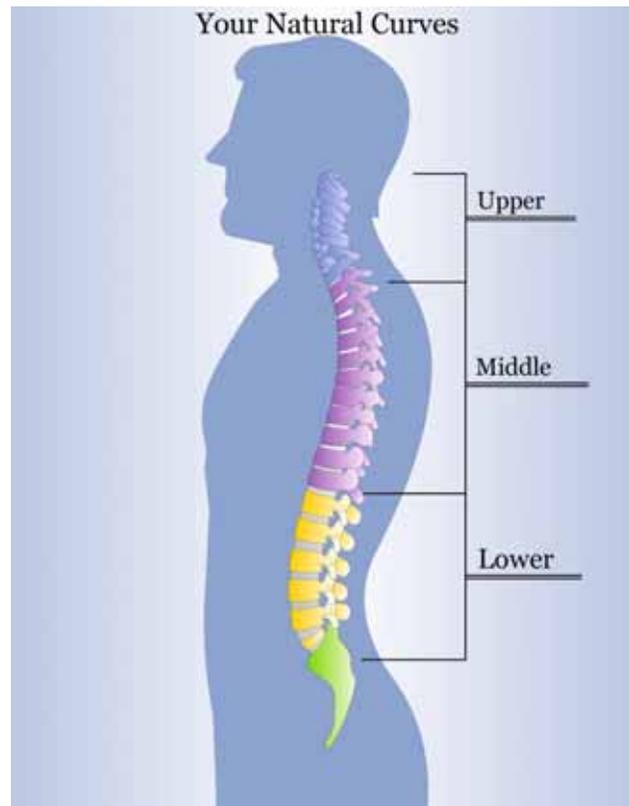
Your spine has three natural curves that correspond to the upper curve (your neck area), mid curve, and lower curve. These three curves form an 's' shape when you are in a correct standing or sitting position.

When you stand straight, your spinal curves are balanced and your weight is evenly distributed throughout your spine. This is your strong back position. One of the keys to lifting properly is maintaining these curves throughout the entire lifting process (picking objects up, walking, and putting objects back down).

Practice finding your strong back position prior to lifting and get a sense of the correct posture. One method to learn the correct posture uses these easy steps:

1. Stand straight with your hands at your sides.
2. Imagine a string at the top of your head pulling gently up.

When you do these steps properly, your chin tucks slightly and you may stand a tiny bit taller. That's all there is to it. You should **not** be standing ram-rod straight like a soldier at attention. Correct posture is a relaxed but strong posture; you feel the appropriate muscles engage slightly and you feel the proper back alignment that you need to maintain while lifting. This is a balanced position where your back is strongest.





Safety Tip: Practice Good Posture

Spend a few seconds every day to practice finding your back position and the natural curves of your back; make maintaining those curves throughout your workday a habit.

Whether sitting, standing, or lifting, maintaining the natural curves in your back is key to reducing back injuries.



Another way to know when your back is in its balanced position is when you can form a straight line from your ears to your shoulders to your hip. As you sit there reading these words, is your back balanced and aligned properly? What do you need to do to align them? For most people that includes sitting up straighter and tilting your pelvis forward to realign the lower curve in your back.

Eliminating and controlling lifting-related hazards

One of the best ways to reduce lifting injuries is to use equipment to do the lifting for you. Cranes, hoists, and forklifts can be smart ways of eliminating lifting injuries.

Using cranes, hoists, or forklifts can be more important when lifting large commercial equipment. Lifting large equipment by hand, even with several people, can be dangerous and lead to major injuries caused by dropped equipment. When working with large and heavy equipment, rent a crane and use a forklift if needed.

To prevent back strains and sprains from slips, trips and falls, floors and walkways should be dry and clear of obstructions. A cluttered and messy jobsite with lumber remnants, extension cords, tools, and equipment randomly scattered not only looks bad to clients, but it also presents severe fall and trip hazards. Clean the jobsite and keep it clean throughout the day. An organized jobsite is safer and makes a positive impact on clients.

Safe lifting procedures

Remember these three simple guidelines while lifting:

- Lift with your legs.
- Maintain your curves.
- Don't twist – when lifting and carrying, move your feet in the direction you are moving without twisting. Your torso will follow naturally.

Proper lifting procedures – maintain your curves

Follow these steps when lifting:

1. Stand close to the object with your feet about shoulder-width apart. (It is OK to put one foot behind the object and the other next to it.)
2. Squat down, maintaining your curves.
3. Grip the object securely.



4. Lift slowly (without jerking) using your legs and maintain your curves.
5. Once you are standing, **do not twist** when you change directions. Move your feet in the direction you want to go and your body will naturally follow with less twisting of your torso.



NOTE: To lower the load or place the object, use these same guidelines in reverse.

Procedures for loading and unloading vehicles

Loading and unloading vehicles is a repetitive task performed daily. Any repetitive task like this should be evaluated to find ways to minimize stress on the body.

The following are suggestions for reducing risks associated with loading and unloading vehicles:

- Load heavy items last in an accessible position to avoid pushing them far into the bed of a vehicle
- Integrated tool chests in vehicles that are easily accessible can make the job of loading and storing tools and equipment easier.
- Store or carry tools and equipment in the shop on a mobile utility cart for easy unloading and loading vehicles. Tools and equipment can be transferred to and from the bed of a truck and the upper shelf of a mobile cart without bending.



- Always use two people to lift and load large and heavy items.



Lifting and roof tops

Solar panels, especially hot water panels, can measure 4ft x 10ft. They are heavy and awkward. Getting these panels onto rooftops is a dangerous job. Ladder-based winch systems are available that can handle the weight of these panels. Whenever using one of these devices, always adhere to the manufacturer's guidelines.

Lifting items to and from a roof is always a challenge, so it's important to find a method that works for the individual. Using hoisting methods and nylon straps may work for some instances. However, when hoisting items onto upper surfaces, always use proper fall restraint equipment to prevent a fall.

Common sense is always an important ingredient to safety. If you are struggling to get a piece of equipment onto a roof – regardless of whether it is heavy, awkward, or both – then find a safer method! Working on rooftops presents enough safety hazards without adding to them.

If the equipment is difficult to handle safely by hand then find another method of getting it to the roof. Use a crane or other mechanical means of lifting such as a winch or block and tackle.

A safer method of getting panels onto difficult rooftops is to hire an experienced crane operator. Crane lifts should always be performed by experienced personnel and hardhats must be worn.



Working smart

Look for smart ways to plan and control the work environment.

- **Eliminate twisting.**

Because twisting while lifting is bad for your back, try to position yourself so that after you pick up the object you can move straight to that location. If this isn't possible, then move in the direction you're headed by changing the position of your feet instead of twisting your back.

- **Place objects off the floor.**

It is easier and safer to lift from an elevated surface. When you know an object will be lifted later, put it down on a table or other elevated surface instead of on the floor.

- **Lower or raise shelves.**

Store objects between waist and shoulder height. The heaviest objects should be stored at waist level.

- **Use dollies and/or carts.**

When moving objects, instead of carrying them, use a dolly or cart. Always remember that it is better to push dollies and carts than to pull them.



- **Stretch first and stretch often.**

Take the time to stretch your muscles before lifting and stretch frequently throughout the day.

- **Slow down.**

Take it slow if you are doing a lot of heavy, repetitive lifting. Allow recovery time between lifts. "Don't overdo it."

- **Get in shape.**

Strengthen your muscles, lose weight if you are overweight, and increase your flexibility. All of these activities can help reduce the probability of a back injury.

- **Listen to your body!**

Feeling discomfort or pain is an indication that something is wrong! Combinations of awkward posture, force, repetitions, and insufficient rest periods are a set up for injury.

Take more frequent “mini-breaks” before you become fatigued. Become aware of mounting stresses, aches, and pains.



Safety Tip: Loosen up before you lift.

Make it a habit to stretch and loosen up before unloading or lifting.

To “warm up” after long transits to the jobsite, perform a walk-around safety inspection of the jobsite prior to lifting heavy items from your vehicle.

During your jobsite inspection, check for:

- Trip and slip hazards.
- Location of other workers on the site.
- Unprotected openings in the roof.
- Other safety hazards.

Effective lifting techniques.

- Lift with your legs
- Do not exceed your physical ability.
- Provide adequate recovery time for tasks that require frequent lifting.
- Provide easy access so the load is in front of the person lifting.

- Eliminate twisting by changing the start or end point of the lift.
- Put items to be lifted between waist and shoulder height
- Lift items close to your body to reduce the stress on your lower back





Safety Tip:

Reduce the weight of the object whenever possible.

Use handles and lifting straps.

Get help if the object has an awkward shape or is too heavy for you to lift or move by yourself.

Oregon OSHA Information

What about back belts?

It's important that you understand that back belts should not be considered personal protective equipment (PPE) in that they physically "protect" you from back injuries.

Devices such as back belts are not recognized by OR-OSHA as control measures to prevent back injury. While they may be accepted by individual workers because they feel as if they provide additional support, if used improperly, they may restrict the body's range of motion and possibly aggravate other ergonomic stressors in the job. Research indicates that the primary value in back belts, when used properly, is that they "remind" the employee to use proper lifting techniques. As a result, fewer back injuries occur. Thus, OR-OSHA does not forbid the use of back belts and similar devices, nor does it endorse their use.



Recovering from lifting-related accidents

Solar contractors sometimes work with small crews in isolated jobsites. Because lifting-related accidents can cause incapacitating injuries, it is crucial to have a plan to deal with emergencies.

Emergency planning protects lives, equipment, and property. By planning for emergencies you can increase your ability to act properly to avoid further injury. Do not wait for an emergency to start thinking about how to respond. It is difficult to think clearly during an emergency; training can increase the chances of a proper response.

In addition to the following information on recovering from lifting-related accidents, please see [Recovering from accidents](#) in Module 1, General jobsite safety on page 21.

What to do

This manual is not meant to provide information leading to self-diagnosis. Back and lifting-related injuries can be complex and very difficult to evaluate.

If an injury occurs, the following suggestions are recommended:

1. Stop working immediately.
2. Assess the pain level and nature of injury.
3. Note that workplace injuries need to be assessed by a qualified physician in order to qualify for workers compensation insurance. Your company should have standard injury reporting guidelines and policies.
4. While it may be possible to continue work in the same or a reduced capacity, working with pain can make an injury worse. If you do not know the extent and specific cause of an injury, continuing to work is risky and can lead to further injury. If you are injured, have your injury assessed by a medical professional who can provide advice to help you manage and recover.



Review quiz: Lifting safety

The following questions and true or false statements help ensure you understand the material presented in this module. Please print your name, sign, and date the review when you are finished.

1. Back injuries account for one of every five workplace injuries or illnesses. (T or F)
2. Most back injuries are the result of a single factor. (T or F)
3. Back belts are considered personal protective equipment (PPE) by OR-OSHA. (T or F)
4. Name three points of proper lifting technique.
5. How many natural curves are in your back?
6. It is easier and safer to lift from an elevated surface. (T or F)
7. Stretching should be done once at the end of the day. (T or F)

Demonstrate the following to the trainer:

- Demonstrate your neutral strong back position.
- Properly lifting an object from the floor, moving it a short distance and placing it back down.

Training subject

Date

Location

Trainee certification: I have received training on the above subject and completed the Review quiz. This training has provided me adequate opportunity to ask questions and learn safety guidelines to determine and correct skill deficiencies. I understand that using these guidelines and procedures safely is a condition of employment. I fully intend to comply with all safety and operational guidelines discussed. I understand that failure to comply with these guidelines may result in progressive discipline (or corrective actions) up to and including termination.

Employee name

Signature

Date

Trainer certification: I have conducted training to the employee listed above. I have explained related procedures, practices, and policies. The employee was given the opportunity to ask questions and practice procedures taught under my supervision. Based on the employee's performance, I have determined that the employee has adequate knowledge and skills to safely perform these procedures and practices.

Trainer name

Signature

Date



Module 3:

Ladder safety

Solar construction sometimes involves working on roof structures and ladders. Unfortunately, ladders are often used improperly in the construction industry resulting in a high rate of accidents. Using ladders properly helps save time, money, and possibly lives.

This module contains the following sections:

Evaluate and identify ladder safety hazards	43
Evaluate your ladder hazards	43
Understanding potential injuries from ladder hazards	44
Procedures for working safely with ladders.....	45
Selecting the correct ladder for the job	46
Transporting and carrying ladders	49
Develop procedures to use ladders properly.....	50
Ladder inspection form.....	51
Working smart.....	58
Recovering from ladder accidents	60
What to do	60
Review quiz: Ladder safety	61

Learning objectives

The ladder safety module presents:

- ◆ The hazards associated with ladder use.
- ◆ Selecting the proper ladder for the job.
- ◆ Inspecting ladders prior to use.
- ◆ Setup and securing the ladder properly.
- ◆ Using ladders properly.
- ◆ Recovering from ladder accidents.

Oregon OSHA Information

Employers must ensure that employees are trained by a competent person to recognize hazards related to ladders and instruct them to minimize these hazards by training on proper use, load carrying capacities, placement and care in handling.

A competent person means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

A qualified person means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter, the work, or the project.



Evaluate and identify ladder safety hazards

Each year sees more than 164,000 emergency room injuries relating to ladders, according to the U.S. Consumer Product Safety Commission. Working with ladders can cause anything from mild sprains, to serious back injuries, to death.

Solar contractors typically use ladders to access roof areas. It is a common misconception regarding ladder safety that care only needs to be taken when heights are involved. Accidents by their very nature are unexpected and a surprise fall from any height can force you to land on harmful items lying nearby or land in an awkward position that can cause serious injuries or death.

Because of the unexpected nature of falls, even falling from lower heights of six feet or less can cause serious back or neck injuries, puncture injuries from falling onto hazards, or broken bones and twisted ankles.

A major source of accidents involves improper setup and use of ladders. All employees using ladders must be properly trained to avoid serious injury or death.

Evaluate your ladder hazards

Review the work day and identify where and how ladders are used. Then develop a safe ladder use policy and procedures to reduce the risks associated with ladders.

The following example of a typical construction situation provides the starting place for evaluating unique risks in your work day. Use these common examples, but also analyze your own situation to identify additional risks in your job.

Ladder use in typical construction work situations can include:

- Using ladders for various tasks at the jobsite.
- Loading and unloading ladders and carrying ladders to work area.
- Climbing ladders to access roofs.
- Climbing ladders to work on wall-mounted equipment.
- Using ladders to rest or hang tools and equipment on.

After you evaluate your work situation related to ladder use, identify the hazards and risks associated with those situations. Then decide what action is needed to address the hazard.

1. Using ladders for various tasks at the jobsite.
 - a. Working conditions include: accessing roofs, working on wall-mounted equipment, working on many different height levels.
 - b. Hazards include: using an inappropriate ladder (fall hazard, shock hazard).
- ⇒ Action: Select the correct ladder for the job.

2. Loading and unloading ladders and carrying ladders to work area.
 - a. Working conditions include: lifting onto truck and carrying ladders to the work area.
 - b. Hazards include: lifting hazards from carrying ladders.⇒ Action: Develop proper procedures for carrying ladders.

3. Climbing ladders to access roofs.
 - a. Working conditions include: positioning ladders to reach rooftops, climbing up onto and down from roofs.
 - b. Hazards include: setting up in unsafe areas, fall hazards from accidents on ladders, electrical hazards from contact with electrical power lines.⇒ Action: Develop safe ladder use procedures for accessing the roof.

4. Climbing ladders to work on wall-mounted equipment.
 - a. Working conditions include: setting up the ladder properly, climbing up and down safely.
 - b. Hazards include: setting up in an unsafe area, setting up improperly, not securing the ladder properly, not climbing up or down properly, resulting in falls.⇒ Action: Develop safe ladder practices for working from ladders.

5. Using ladders to rest or hang tools and equipment on.
 - a. Working conditions include: working on ladders and resting tools on the top of step ladders or on the steps of any ladders.
 - b. Hazards include: items falling from ladder resulting in impact-related injuries.⇒ Action: Eliminate tool falling hazard by not using ladders to store your tools.
⇒ Action: Use a ladder or equipment specifically designed for tools.

The actions listed above will be addressed in the ‘Work Safely’ section that follows the understanding injuries section below.

Understanding potential injuries from ladder hazards

Because of the unexpected nature of falls, *even falling from lower ladders of six feet or less* can result in the following injuries:

- Death.
- Serious back, neck, torso, or limb injuries.
- Puncture injuries from falling onto items.
- Broken bones and twisted ankles.

Tools falling from ladders can result in significant injuries:

- Eye injuries.
- Puncture and bruise injuries to the head.



Procedures for working safely with ladders

Ladders should always be used according to manufacturer guidelines. Check the ladder for warnings, rated use, and instructions. If proper information is not available, note the model and check with the manufacturer for proper use instructions and to ensure it is rated for the work you are doing.



The previous section described ladder hazards using an example to evaluate potential risk areas for typical construction crew work. Now it's time to develop a strategy to reduce the risks associated with ladder use.

This section helps you develop strategies to either eliminate or control the hazard. Since many construction hazards are difficult to eliminate altogether, most of the suggestions deal with controlling the hazard by developing safe work practices and habits. However, always be on the lookout for ways of eliminating hazards altogether.

The following actions were identified in the previous section:

- ⇒ Action 1: Select the correct ladder for the job.
- ⇒ Action 2: Develop proper procedures for carrying ladders.
- ⇒ Action 3: Develop safe ladder use procedures for accessing the roof.
- ⇒ Action 4: Develop safe ladder use practices for working from ladders.
- ⇒ Action 5: Eliminate tool-falling hazards by not using ladders to store tools.
- ⇒ Action 6: Use a ladder or equipment specifically designed for tools.

To address these actions, this section provides details on the following topics:

- Selecting the correct ladder for the job.
- Transporting and carrying ladders.
- Develop procedures to use ladders properly.
- Working with tools while using ladders.
- Working smart.

Selecting the correct ladder for the job

An important first step for safety is to use the proper tool for the job. Construction crews use ladders daily. Ladders come in different sizes and designs that are specific to tasks. Choosing the correct ladder for a specific task is as important as using the correct hammer. You wouldn't use a ball peen hammer for framing work – choose and use the correct ladder for the work you will be doing.

Selecting the right type of ladder

Ladders are intended and built for a specific purpose and should always be used as intended. Three ladder types are typical in the construction industry:

- **Step ladder**

Step ladders are versatile free-standing ladders. Step ladders are designed to be used in the fully 'open' position. Step ladders are not designed to be used to gain access to another level such as a rooftop and should never be used for this purpose. Nor should step ladders ever be used in the folded position leaned up against a wall or other structure.



- **Straight ladder**

Straight ladders are the most basic ladder design and because of this are normally lighter and easier to maneuver into place. Size limitation is a common barrier to using straight ladders. Use a straight ladder only when it is long enough to properly reach your work. When used properly, straight ladders can be used to work from or to gain access to another level such as a rooftop.



- **Extension ladder**

Extension ladders are similar to straight ladders and normally used to reach higher areas. Extension ladders have a 'base' section and a movable 'fly' section. When used properly, extension ladders can be used to work from or to gain access to various levels and rooftops.





Safety Tip: Make it a habit to plan ahead. Know the type of work you are going to do and make sure the proper ladder is available. This prevents you from getting to the jobsite with the wrong equipment and either creating delays or, worse yet, producing a situation where you use the wrong ladder in an unsafe manner.

Choosing the correct ladder work-load rating

Ladders are rated according to the weight-bearing load they are designed for, according to ANSI and OSHA standards as follows:

Ladder Use	ANSI Rating	Performance Load*
Special Duty (commercial use)	Type IAA**	375 lbs
Extra Heavy Duty (commercial use)	Type IA**	300 lbs
Heavy Duty (commercial use)	Type I	250 lbs
Medium Duty	Type II	225 lbs
Light Duty	Type III	200 lbs

*Ladder performance rating includes the combined weight of the user plus materials. For example: Type IA ladders: the combined weight of you and any equipment you have on should not exceed 300 lbs.

**Type IA or Type IAA-rated ladders are recommended for construction work. Check the manufacturer’s information located on your ladders to verify the performance-load rating.

Selecting the right ladder material

The main consideration for selecting proper ladder material is whether it will be used near electricity. If electrical lines or energized equipment are anywhere near the jobsite and the ladder can come into contact with it, choose a ladder with non-conductive side rails such as fiberglass. **Never use aluminum or other metal ladders near electrical work.**

Aluminum and fiberglass are the most commonly used ladder materials today and recommended for most construction work. Both materials are available in the different ANSI ratings listed above.

While wood ladders are still in use, they are more susceptible to weather and wear damage and are not recommended for construction use.



Safety Tip:

Never use a metal ladder near electrical lines or equipment. Always look up prior to raising a ladder to ensure no overhead powerlines are present.

Choosing the proper ladder length

Choose the ladder length based on the contact point where your ladder touches the roof line or wall. Keep in mind that the ‘size’ of the ladder is not the ‘working height’ of the ladder. For example, a typical 24-foot extension ladder should only be used on a roof line of 17 ft or lower.

Three primary issues regulate the ladder working height:

- Overlap for extension ladders.
- The safe standing level on the ladder.
- The extension of the ladder above the roof line when accessing the roof.



Safety Tip: When selecting a straight or extension ladder, choose a length that extends a minimum of 3 ft above the rung you need to stand on to work from. When using extension and straight ladders, the fourth rung from the top is the highest rung to climb to or work from.

Extension ladder sections must overlap from 3 to 5 ft depending on the size of the ladder. Check your manufacturer’s recommendations to ensure the correct overlap.

Extension ladder length	Overlap
Up to 36 ft	3 ft
36-48 ft	4 ft
48-60 ft	5 ft

Ladder Size	Example Maximum Working Height	
	Working on wall	Accessing Roof
16 ft	13 ft	9 ft
20 ft	17 ft	13 ft
24 ft	21 ft	17 ft
28 ft	24 ft	21 ft
32 ft	29 ft	25 ft

Oregon OSHA Information

Ladders must extend at least 36 inches above an elevated surface you are accessing, such as a roofline when used to access the roof. This provides a safe hand hold when stepping onto or off of the ladder.

Transporting and carrying ladders

Transport and carry ladders properly to maintain the good working condition of the ladder and to protect your back from injuries.

Use proper lifting techniques illustrated in Module 2 [Lifting safety](#) on page 27 when lifting ladders. If the ladder is too heavy to comfortably lift and place onto your truck, get help. Ladders can be heavy and should be picked up and carried with care.

- Carry ladders horizontally when moving them into place.



- Use two people to move and position ladders whenever possible.



- Make it a practice to load everything onto the truck first except for the heavy awkward items such as ladders—then get a helping hand to complete loading the ladder. Once a ladder is in the truck, secure it properly to keep it from moving around—you need to use strong bungee cords or tie-down straps that can cinch tightly to prevent movement. While chains may be needed to prevent theft of the ladder, they typically cannot prevent the ladder from bouncing around during transit, which can damage the ladder.



Develop procedures to use ladders properly

This section will cover the issues noted below starting with the ladder inspection form.

Using ladders properly includes:

- Inspecting ladders prior to every use.
- Setting up and securing the ladder.
- Using ladders safely.

The inspection form on the following page is provided to print and use for your company. This inspection form is derived from the Werner Ladder inspection form (www.wernerladder.com).

Ladder inspection form

Ladders should be inspected prior to each use and after any incident that could affect its safe use. If a ladder is found to be damaged, it should be properly tagged "DO NOT USE". Ladders with defects should be repaired or disposed of properly.

Step Ladder Inspection:

		YES	NO
Steps:	Loose, bent, or missing	<input type="checkbox"/>	<input type="checkbox"/>
Rails:	Cracked, bent, split or frayed	<input type="checkbox"/>	<input type="checkbox"/>
Labels:	Missing or not readable	<input type="checkbox"/>	<input type="checkbox"/>
Top:	Cracked, loose, or missing	<input type="checkbox"/>	<input type="checkbox"/>
Spreader:	Loose, bent, or broken	<input type="checkbox"/>	<input type="checkbox"/>
General:	Rust, corrosion, loose	<input type="checkbox"/>	<input type="checkbox"/>
Other:	Bracing, both shoes, rivets	<input type="checkbox"/>	<input type="checkbox"/>
Condition:	Dirt, oil, or other material on steps or rails	<input type="checkbox"/>	<input type="checkbox"/>



Circle Areas of Damage

Actions:

- Ladder tagged with "DO NOT USE" and removed from service
- Ladder is in good condition

Straight or Extension Ladder Inspection:

		YES	NO
Rungs:	Loose, cracked, bent, or missing	<input type="checkbox"/>	<input type="checkbox"/>
Rails:	Cracked, bent, split, or frayed	<input type="checkbox"/>	<input type="checkbox"/>
Labels:	Missing or not readable	<input type="checkbox"/>	<input type="checkbox"/>
Rung Locks:	Loose, stuck, bent, missing, or broken	<input type="checkbox"/>	<input type="checkbox"/>
Rope & Pulley:	Pulley loose, bent, rope frayed or cut	<input type="checkbox"/>	<input type="checkbox"/>
Hardware:	Loose, bent, or broken	<input type="checkbox"/>	<input type="checkbox"/>
Shoes:	Worn, broken, missing, dirty, slippery	<input type="checkbox"/>	<input type="checkbox"/>
Other:	Bracing rivets missing or loose	<input type="checkbox"/>	<input type="checkbox"/>
Condition:	Dirt, oil, or other material on rungs or rails	<input type="checkbox"/>	<input type="checkbox"/>



Circle Areas of Damage

Actions:

- Ladder tagged with "DO NOT USE" and removed from service
- Ladder is in good condition

Inspector: _____ Date: _____

Setting up and securing the ladder

Once you select the correct ladder for the job and inspect it, you're ready to set it up for use. Ladder setup includes these basic issues:

- Proper site placement.
- Positioning the ladder properly.
- Securing the ladder in place.

Choosing the proper site to set up your ladder

In solar construction work, you typically access the roof near the solar installation. If the ladder cannot be securely placed directly at the location of the installation, look for a safer location. A safe ladder location is level and out of walkway areas and doorways. The location should enable you to safely access the installation once you are on the roof.

ALWAYS stay at least 10 ft away from overhead power lines when setting up a ladder.

Assess the roof line from the ground and search for the optimum location to place the ladder. You may need to walk around the house or building to assess different roof access points. Keep in mind that, once on the roof, you need to move to location of the solar installation; part of your consideration for the safe placement of the ladder must include your safety when moving from the ladder to the location of the solar installation.

Ladders should not be placed in walkways. If there is no other choice than to position a ladder near a walkway or door, then barricade all traffic areas near the ladder. Doorways should be locked, barricaded, or guarded by another person.



Safety Tip: when looking for a proper ladder setup site, you can use this time to perform a safety walk-around.

Note:

- Trip and slip hazards.
- Location of other workers on the site.

Positioning the ladder properly

Once you identify the best location to access the roof, set up the ladder:

- Prior to raising a ladder, check the area for electrical wires, tree limbs, or other obstructions.
- The preferred method to raise an extension ladder into place involves two people. One person can hold the base of the ladder by placing their foot on the bottom rung. The second person raises the ladder, walking the ladder up one rung at a time until the ladder is vertical.
- This process is similar to the one shown below, raising the ladder with one person. A wall is used to 'foot' the ladder instead of a person.
- If you have difficulty raising a ladder into place it is sometimes possible to rest the ladder feet against the base of the wall you are working on.
- Place the sliding 'fly' part of the extension ladder face down,
- Starting at the top of the ladder, walk toward the wall while raising the ladder one rung at a time.
- Once the ladder is in position the sliding 'fly' section will be up and facing in the correct position



- A properly raised ladder will have an angle of about 75 degrees. Place your toes at the feet of the ladder and, standing straight, reach out and you should be able to grab a rail in front of you in a properly positioned ladder.



Safety Tip: Use the “stand and reach method” to get the proper angle of the ladder. This is an easy method to approximate the 4-1 rule, which positions your ladder at the proper angle.

A ladder at too steep an angle is unstable and increases your chances of falling backwards while your climbing it.

Too shallow of an angle and the ladder can slide out from under you or reduce its rated capacity and bend, bounce, or break while you're climbing it.



- You can also use the rungs of the ladder to help estimate proper setup. The rungs on most ladders are about 1 ft apart. If accessing the roof, make sure your ladder extends at least 36 inches above the roof line. A ladder with the standard 1 ft spacing has a minimum of 3 rungs extending above the roof line when accessing the roof.

The ladder can be extended higher than 36 inches if needed to increase the grab point when accessing or departing the roof. Four or five feet may be more appropriate for some roofs. Regardless of how high the ladder, it will be more secure if you fasten it to the roofline with a lashing or cord.



- Once an extension ladder is raised into place in its proper face-up position, make sure it is level and stable. There are two sides to a ladder. Make sure the ladder is facing in the proper direction. The moveable fly section will be ‘up’ and the base section ‘down’ in a properly positioned extension ladder.



- If the area where you must place the ladder is not level, use a manufactured leveling device instead of rigging something up on your own. If you are using leveling devices attached to the ladder, make sure to follow the manufacturer's directions.

Using a manufactured leveling device that is rated for the loads you are putting on the ladder is safer than piling objects under one of the ladder rails. Piling objects under a rail is NOT a safe method of leveling a ladder.

- If your ladder is located in dirt or grass you may be able to dig out under the rails to level the ladder. This is safer than piling objects under one of the rails as discussed above.



- Once an extension ladder is in place and raised to the desired level, make sure that both rung locks are set properly.
- You should be able to put your full weight on the first rung of the ladder without it shifting. If the ladder shifts or indicates that it is not stable, then reposition the ladder until it is stable.
- Both feet of the rails should rest evenly on the ground, and both top rails should rest squarely on the wall or roofline.



Safety Tip: During the bidding process, the company should note the height of the roofline, if there are any electrical lines nearby, and any other circumstances that affect the ladder setup (leveling). By noting these items ahead of the actual work, the installation crew can take the proper ladder and tools to safely complete the job.

Securing the ladder

Oregon OSHA requires that ladders be secured against tipping. Many ladder accidents occur because of improperly secured ladders. There are several quick methods to secure the ladder.

While a ladder can be deemed 'secure' if it is properly placed and on dry and level ground, it is usually safer to physically secure the ladder in place, especially when accessing a roof.

The base of the ladder can be secured in several ways and there is no defined method of doing so. However, general practice is to tie the base to the ground to prevent it from moving when you access the ladder from the roof.

Oregon OSHA Information

Ladders must be 'secured' when used on the job. Wind, pushing, or pulling on the ladder have all resulted in ladders and people falling from rooftops.

If the ladder base is resting on grass or dirt, use stakes in the ground near the ladder feet to anchor the ladder.

If the ladder base touches concrete or a hard surface where stakes are not practical, use the best method available. One possible method is to add stakes close to the building where open ground is present and run a line to the ladder, including a caution marker if needed.

The photos at right show a twist stake that can be reused and installed quickly.



Secure the top of your ladder on your first trip up. Securing the top of the ladder is critical when accessing the roof. This is one of the most dangerous areas when working with a ladder.

One method of securing the top of the ladder is shown in the photo at right and below using a nylon strap, screw and large washer.

The nylon is wrapped several times around an appropriate rung then secured to the fascia with an appropriate screw and washer.





If it is not possible to secure a ladder using anchors then a person can stand at the base of the ladder and secure it manually against slipping.

Having a co-worker hold the ladder when you are climbing can be another good method of securing the ladder.



Using the ladder safely

After the ladder is properly secured in place, it is ready for use. These practices make your time on the ladder more efficient and safe:

- Always face the ladder when climbing up or down.
- Never exceed the rated capacity of the ladder and use only as designed. (For example, never use a step ladder as a straight ladder). Consult the manufacturer's recommendations for more information.
- The areas near the bottom and top of the ladder must be kept clear to avoid tripping or falls.
- Never move, 'walk' or 'jog' a ladder while you are on it. Climb down first and then reposition the ladder.
- Ladders should not be used in windy conditions.
- Only one person should be on a ladder at one time.
- Maintain a 3-point contact when working from a ladder.
- Do not climb while holding something in your hands – use your tool belt to carry tools. If you need to move equipment to the roof that cannot be fastened or carried safely in a tool belt, tie off properly, using fall protection, and use a rope or hoist to raise and lower tools and other objects.



Safety Tip: Never climb on, or work from, the top two steps of a step ladder.

Never step on, or work from, the top three steps of straight and extension ladders.

- Whenever working on energized equipment or near power lines, use caution and fiberglass ladders. Never use metal or aluminum ladders near electricity – and remember, no one, for any reason, is allowed within 10 feet of an overhead power line.
- Raised ladders should never be left unattended. When your workday is finished, even if the total job isn't, take down and secure all ladders.
- Climb ladders with shoes that have slip-resistant soles.
- When working from the ladder, always work within an arm's reach from the ladder. While working, keep both feet on the rungs and use your belt buckle as a guide to keep your weight centered on the ladder during all times. With both feet on the rungs, your belt buckle should never stray outside of the side rails.



Working smart

Even a secure ladder that is the right choice for the job can be a safety hazard if tools are improperly stored or temporarily rested on it. Storing equipment on ladders is unsafe! Tools and equipment can easily fall when you move the ladder, causing injury or damage.

If you need access to tools on a ladder, use a tool pouch or storage unit that was designed to fit onto a ladder. Tool pouches fit securely on ladders and hold tools in place. They are large and more likely to remind you to remove them from the ladder prior to moving it.

Working smart with ladders can include the following items:

- Identify ladder needs before going to a job site to ensure you have the right equipment for that job.
- Never use a metal ladder near electrical power lines or circuits.
- Develop procedures to:
 - Inspect ladders before each use and after dropping.
 - Check the ladder material and rating to be sure it is the right ladder.
 - Assess the roof to locate any hazards and find the best place to set up the ladder.
 - Set up and secure the ladder for each use

- This Safe-T ladder extension from Guardian safety presents a new and easy way to effectively extend the reach of a ladder for a few feet and provides an easier method of getting onto and off of rooftops.

The two photos at right show how the person walks through the opening instead of around as they would with a standard ladder.



- Many manufacturers offer ladder leveling devices. These devices are essential when you're working on harder surfaces such as concrete that cannot be altered by digging.



- Working over gutters can be another challenging task. Using a stand-off device such as the one shown here can save gutters and time.



- When using extension ladders placed on dirt or grass areas you can flip the shoes to enable the spurs to bite into the dirt and provide some added stability. Not all ladders have shoes with spurs that are made for both hard surfaces and soft surfaces. When purchasing a ladder, buy a quality one with these dual purpose shoes.





Recovering from ladder accidents

Solar contractors sometimes work with small crews in isolated jobsites. Because ladder falls can cause incapacitating injuries, it is crucial to have a plan to deal with emergencies.

Emergency planning protects lives, equipment, and property. By planning for emergencies you can increase your ability to act properly to avoid further injury. Do not wait for an emergency to start thinking about how to respond. It is difficult to think clearly during an emergency; training can increase the chances of a proper response.

In addition to the following information on recovering from ladder accidents, please also see [Recovering from accidents](#) in Module 1, General jobsite safety on page 21.

The following safety planning checklist provides guidelines for your company safety plan:

- Communicate expected return and call in times with a main office or other person not at the jobsite.
- Make sure there is phone access at the jobsite. If there is no phone access, work with another person at the site, or at the very least, assure that someone expects you to return by a certain time.
- Someone at the jobsite should have first-aid and CPR training.
- Carry a first-aid kit.
- Find out and note the locations of any nearby hospitals or clinics.
- Make sure your employee emergency-contact information, such as phone number, person to contact, and any pertinent medical information, is up-to-date and accessible.

What to do

If you fall from a ladder the following actions are suggested by the American Academy of Orthopedic Surgeons*:

- Calmly assess the situation, and determine if you are hurt.
- Get up slowly if you're able.
- If you feel that an injury has occurred that prevents standing or walking, don't panic. Call for assistance. If the injury is serious, call 911.
- If you are not injured, rest a while and regain your composure before continuing.

**Climb it Safe!* brochure available at: www.aaos.org/



Review quiz: Ladder safety

The following questions and true or false statements help to ensure that you understand the material presented in this module. Please print your name, sign, and date the review when you are finished.

1. Can a step ladder be used to access the roof?
2. How can you tell if the ladder is set up at the proper angle?
3. When using a ladder during construction work, under what conditions is it required to be secure against tipping?
4. How many points of contact should you have when working from a ladder?
5. The body should be centered between the rails of a ladder while climbing or working from the ladder. (T or F)
6. Ladders are safe in windy conditions. (T or F)
7. When should ladders be inspected?
8. You can safely carry objects while climbing a ladder. (T or F)
9. An aluminum ladder should not be used when?

Demonstrate the following to the trainer:

- Properly lifting and carrying a ladder.
- Proper ladder setup.
- Properly climbing a ladder.

Training subject

Date

Location

Trainee certification: I have received training on the above subject and completed the Review quiz. This training has provided me adequate opportunity to ask questions and learn safety guidelines to determine and correct skill deficiencies. I understand that using these guidelines and procedures safely is a condition of employment. I fully intend to comply with all safety and operational guidelines discussed. I understand that failure to comply with these guidelines may result in progressive discipline (or corrective actions) up to and including termination.

Employee name

Signature

Date

Trainer certification: I have conducted training to the employee listed above. I have explained related procedures, practices, and policies. The employee was given the opportunity to ask questions and practice procedures taught under my supervision. Based on the employee's performance, I have determined that the employee has adequate knowledge and skills to safely perform these procedures and practices.

Trainer name

Signature

Date



Module 4:

Fall protection and jobsite trip hazards

Fall protection and trip hazards relate to roof work, ladders, and general jobsite conditions. Although falls from roofs and ladders are obviously hazardous, you don't have to fall far to be seriously injured.

Falls are always unexpected; even falls from a low height or from tripping are dangerous accidents. A fall from a ladder or rooftop, or tripping on jobsite debris, can result in landing in an awkward position and falling onto potentially hazardous objects.

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Learning objectives

The fall and trip safety prevention module describes:

- ◆ Hazards associated with working on roofs and falling.
- ◆ The definitions of fall protection and the different fall-protection systems.
- ◆ Basic introduction to implementing fall-protection systems.
- ◆ Recovering from roof and fall-related accidents.

RELATED MODULE: Solar contractors typically use ladders to access roof areas. Roof safety and fall prevention go hand in hand with working safely on ladders. Therefore it is important to also complete Module 3 [Ladder safety](#) on page 41.

Use the following process to minimize fall hazards:

1. Evaluate and identify fall hazards.
2. Eliminate or remove fall hazards.
3. Control fall hazards that cannot be eliminated.
4. Recover from accidents.

Oregon OSHA Information

OR-OSHA Division 3/Subdivision M covers fall protection for the construction industry.

Fall protection systems must meet the criteria in OR-OSHA Div3/Sub M 29CFR 1926.502 Fall Protection Systems Criteria and Practices.

OR-OSHA requires employers to train workers to use fall-arrest systems and other personal protective equipment correctly while performing their jobs, in accordance with fall protection standards in Division 3 Subdivision M.

See Oregon OSHA's Division 3 standards webpage for more info:
www.orosha.org/standards/div_3.html



Evaluate and identify fall and trip safety hazards

Fall and trip hazards include anything in the workplace that could cause an unintended loss of balance and result in a fall. To take the first step in identifying hazards, learn the specifics about the work you are going to do, along with when and where it takes place. Consider the following questions when evaluating each job and jobsite:

- General jobsite
 - Is construction debris scattered randomly at the site?
 - Are extension cords or other ropes or lines present?
 - Are floor or ground areas slippery from oils, ice, water or other substances?
 - Is the jobsite kept clean and orderly?
 - Do any of the 6-foot fall exceptions apply? (See the Oregon OSHA Information box in the section [Fall-protection systems](#) on page 69.)
- Ladders
 - Are appropriate ladders being used for the task?
 - Are they in good working condition?
 - Are employees trained to use them properly?
- Roof areas
 - How are you getting onto and off of the roof?
 - Does the 10-foot rule apply? (See the Oregon OSHA Information box in the section [Fall-protection systems](#) on page 69.)
 - Are there skylights or unprotected holes someone can fall through?
 - Are trip hazards present (such as vent pipes, tools laying around, other equipment, etc.)?
 - Is the roof slippery (moss, rain, snow, ice, etc.)?

Evaluate your fall and trip hazards

The purpose of identifying fall hazards is to determine how to eliminate or control them before they cause injuries.

Fall prevention is more than just being safe on ladders and roof tops. Falls leading to serious injuries can happen anywhere, thus the jobsite evaluation needs to address potential falls wherever they may happen.

Trip hazards, such as debris or tools lying on the ground or on walking surfaces, can lead to injuries such as sprained ankles but can also increase the risk of falling. Trip hazards on rooftops create an unsafe environment that can lead to falls from the roof.

Following is an example of a typical scenario that construction crews may face. You may come up with additional areas in your job that need to be addressed. Use these common examples, but analyze your own situation as well. By reviewing your work day and identifying potential fall hazards, you can create a fall hazard risk-reduction strategy for your situation.

Some typical fall and trip hazards include:

- Tripping on jobsite debris, cords, or equipment.
- Working with ladders.
- Working from heights.

This example evaluation of construction site hazards helps identify the actions needed to address them. These action items are addressed in the following section [Safety procedures for fall and trip hazard protection](#) on page 67.

1. General jobsite trip hazards
 - a. Working conditions: clutter, equipment, and cords are trip hazards on the jobsite including the prep area at ground level and roof level.
 - b. Hazards include: trip hazards resulting in fall-related injuries. These can occur on ground level or on roof tops.

⇒ Action: Eliminate trip hazards by removing the debris.

⇒ Action: Develop clean jobsite and work area practices.
2. Ladder and roof area fall hazards
 - a. Working conditions include: climbing onto and off of rooftops and working on rooftops.
 - b. Hazards include: falls from ladders or roofs resulting in fall-related injuries.

⇒ Action: Train employees on ladder safety practices. See [Procedures for working safely with ladders](#) on page 45.

⇒ Action: Eliminate roof and ladder hazards for employees not required to be on roofs and ladders.

⇒ Action: Develop and train employees on fall-protection policies and procedures.

The actions listed above will be addressed in the ‘Work Safely’ section that follows the understanding injuries section below.

Understanding potential injuries from fall and trip hazards

Falling from even the smallest heights can result in serious injuries, including death.

Nationally, falls are the leading cause of work-related deaths among construction workers (33.2% of construction fatalities in 2002 were due to falls) and approximately 70,000 serious injuries a year result from falls. Furthermore, work-related fatalities from falls in all industries have increased from 600 in 1992 to 810 in 2001.

In Oregon, falls were the second-leading cause of death in all industries in 2001. Over the last 10 years, Oregon has averaged five fatalities and over 4000 serious injuries a year from falls—following only sprains/strains as the leading cause of accepted worker’s compensation claims.

Just a few of the potential injuries from fall hazards include:

- Death.
- Severe/traumatic/massive head/brain/skull injuries.
- Broken/fractured/shattered bones.
- Spinal injuries/ internal organ injuries.



Safety procedures for fall and trip hazard protection

Fall protection means more than equipment. Fall protection includes the actions you take to eliminate fall hazards, to prevent falls, and to ensure that workers who may fall aren't injured.

Planning for fall hazards, maintaining a clean jobsite, using personal fall-protection gear, and planning for emergencies will form the basis of your fall risk-reduction strategy.

Fall-protection definitions:

- **Fall protection:** What you do to eliminate fall hazards and to ensure that workers who may fall aren't injured – includes fall prevention.
- **Fall prevention:** Fall prevention and protection are often used interchangeably. In this manual the term 'fall prevention' is used to describe measures that prevent falls. These measures include any means used to reasonably prevent exposure to fall hazards, either by eliminating work at elevation, using aerial lifts, scaffolds, work platforms with guardrails, or using similar prevention measures.
- **Fall-protection systems:** Systems that arrest or prevent falls from occurring. These systems include all potential fall-protection systems.
- **Personal fall-protection systems:** Systems that arrest or prevent falls from occurring. These systems include personal protection systems designed for individual use.
 - **Fall arrest:** Arresting or stopping a fall after a fall happens.
 - **Fall restraint:** Preventing falls from happening by restricting the movement of an individual to the safe working surface away from an edge or fall exposure.

The previous section described trip and fall hazards using an example to evaluate potential risk areas for typical construction crew work. Now it's time to develop a strategy to reduce the trip and fall risks.

This section helps you develop strategies to either eliminate or control the hazard. Since many construction hazards are difficult to eliminate altogether, most of the suggestions deal with controlling the hazard by developing safe work practices and habits. However, you should always be on the lookout for ways of eliminating hazards altogether.

The following actions were identified in the previous section:

- ⇒ Action 1: Eliminate trip hazards by removing the debris.
- ⇒ Action 2: Develop clean jobsite and work area practices.
- ⇒ Action 3: Train employees on ladder safety practices. See [Procedures for working safely with ladders](#) on page 45.
- ⇒ Action 4: Eliminate roof and ladder hazards for employees not required to be on roofs and ladders.
- ⇒ Action 5: Develop and train employees on fall-protection policies and procedures.

Action 1 is self explanatory and the smartest way to avoid hazards – by eliminating them altogether. Use a proper on-site dumpster to clean up construction debris and keep unused tools stored in tool bags.

Action 3 is addressed in the ladder safety section. See that section for more information on that subject.

Action 4 can be addressed by setting up a company policy to only allow required and trained personnel on ladders and roofs. This eliminates the hazards for those that do not need to access roofs or use ladders.

This section will address actions 2 and 5 by covering the following sections:

1. Develop clean jobsite and work area practices.
2. Fall protection policies and procedures.
3. Personal fall-protection systems.
4. Working smart.

Develop clean jobsite and work area practices

Having a clean worksite makes sense from a safety standpoint and in presenting a positive image to your clients. From the job start to finish, having a cleaner worksite with no trip hazards lying around is safer. Below are several potential means of cleaning up a worksite. You should develop policies that are adhered to and enforced.

- Maintain a clean and orderly jobsite. Do not allow construction debris to be randomly scattered at the jobsite. If debris is present, use a construction debris dumpster.
- Use proper tool boxes, tool belts, and storage devices to prevent tools from lying randomly throughout the jobsite.
- Put barriers around hazardous areas that physically block entrance to the hazard.

Fall protection policies and procedures

NOTE: Persons taking this course should not be considered trained in the use of fall-protection equipment nor considered a competent or qualified person for purposes of installing a fall-arrest system without further training and experience in that field. Likewise, all persons must be further trained to use fall-arrest equipment in strict adherence with individual manufacturers' instructions and according to safe work practices. This material, or any other material used to inform employers of compliance requirements of Oregon OSHA standards through simplification of the regulations should not be considered a substitute for any provisions of the Oregon Safe Employment Act or for any standards issued by Oregon OSHA.

Adequate fall protection cannot be learned from a manual alone. Employers must ensure that employees exposed to fall hazards are trained by a competent person to recognize and minimize those hazards.

A comprehensive fall protection course is outside the scope of this manual. This manual will cover some of the basics of fall protection and encourage you to take further training available from OSHA and professional training courses.

Working safely on rooftops takes more than technical fall protection training. Common sense should also be used to address fall hazards, such as: if it's raining or snowing or icy, do something else that day instead of getting onto an unsafe roof.

An important aspect of fall hazard prevention is planning. The elements below should be incorporated into your company fall protection policies and procedures. At least one person at your company should be a competent person that can train others in the details of fall protection safety.

Fall hazard prevention includes the following elements:

- Evaluate the work site to identify fall hazards.
- Eliminate the hazard if possible.
- Identify the actions needed to address remaining hazards.
- Develop fall-prevention and fall-protection measures to be used for each hazard identified.
- Educate and train the workers.

See *OR OSHA Document #301: Introduction to Fall Protection* for more complete information.

Fall-protection systems

The following table and subsequent sections describe fall-protection systems. For more detailed information on these fall-protection systems, please see OR OSHA rules: Division 3 Subdivision M (Fall protection).

Typical fall-protection systems used by solar installers	
Types of fall-protection system	What it does
Personal fall-arrest system	Arrests your descent after a fall occurs
Personal fall-restraint system	Prevents a fall from occurring
Guardrail system	Prevents a fall from occurring

Oregon OSHA Information

The 10-foot rule:

OR-OSHA Division 3/Subdivision M [Fall Protection] OAR 437-003-1501 requires employers to ensure that fall-protection systems are provided, installed, and implemented when employees are exposed to a hazard of falling 10 feet or more to a lower level.

Six-foot exceptions:

Fall protection must be provided when employees are exposed to the following hazards of falling 6 feet or more:

1. Holes (such as openings or skylights workers could fall into).
2. Wall openings.
3. Established floors, mezzanines, balconies and walkways with unprotected sides or edges.
4. Excavations.

Dangerous equipment note:

Employees must be protected from falls into or onto dangerous equipment regardless of height!

Slide-guard systems:

OR-OSHA requires employers to ensure that slide-guard systems, and their use, comply with the provisions located in Division 3 Subdivision M, OAR 437-003-3502.

See OAR 437-003-3502 for complete information on the conditions and requirements for using them. They must be installed under the supervision of a competent person.

NOTE: Although technically you may be able to use slide guards for fall protection, in general, although slide guards can enhance other fall-protection measures, when used alone slide guards are NOT recommended or considered adequate protection by many professionals in the industry.

What are personal fall-arrest systems?

A personal fall-arrest system consists of an anchorage, connectors, and a full-body harness that work together to stop a fall and to minimize the arrest force. Other parts of the system may include a lanyard, a deceleration device, and a lifeline. Personal fall-arrest systems must attach to the rear D-ring.



The anchorage for a fall-arrest system must support at least 5,000 pounds. The personal fall-arrest system is effective only if you know how all of the components work together to stop a fall. Getting professional training in proper use of fall-arrest gear is highly recommended.



What are personal fall-restraint systems?

Unlike the personal fall-arrest system, which is designed to stop a fall, a personal fall-restraint system prevents a worker from reaching an unprotected edge to prevent a fall from occurring. The system consists of an anchorage, connectors, and a body harness or a body belt. The attachment point to the body belt or full-body harness can be at the back, front, or side D-rings.

The anchorage for a fall-restraint system must support at least 3,000 pounds or be designed and installed with a safety factor of at least two. If you're not sure how much an anchorage will support, have a qualified person evaluate it.

What are guardrail systems?

A guardrail system consists of a top rail, mid-rail, and intermediate vertical member. Guardrail systems can also be combined with toe boards that prevent materials from rolling off the walking/working surface.

Guardrail systems must be free of anything that might cut a worker or snag a worker's clothing. Top rails and mid-rails must be at least one-quarter-inch thick to reduce the risk of hand lacerations; steel or plastic banding cannot be used for top rails or mid-rails.

For more information see Appendix B in Division 3 Subdivision M – GUARDRAIL SYSTEMS NON-MANDATORY GUIDELINES FOR COMPLYING WITH §1926.502(b).

Personal fall-protection systems

The harness shown at right is commonly used for fall arrest in solar construction safety. Since this protection is commonly used on residential roofs, it is best to use a harness such as this. Note that the D-ring attaches only in the back of this vest.

The properly donned harness illustrates all buckles securely fastened and leg straps properly snug. If a fall should occur, this setup will assist in protecting your body during the fall.

Note that rigging up improperly provides a false sense of security. If your safety harness is not set up properly, it will probably not protect you during a fall. The forces on the harness that occur from even a short distance can cause injury in a well fitted harness. Wearing an improperly fitted harness during a minor fall could lead to tragic consequences. Take a few extra seconds and put your harness on properly.



Using fall-restraint systems

Fall restraint systems prevent you from falling over or off of an elevated surface. These systems stop you short before you get to the edge of an elevated surface. A properly used fall restraint system prevents you from getting to the roof edge no matter where you work on the roof. In residential construction, it is rare that a pure fall restraint system will work under all residential roof conditions. For this reason, a fall-arrest system is preferred.

A fall restraint system is more likely appropriate in solar installations on a commercial buildings with larger flat roofs. Workers can be protected from unprotected edges by properly using a fall restraint system that prevents them from reaching the edge.

Using fall-arrest systems

Fall-arrest systems protect you after a fall. They are designed to 'arrest' or stop your fall safely, before you impact the ground or a surface below the one you are working on. In order to perform properly, fall-arrest systems must be used properly.

The best method of learning to use fall-arrest systems properly is to take a professional course from a trained individual. Always follow manufacturers directions for the system you use.

The figure at right shows the shock absorber of a fall-arrest system that is ready to deploy (top) and the same system after deployment (bottom). The deployed system lengthened several feet while absorbing the shock of a fall.



The figure at right shows a retractable fall-arrest system. Be sure to use these systems according to manufacturers directions. These can enhance fall protection by offering innovative solutions but usually have design limits such as a limit on the slope of a roof that it can be used on.



Important points to remember when using fall-arrest systems:

- Inspect your gear properly to ensure it will protect you when needed.
- A fall-arrest anchor must be capable of supporting 5000 lbs for each worker.
- A full body harness with a D-Ring located in the mid back near shoulder level must be used.
- Your full body fall-arrest harness must be correctly worn. A loosely donned harness will not protect you properly if you fall.

- Only locking snap hooks and carabineers can be used for fall-arrest connectors.



- You must ensure that your fall-arrest system is properly adjusted for height – a system with too much line allowing you to hit the ground before it stops your fall is worthless. You must add the line length, your height, plus the elongation of the shock absorber section and take the anchorage point into consideration. If you are constantly moving on a rooftop you may need to use a retractable fall-arrest system or adjust your lanyard appropriately to ensure your system will stop you before you hit the ground.
- Prompt rescues should be planned for after a fall. Fall-arrest harnesses are designed to stop your fall and reduce injuries – they are not designed to hang in for extended periods of time. Hanging in a body harness can lead to suspension trauma leading to serious further injuries. Prompt rescue is essential for fall-arrest protection.
- Follow the manufacturers guidelines for the equipment you are using and always make sure the full system includes compatible components.

Oregon OSHA Information

OR-OSHA rules allow no more than a 6-foot free fall for fall-arrest systems.

This is important as the longer you fall the greater the forces that are exerted on you. A free fall that is arrested after you fall more than 6 feet can exert enough force on your body to cause great body injury – even if your fall-arrest shock absorber deploys. Limiting your free fall distance is an important concept to properly using fall arrest.

Working Smart

- **Cover holes.**

Simple and effective when they are properly installed, rigid covers prevent workers from falling through skylights or temporary openings and holes in walking/working surfaces.

- **Use fences and barricades.**

Fences and barricades are warning barriers, usually made from posts and wire or boards that keep people away from hazards such as wells, pits, and shafts.

- **Identify fall hazards that you *can* eliminate.**

Eliminating a fall hazard is the most effective fall-protection strategy. Ways to eliminate fall hazards include:

- ♦ Perform construction work on the ground before lifting or tilting it to an elevated position.
- ♦ Install permanent stairs early in the project so that workers don't need to use ladders between floors.
- ♦ Use tool extensions to perform work from the ground.

- **Identify fall hazards that you *can't* eliminate.**

If you can't eliminate fall hazards, you need to prevent falls or control them so that workers who might fall are not injured.

- ♦ Ways to prevent falls include covers, guardrails, handrails, perimeter safety cables, and personal fall-restraint systems.
- ♦ Ways to control falls include personal fall-arrest systems, positioning-device systems, and safety-net systems. Use these fall-protection systems only when you can't eliminate fall hazards or prevent falls from occurring.

- **Ensure that existing guardrails and covers meet Subdivision 3/M requirements**

Guardrails must be designed and built to meet the requirements of 1926.502(b). Covers must meet the requirements of 1926.502(i).

- **Determine whether anchorages are necessary**

If workers use personal fall-arrest or restraint systems, they need secure anchorages for their lifelines or lanyards. Anchorages for personal fall-arrest systems must be able to support at least 5,000 pounds per attached worker or be designed by an engineer with a safety factor of at least two—twice the impact force of a worker free-falling 6 feet. Anchorages for personal fall-restraint systems must be able to support at least 3,000 pounds per attached worker or be designed with a safety factor of at least two—twice the peak anticipated dynamic load.

- **Get professional training**

Training from a fall protection professional can be invaluable. Learning how personal fall protection gear should be used and when to use it is as important to your job as acquiring continuing education on the equipment you're installing. Like other gear, fall-protection equipment changes and improves over time. Make it a habit to stay current with fall protection training.

- **Use good tool bags to prevent trip hazards**

Use good organizers that will not spill on roof tops. Many of these bags can be tied off on steeper roofs if needed.

- Buckets do not belong on rooftops! They present safety hazards if they tip over and spill their contents onto people standing below.



- The CLC storage bag at right is great for holding screws, bolts, nails, and other small items often used in solar construction.



- The CLC tool bag at right is great for holding tools used often in solar construction. It has a rectangular bottom that resists tipping over on roof tops.



- The CLC tool bag at right is great for holding tools. Many of these bags have D-rings as well that allow you to rope the bag to the roof instead of carrying them.



- NOTE: when roping items onto rooftops the person on the roof pulling the gear up must be tied off with appropriate fall restraint gear!

Oregon OSHA Information

When is fall protection needed?

The fall protection requirements 10-foot rule along with the 6-foot and dangerous equipment exceptions are clear and simple. Unfortunately jobsites vary widely and present many seemingly gray areas. In the end, your life, and/or your employee's lives depend on making the right decision.

Keeping in mind the requirements noted above, when you look at your particular jobsite you must answer the question: is there a potential fall hazard present? If the answer is yes, noting the requirements above, then fall protection is required. Fall protection is required for all exposure to falls with respect to the 10-foot, 6-foot, and dangerous equipment requirements.

A detailed questions and answers from OR-OSHA to further interpret and clarify Oregon OSHA fall-protection standards is available at:

<http://www.cbs.state.or.us/external/osha/interps/2002/vertaccsystech.pdf>



Recovering from fall and trip accidents

Solar contractors sometimes work with small crews in isolated jobsites. Because falls can cause incapacitating injuries, it is crucial to have a plan to deal with emergencies.

Emergency planning protects lives, equipment, and property. By planning for emergencies you can increase your ability to act properly to avoid further injury. Do not wait for an emergency to start thinking about how to respond. It is difficult to think clearly during an emergency; training can increase the chances of a proper response.

In addition to the following information on recovering from fall and trip accidents, please see [Recovering from accidents](#) in Module 1, General jobsite safety on page 21.

If a fall-related emergency could happen at your jobsite, have a plan for responding to it immediately. Workers who use personal fall-arrest systems, especially if they work alone, must know how to promptly rescue themselves after a fall or they must be promptly rescued.

Prompt rescue required

If a worker is suspended in a personal fall-arrest system, OSHA requires that employers must provide for "prompt rescue of employees in the event of a fall or shall ensure that employees are able to rescue themselves." "Prompt" means without delay. A worker suspended in a harness after a fall can lose consciousness if the harness puts too much pressure on arteries. A worker suspended in a body harness must be rescued in time to prevent serious injury.

Rescuing yourself after a fall

Recovery from a roof fall where you're hanging 20 feet off the ground from your fall-arrest gear could be very difficult if you're by yourself. How do you lower yourself to the ground without a plan?

While self rescue is an option it takes training and practice under the supervision of a qualified trainer. If you find yourself hanging high off the ground with no method of getting down, it will not only be a hassle, it could also become dangerous. Fall-arrest gear is designed to stop your fall. It is not designed to sit in for periods of time. These personal protection rigs can cut off circulation and cause serious medical issues. It's important to get safely down from your fall as soon as possible.

Self-rescue training is outside the scope of this training manual. Attend OSHA and safety manufacturers training courses to learn more on this topic.

For further information see the following references:

The following publication includes a section on self rescue:

<http://www.lni.wa.gov/wisha/publications/FallProtectionEmergencies.pdf>

Oregon OSHA publications:

Fall protection for the Construction Industry

Take OR-OSHA course 301: Introduction to Fall Protection



Review quiz: Fall protection and jobsite trip hazards

The following questions and true or false statements help to ensure you understand the material presented in this module. Please print your name, sign and date the review when you are finished.

1. Falls are the leading cause of work-related deaths among construction workers. (T or F)
2. A fall hazard is anything in the workplace that could cause an unintended loss of balance or bodily support and result in a fall. (T or F)
3. What is the purpose of identifying roof and fall safety hazards?
4. What factors can increase the risk of falls?
 - a. Tasks exposing workers to overhead power lines
 - b. Using scaffolds, ladders, or aerial lifts on unstable or uneven ground
 - c. Working during hot, cold, or windy weather
 - d. Working extended shifts that could contribute to fatigue
 - e. All of the above
5. What is fall protection?
 - a. Eliminating fall hazards
 - b. Preventing falls
 - c. Safety equipment designed to prevent or reduce the impact of falls
 - d. Ensuring that workers who may fall aren't injured
 - e. All of the above
6. What does a personal fall-arrest system do?
7. What does a personal fall-restraint system do?
8. What does "prompt rescue" mean?
9. What can happen to a worker suspended in a harness after a fall?

Demonstrate the following to the trainer:

- Properly donning a fall-protection harness
- Properly hooking into an anchor point (located at ground level for training)
- The proper use of fall-protection gear
- Describe the conditions when fall protection is required

Training subject	Date	Location
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Trainee certification: I have received training on the above subject and completed the Review quiz. This training has provided me adequate opportunity to ask questions and learn safety guidelines to determine and correct skill deficiencies. I understand that using these guidelines and procedures safely is a condition of employment. I fully intend to comply with all safety and operational guidelines discussed. I understand that failure to comply with these guidelines may result in progressive discipline (or corrective actions) up to and including termination.

Employee name	Signature	Date
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Trainer certification: I have conducted training to the employee listed above. I have explained related procedures, practices, and policies. The employee was given the opportunity to ask questions and practice procedures taught under my supervision. Based on the employee's performance, I have determined that the employee has adequate knowledge and skills to safely perform these procedures and practices.

Trainer name	Signature	Date
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Module 5:

Solar plumbing safety

Plumbing involved in solar construction is similar to general plumbing and workers face many of the same risks. Hazards that are unique to solar plumbing contractors include working on rooftops and exposure to burn risks from the very hot temperatures that can occur simply from a solar hot water collector sitting in direct sunlight.

Burns and injuries from soldering, steam, and hot water are the primary focus of this module.

RELATED MODULE: General journeyman plumbers may also not be used to working on rooftops. These hazards are addressed in Module 4 [Fall protection and jobsite trip hazards](#) on page 63 and journeyman not trained to work safely on rooftops are encouraged to read that module.

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Learning objectives

This plumbing safety module presents:

- ◆ The hazards associated with plumbing.
- ◆ How to work safely with plumbing.
- ◆ Recovering from plumbing accidents.



Evaluate and identify solar plumbing safety hazards

When you understand how and why solar plumbing-related injuries occur, you can better analyze unique work situations and customize a risk-reduction strategy that works for you.

It's important to review the work day and identify where and how you are exposed to safety hazards when working on solar plumbing. The results can be used to develop policies and procedures to reduce the risks associated with plumbing found in the solar industry.

Evaluate solar plumbing hazards

To establish policies and procedures that reduce the risks associated with safe solar plumbing, review your work day and identify where and how hazards occur. This section uses an example to help identify action items to reduce risks. You may come up with additional situations in your job that need to be addressed. Use these common examples, but analyze your unique situation as well.

Work involving the plumbing of solar hot water systems can include:

- Working on rooftops.
- Using plumbing torch systems in small confined spaces.
- Soldering pipes above shoulder level.
- Handling and working with solar hot water collectors (both flat plate and evacuated tube).

Once you've identified the hazards in your work situation related to solar plumbing, determine what actions are needed to reduce risks associated with those situations.

1. Working on rooftops.
 - a. Working conditions include: accessing roofs, working on plumbing systems on rooftops.
 - b. Hazards include: fall hazards from using ladders and working at heights.⇒ Action: Develop and follow fall-protection policies and procedures (these are discussed in Module 4 [Fall protection and jobsite trip hazards](#) on page 63 and will not be discussed further in this module).
2. Using plumbing torch systems.
 - a. Working conditions include: using plumbing torch systems in small dry attic and basement spaces.
 - b. Hazards include: burns and smoke exposure and risk to your client's home or business.⇒ Action: Develop proper procedures using plumbing torches in all work areas.
3. Soldering at or above shoulder height.
 - a. Working conditions include: lifting soldering equipment and operating it above shoulder level.
 - b. Hazards include: burn hazards from dripping solder.⇒ Action: Reduce the risk by working from a step ladder and develop procedures working at shoulder heights and above when a ladder is impractical.
⇒ Action: Use personal protective equipment such as eye protection and clothing to prevent burns.

4. Handling and working with solar hot water collectors.
 - a. Working conditions include: moving solar hot water collectors to a rooftop and working at heights to perform installation and maintenance on systems.
 - b. Hazards include: lifting hazards and burn hazards from exposure to very hot manifolds if the collector is exposed to sunlight.
- ⇒ Action: Remove the risk by covering solar collectors to prevent them from heating up and develop procedures for working safely with collectors.
- ⇒ Action: Remove risks associated with lifting using the training in Module 2 [Lifting safety](#) on page 27.

The actions listed above will be addressed in the ‘Work Safely’ section that follows the understanding injuries section below.

Understanding potential injuries from solar plumbing hazards

Understanding potential injuries from identified hazards provides you with information to evaluate the risks you are taking.

Serious injuries, including death, arise from jobsite accidents. Just a few of the potential injuries from solar plumbing accidents include:

- First, second, and third-degree burns.
- Eye injuries from dripping or splattering hot solder.



Practices for working safely with solar plumbing

The previous section describes solar plumbing hazards using an example to help you evaluate your potential risk areas. Now it's time to develop a strategy to reduce the risks associated with solar plumbing.

This section helps you develop strategies to either eliminate or control the hazard with action items in the example. Since many construction hazards are difficult to eliminate altogether, most of the suggestions deal with controlling the hazard by developing safe work practices and habits. However, always be on the lookout for ways to eliminate hazards altogether.

The following actions were identified in the previous section:

- ⇒ Action 1: Develop and follow fall-protection policies and procedures (these are discussed in Module 4 [Fall protection and jobsite trip hazards](#) on page 63 and will not be discussed further in this section).
- ⇒ Action 2: Develop proper procedures using plumbing torches in all work areas.
- ⇒ Action 3: Reduce the risk by working from a step ladder and develop procedures working at shoulder heights and above when a ladder is impractical.
- ⇒ Action 4: Use personal protective equipment such as eye protection and clothing to prevent burns.
- ⇒ Action 5: Remove the risk by covering solar collectors to prevent them from heating up and develop procedures for working safely with collectors.

These actions are covered in the following four sections:

1. Safety procedures for typical plumbing torches.
2. Soldering joints above shoulder level.
3. Safety concerns with solar collectors.
4. Working smart.

Safety procedures for typical plumbing torches

Solar plumbing contractors often work in small cramped spaces, such as attics and basements that can have dry and flammable material close at hand.

Working with open flames near wood framing, paper insulation backing, and other combustibles in the work area presents a high fire risk.

To reduce the risk of damage or injury when using a plumbing torch:

- Use flameproof fire shields to prevent a fire.
- Always know what is in front of and behind the area you are working on to avoid burning through electrical wire or other items that you cannot see.
- Always carry a fire extinguisher.
- Remove the fire hazards by removing flammable material near your work area.
- Always use eye-protection gear, long-sleeve shirts, and gloves to prevent burns.
- When you turn off a torch and put it down, make sure it is completely off and that the hot tip is not resting on flammable material.
- Note that clothing made of synthetic materials can be much more susceptible to burning or melting when exposed to heat such as hot solder.



Soldering joints above shoulder level

Soldering joints above shoulder level presents additional safety risks for solar contractors because hot solder can more easily drip and splatter unexpectedly off of another surface (such as the top of a hot water tank). Dripping solder can splatter and cause serious burns including eye injuries.

To reduce the risk from soldering above shoulder level:

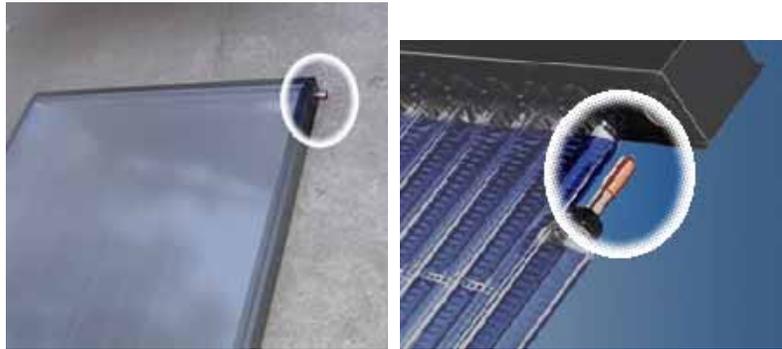
- Reduce the hazard by standing on a step ladder to position yourself above the work.
- Use eye-protection gear to prevent solder from reaching your eyes.
- Wear long-sleeve shirts made of natural fibers rather than synthetic material more prone to melting and burning and use gloves to prevent burns.

Safety concerns with solar collectors

Solar collectors are designed to collect solar radiation and generate heat. Solar collectors can generate enough heat to create a significant safety hazard when left in the sun without fluid. There are two serious burn hazards.

- If fluid is applied to a hot solar system, it can flash the liquid to steam causing a risk of serious burns.
- The collector manifolds can become extremely hot. These hot manifolds (illustrated at right) will cause burns if you touch them.

Although most of the collector can be handled safely, you should wear gloves when handling them.



Note that it can take a good deal of time to cool down a solar collector that has been sitting in direct sunlight.

To safely handle solar collectors:

- Remove the hazard by covering the collector with opaque material to prevent sunlight from heating the elements inside. Not all barriers block the sun sufficiently; the barrier must be opaque to block the sunlight and adequately remove the high-heat hazard.
- Never charge a solar hot water system that has been recently exposed to the sun.
- Use gloves when handling solar collectors to prevent burns from hot collectors.
- Always use two people when lifting or carrying large solar collectors.



Working smart

Plumbing with open flame torches in enclosed spaces can be a serious danger in solar construction.

To reduce fire and burn hazards, plumbing contractors should always carry, in their tool bag, a fire extinguisher that works properly. Make sure to read the manufacturer's directions for proper use and recharge needs. Note that fire extinguishers are meant to put out very small fires. If a fire starts to burn out of control, leave the area and call for help immediately.

Fire extinguishers come in different types to fight different fires. The common class extinguishers are:

Class A – Ordinary combustible material fires (wood, paper, rubber, and many plastics).

Class B – Flammable liquid, gas or grease fires.

Class C – Energized-electrical equipment fires (extinguishing material does not transmit electricity back to the user of the extinguisher).

A multipurpose ABC extinguisher is a good choice for most situations in solar plumbing. Extinguishers that use CO₂ as the primary extinguishing component (used for BC rated fires) are not recommended as they will not work well on class A fires and they extinguish the fire by removing oxygen. When working in small spaces, it could be dangerous to use a Class B or C extinguisher that displaces the oxygen you need to breath.

The ABC fire extinguisher at right is a good example of a small unit, weighing less than 4lbs that could easily fit into your tool bag.

Fire extinguishers must be checked monthly to ensure they are charged and ready to work.





Recovering from solar plumbing accidents

Solar contractors sometimes work with small crews in isolated jobsites. Because solar plumbing accidents can cause incapacitating injuries, it is crucial to have a plan to deal with emergencies.

Emergency planning protects lives, equipment, and property. By planning for emergencies you can increase your ability to act properly to avoid further injury. Do not wait for an emergency to start thinking about how to respond. It is difficult to think clearly during an emergency; training can increase the chances of a proper response.

In addition to the following information on recovering from solar plumbing accidents, please see [Recovering from accidents](#) in Module 1, General jobsite safety on page 21.

Burns and eye injuries are common plumbing hazards. Seek immediate medical attention for any eye injuries caused by hot solder.

Burns are classified in three different levels of severity:

1. First degree: least serious burn (when it affects a small area only). Red skin, pain, and swelling may occur.
2. Second degree: more serious burn. Intense red coloring, with splotchy appearance, with severe pain and swelling may occur.
3. Third degree: most serious burn. Skin may appear black or charred white. Often there is so much damage that no pain occurs. Even small third-degree burns are dangerous and can induce shock. You should seek medical attention immediately for all third-degree burns.

The size of burn is important in determining the severity of the accident. When only a small area is burned (except for third-degree burns) it is less serious. First and second-degree burns affecting only 2 to 3 inches in diameter or less can be treated as minor burns.

First aid for minor burns:

- Cool the burn as soon as possible by holding the burned area under cold running water for 5 minutes or until the pain subsides. If cold running water is not available you can use a cool dampened cloth to cover the area or immerse the burn in cold water.
- Burns should be covered with a sterile gauze bandage. Wrap the gauze loosely to avoid putting pressure on burned skin. Bandaging keeps air off the burned skin, reduces pain, and protects blistered skin.

Ice is not recommended for burns as the direct application of ice can further damage the skin due to frostbite.



Review quiz: Solar plumbing safety

The following questions and true or false statements will help to ensure you understand the material presented in this module. Please print your name, sign and date the review when you are finished.

1. What plumbing activity is unique to solar contractors?
2. Solar collectors remain cool until fluid is added. (T or F)
3. Covering a solar collector with opaque material prevents sunlight from heating the elements inside. (T or F)
4. When choosing a fire extinguisher, a good option for most situations in solar plumbing is what type?
5. What are the most common plumbing hazards?
6. The direct application of ice is not recommended for burns. (T or F)
7. When soldering joints above eye level, what are three ways to reduce risk of injury?
8. Solar collectors that are exposed to direct sunlight cool down quickly when they are covered. (T or F)

Demonstrate the following to the trainer:

- Explain how to check a fire extinguisher and how it is supposed to be used when putting out a fire.

Training subject	Date	Location
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Trainee certification: I have received training on the above subject and completed the Review quiz. This training has provided me adequate opportunity to ask questions and learn safety guidelines to determine and correct skill deficiencies. I understand that using these guidelines and procedures safely is a condition of employment. I fully intend to comply with all safety and operational guidelines discussed. I understand that failure to comply with these guidelines may result in progressive discipline (or corrective actions) up to and including termination.

Employee name	Signature	Date
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Trainer certification: I have conducted training to the employee listed above. I have explained related procedures, practices, and policies. The employee was given the opportunity to ask questions and practice procedures taught under my supervision. Based on the employee's performance, I have determined that the employee has adequate knowledge and skills to safely perform these procedures and practices.

Trainer name	Signature	Date
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Module 6:

Solar electrical safety

Working on or near electricity can be very dangerous. The term electrocution refers to death from electrical shock. Electrocution is the third-leading cause of work-related deaths among 16- and 17-year-olds. Electrocution is the cause of 12% of all workplace deaths among young workers.

This solar electrical safety module helps you understand hazards and develop a plan for working safely around solar electric systems.

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Learning objectives

This solar electrical safety module presents:

- ◆ The hazards associated with electricity.
- ◆ How to work safely with electricity.
- ◆ Recovering from electrical-related accidents.

Whenever you work with power tools or electrical circuits there are safety risks from electrical shock.

Electrical shock occurs when you complete a path for current to flow through your body. The risk of shock is always present in live electrical circuits. Since electric current will take the path of least resistance to ground, if you contact a live circuit and complete a path to ground or to another circuit, you will get shocked.

Shocks can be minor resulting in a very sharp pain. Shocks can also cause serious injury or death. Getting shocked can also lead to falls from rooftops or ladders, leading to fall related injuries. Although, in general, the higher the voltage the higher the risk, it's possible that electric currents of as little as 100mA can induce ventricular fibrillation, disrupting your heart's normal blood pumping operation, resulting in convulsions and possibly death. In comparison, a typical house electrical service of 120vAC can produce currents thousands of times higher than 100mA.

As with other workplace hazards, use this process to minimize electrical hazards:

1. Evaluate and identify electrical hazards.
2. Eliminate or remove electrical hazards.
3. Control electrical hazards that cannot be eliminated.
4. Recover from accidents.



Evaluate and identify solar electrical safety hazards

Identifying electrical-related safety hazards in your job helps you determine how to eliminate or control them before they cause injuries. The following section describes important factors to consider in conducting an evaluation and defining actions to address solar electric hazards at your work site.

Solar electric systems present the unique condition of having two electrical power sources in the home or business. Electrical power comes from both the utility and from the solar electrical system. Pulling the main breaker will shut down the utility power but will not shut off a solar electric array. This is a new consideration for many electricians and must be understood while working on electrical systems that use solar energy.

Both electric shock and arc-flash are potential hazards that must be protected against when working on solar electric photovoltaic (PV) systems.

NOTE: Some common myths claim that AC (alternating current) is more dangerous than DC (direct current) or vice versa. Neither myth is true because both AC and DC currents present significant safety hazards. The truth is that electrical current can kill – whether it is DC or AC. They are both dangerous sources of current and both should be treated with the same safety practices.

General electrical hazards

- **Overhead power lines.**

Overhead power lines are not insulated – they can and do kill people that contact them. More than half of all electrocutions are caused by direct worker contact with energized power lines. When cranes, work platforms, or other conductive materials such as ladders or aluminum mounting rails contact overhead wires, the equipment operator or other workers can be killed. If you do not maintain required clearance distances from power lines, you can be shocked and killed. You must always stay a minimum of 10 feet away from overhead power lines! (The minimum distance for voltages up to 50kV is 10 feet. For voltages over 50kV, the minimum distance is 10 feet plus 4 inches for every 10 kV over 50kV.)

Oregon OSHA Information

- Employers must not allow their workers to work near any part of an electrical circuit UNLESS the circuit is de-energized (shut off) and grounded, or guarded in such a way that it cannot be contacted.
- Ground-fault protection must be provided at construction sites to guard against electrical shock.

- **Electrical systems and tools that are not grounded or double-insulated.**

The most common OSHA electrical violation is improper grounding of equipment and circuitry. The metal parts of an electrical wiring system that are exposed (switch plates, ceiling light fixtures, conduit, etc.) should be grounded and at zero volts. If the system is not grounded properly, these parts may become energized. Metal parts of motors, appliances, or electronics that are plugged into improperly grounded circuits may be energized. When a circuit is not grounded properly, a hazard exists because unwanted

voltage cannot be safely eliminated. If there is no safe path to ground for fault currents, exposed metal parts in damaged appliances can become energized.

Extension cords with missing or broken ground terminals are unsafe and should never be used. If you contact a defective electrical device that is not grounded (or is grounded improperly), and you complete a path to ground, you will be shocked.

- **Overloaded circuits.**

Overloads in an electrical system are hazardous because they can produce heat or arcing.

A ground fault circuit interrupter, or GFCI, is an inexpensive lifesaver. GFCIs detect any difference in electrical current between the two circuit wires. This difference in current could happen when electrical equipment is not working correctly, causing leakage current. If leakage current (a ground fault) is detected in a GFCI-protected circuit, the GFCI switches off the current in the circuit, protecting you from a dangerous shock.

GFCIs are set at about 5 mA and are designed to protect workers from electrocution. GFCIs also detect the loss of current resulting from leakage through a person who is beginning to be shocked. If this situation occurs, the GFCI switches off the current in the circuit. GFCIs are different from circuit breakers because they detect leakage currents rather than overloads. Circuits with missing, damaged, or improperly wired GFCIs may allow you to be shocked.



Wires and other components in an electrical system or circuit have a maximum amount of current they can carry safely.

If too many devices are plugged into a circuit, or if a single device draws too much current, or if incorrect wire size is used, the electrical current can heat the wires to a very high temperature. Excessive heat can melt insulation and lead to arcing which can create ground faults or fires.

In order to prevent too much current in a circuit, a circuit breaker or fuse is placed in the circuit. Breakers and fuses do the same thing: open the circuit to shut off the electrical current. If the breakers or fuses are too big for the wires they are supposed to protect, an overload in the circuit will not be detected and the current will not be shut off.

- **Ladders that conduct electricity.**

- ♦ Do not use metal ladders near electrical circuits or lines. Instead, use ladders made of fiberglass.
- ♦ Beware of overhead power lines when you work with ladders and scaffolding.
- ♦ If you receive a shock while on a ladder or scaffolding—even a mild one—you may lose your balance and fall, which can result in injury or death.

- **Electrical hazards can be made worse if the worker, location, or equipment is wet.**

You don't have to be standing in water to be electrocuted. Wet clothing, high humidity, and perspiration also increase your chances of being electrocuted.

Working in wet conditions is hazardous because it increases the chance of completing a path for current flow. If you touch a live wire or other electrical component—and you are well-grounded because you are standing in a wet area—you will receive a shock.

Evaluate your electrical hazards

It's important to evaluate each specific situation to develop a list of hazards and potential injuries that could occur at your work site. Understanding hazards and potential injuries, along with knowing the likelihood of an accident occurring, enables you to set up a suitable safety policy for each specific job. This evaluation will help you set up policy and procedures to reduce the risks associated with electricity and energized equipment.

The following examples demonstrate work conditions that construction crews face while working with solar electric systems. You may come up with additional situations in your job that need to be addressed. You are encouraged to use these common examples but to analyze your own situation as well.

Electrical hazards in construction work situations can include:

- Using power tools and electric cords.
- Working with existing and new wiring and circuits.
- Working with solar electric PV panels, batteries, and equipment.

Once you've gone through your work situation related to electricity and energized equipment, you need to identify the hazards and risks associated with those situations. Then decide what action is needed to address the hazard.

1. Using power tools and electric cords.
 - a. Working conditions include: using power tools and extension cords.
 - b. Hazards include: using non-GFCI power cords, un-grounded power tools, and frayed or improperly spliced electric cords resulting in injuries associated with electric shock.⇒ Action: Develop policies and procedures for using power tools and electric cords.
2. Working with existing and new wiring and circuits.
 - a. Working conditions include: working on DC and AC wiring, connecting to utility.
 - b. Hazards include: exposure to live electric circuits or energized equipment resulting in injuries associated with electric shock and arc-flash.⇒ Action: Develop policies and procedures working with new and existing electric circuits.
3. Working with solar electric PV panels, batteries, and equipment.
 - a. Working conditions include: wiring and connecting PV arrays, installing and removing batteries, and working with inverters and balance of system equipment.
 - b. Hazards include: moving and installing PV panels, working with inverters and balance of system equipment resulting in injuries associated with electric shock and arc-flash.⇒ Action: Develop safe practices for working with solar electric systems.
⇒ Action: Develop safe practices installing, handling, and disposing of batteries.

The actions listed above will be addressed in the 'Work Safely' section that follows the understanding injuries section below.

Understanding potential injuries from solar electric hazards

Electrical injuries can include the following:

- Electrocution (death due to electrical shock).
- Electrical shock causing:
 - ◆ Severe burns.
 - ◆ Convulsions leading to ventricular fibrillation and internal or fall-related injury.
 - ◆ Numbness, tingling, paralysis.
 - ◆ Vision, hearing, or speech problems.



Practices for working safely with solar electric systems

The previous section described how to identify jobsite hazards using an example to evaluate potential risk areas for typical solar construction work related to solar electric systems. Now it's time to develop a strategy to reduce these risks.

This section helps you develop strategies to either eliminate or control the hazards in the action items noted in the previous section. Since many construction hazards are difficult to eliminate altogether, most of the suggestions deal with controlling the hazard by developing safe work practices and habits. However, you should always be on the lookout for ways to eliminate hazards altogether.

The following actions were identified in the previous section:

- ⇒ Action 1: Develop policies and procedures for using power tools and electric cords.
- ⇒ Action 2: Develop policies and procedures working with new and existing electric circuits.
- ⇒ Action 3: Develop safe practices for working with solar electric systems.
- ⇒ Action 4: Develop safe practices installing, handling, and disposing of batteries.

The following sections help you develop plans to reduce hazards while:

1. Working with power tools and electric cords.
2. Working with electrical circuits.
3. Working with solar electric systems.
4. Working with batteries.

Oregon OSHA Information

OAR 437-003-0404, Branch Circuits, requires ground-fault circuit interrupters (GFCIs) on all 125-volt, single-phase, 15-, 20-, and 30-ampere receptacles that are not part of the permanent wiring of a building or structure. If a permanently wired receptacle (not equipped with GFCI protection) is used for temporary electric power in a construction project, GFCI protection must be provided at the user end.

Portable plug-in and cord-type GFCIs are probably the most practical devices for construction workers who use cord sets for temporary power when there is no protection at the source.

Working with power tools and electric cords

Companies working with power tools and electric cords must create clear safety policies for the maintenance and use of this equipment. Following are some areas to consider when setting power tool and electric cord safety practices and policies.

- Ground Fault Circuit Interrupters (GFCI or GFI) save lives.
 - ♦ Know and understand OSHA rules on GFCI devices. See Oregon OSHA information box on GFCI requirements.
 - ♦ Ensure all extension cords and equipment are protected by GFCI. Follow manufacturers testing procedures to insure the device is working properly.
 - ♦ Always use GFCI protected extension cords and equipment on the job.
- Construction equipment is used in rugged environments – equipment inspections can help ensure equipment is maintained in safe working condition.
 - ♦ Electric equipment and power cords should always be inspected after an accident or damage occurs.
 - ♦ Power cords with ground prongs missing should never be used.
 - ♦ Visually inspect electrical equipment prior to every use for electrical hazards such as missing prongs, frayed cords, cracked tool cases etc. Remove from service and apply a warning tag to any tools that are damaged.

Working with electrical circuits

Preventing electric shock by working on de-energized circuits is a key to electric safety.

Following are some items to consider when working on electric circuits.

- Always de-energize circuits before beginning work on them.
 - ♦ You can't get shocked by a de-energized circuit. Unfortunately, many electric accidents have been caused by assumed 'dead' circuits. Working safely on circuits includes testing them for hazardous energy prior to working on them.
 - ♦ Use a meter or circuit test device such as a current clamp to ensure the circuit is dead prior to working on it.

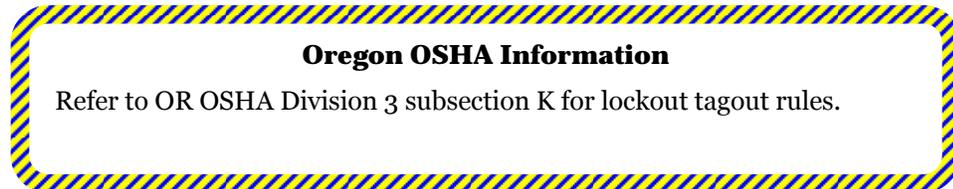


Safety Tip: Verify that your meter is operating properly on a live circuit to ensure it is working. This ensures that you have the meter leads in the proper terminals, the meter settings properly set, and that your meter is operating correctly.

Make sure that you're meter is properly set to check for AC or DC voltage depending on the circuit you are working on.

When checking for a circuit under load a current clamp is a safer device to use than a typical multi-meter – current clamps do not require you to break the circuit and thus limit an arc-flash hazard.

- Implement circuit lock and tag out rules
 - ◆ Lock out the power on systems that are capable of being locked out. Remember that the lock out tag is not for the person that you are aware of and that knows you are working on the electrical circuit – it's for the person you don't know and that doesn't know you are working on the circuit. You must notify all affected persons.
 - ◆ Tag out all circuits that you're working on at points where that equipment or circuit can be energized.



Working with solar electric systems

Electricians are familiar with electricity coming from the utility side of the meter. With solar electric systems there are 2 sources of electricity: the utility and the solar electric system. Turning off the main breaker doesn't stop a solar electric system from having the capacity to produce power. Electricians are used to isolating the 'load' from the power source (usually with a breaker or other disconnect switch) and then they proceed to work on that 'safed zero energy load'. With a solar electric system you work on the power source itself (the PV panels or associated wiring) – this is fundamentally different than working on a 'safed load' and you must keep this in mind. Even low light conditions can create a voltage potential that can lead to a shock or arc-flash. A surprise shock delivered at the wrong time could cause a fall from a roof or ladder.

- Follow the procedures listed in the previous section on working with electrical systems
 - ◆ Note that PV inverters may have significant capacitors that could hold a charge after the power source is removed – always follow manufacturer's directions and check the equipment you are working on for specific operation and safety information.
- The only method of 'turning off' a solar array is removing the 'fuel' source – the sun. If needed, cover the array with an opaque cover that blocks sunlight to prevent a solar panel from generating electricity.
- Small amounts of sunlight can produce a voltage potential and shock or arc-flash hazard
 - ◆ Voltages can be present even in very low light conditions. While these voltages may not be enough to operate the inverter, the potential voltages are enough to produce a shock to an unsuspecting installer. Surprise shocks can cause injuries directly or cause a fall from a roof or ladder.
 - ◆ Prior to working on a string of solar PV panels, if you're going to be connecting or disconnecting circuits, you should disrupt the current path by disconnecting the DC Disconnect switch. Tag and lock out the circuit using standard procedures discussed in the previous section.
- Grid tied solar systems have 2 energy sources to consider
 - ◆ Shutting off the main circuit breaker does not affect the potential output of a solar PV array – even if the inverter shuts off.

It's important to remember that opening (turning off) the main breaker does not shut off the power source from the solar array. Wires from the PV side of the

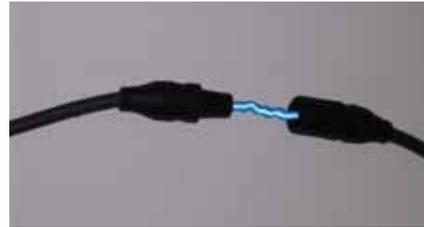
circuit can still have a voltage potential that can deliver significant current even in low light conditions.

- ◆ Disconnect switches can isolate the solar PV array but they do not shut the power off.

Remember that if you open the DC disconnect switch, the line from the solar PV array can still have voltage potential on it. This is similar to the voltage potential present on the utility side of the line after the main breaker is opened. Treat the wiring coming from the solar PV array with the same caution you treat the utility power line. A residential PV array can have up to 600 VDC potential.

- An electric arc-flash hazard exists while adding or removing a series of solar PV panels

- ◆ NEVER disconnect PV module connectors or other associated PV wiring under load!
- ◆ While adding or removing a series of solar PV panels, if a path for current is completed or the string was under load, an electrical arc can occur across the wire junction. The energy from the bright arc-flash can cause severe burns. Another hazard is the surprise arc blast causing you to lose balance and fall off a roof or ladder.
- ◆ Always open the DC Disconnect Switch prior to working on a solar PV system.



- ◆ Use a current clamp to check for hazardous energy prior to working on a PV array.



Working with batteries

Working with battery back-up systems can be the most dangerous part of solar electric installations and maintenance. Batteries can be dangerous!

Make sure all employees working with batteries understand the dangers and safety codes relevant to battery systems.

- Refer to NEC and manufacturing guidelines for issues pertaining to proper handling, installation, and disposal of batteries.
- Typical batteries are lead acid. Both lead and acid are harmful chemicals. Lead is known to cause reproductive harm and acid can cause severe burns.
- Care should always be taken to prevent arcing at or near battery terminals. Always open the Main DC disconnect switch between the batteries and the inverter prior to servicing or working on the battery bank.
- Battery banks can store voltages with very high current potential. These higher potentials can create electrical arc hazards. Metal tools and personal jewelry can create arcing on batteries that lead to severe burns or battery explosions. Remove personal jewelry and use only appropriate tools when working on batteries.
- When working on batteries it is recommended that eye protection be worn.
- Dead batteries are considered hazardous and must be recycled properly.

Working smart

Controlling contact with electrical voltages and the currents they can cause helps you create a safe work environment. In addition to preventing shocks, a safe work environment reduces the chance of fires, burns, and falls.

Make your solar electric construction environment safer by:

- Prevent shocking currents from electrical systems and tools by grounding them.
- Prevent potential hazardous currents by using GFCIs.
- Work with a “buddy.”

Do not work alone. Both of you should be trained in CPR. Both of you must know what to do in an emergency.

- Plan to lock out and tag out circuits and equipment.

Before work is done on a circuit, shut off the circuit, lock and tag out the circuit at the distribution panel, then test the circuit to make sure it is de-energized.

Working on energized (“hot”) circuits is one of the most dangerous things any worker could do. If someone turns on a circuit without warning, you can be shocked, burned, or electrocuted. The unexpected starting of electrical equipment can cause severe injury or death.

- Remove jewelry and metal objects.

Remove jewelry and other metal objects or apparel from your body before beginning work. These can cause burns if worn near high currents and can get caught as you work.



Recovering from electrical accidents

Solar contractors sometimes work with small crews in isolated jobsites. Because electrical accidents can cause incapacitating injuries, it is crucial to have a plan to deal with emergencies.

Emergency planning protects lives, equipment, and property. By planning for emergencies you can increase your ability to act properly to avoid further injury. Do not wait for an emergency to start thinking about how to respond. It is difficult to think clearly during an emergency; training can increase the chances of a proper response.

In addition to the following information on recovering from electrical accidents, please see [Recovering from accidents](#) in Module 1, General jobsite safety on page 21.

What to do

1. Shut off the power supply if the victim is still in contact with the energized circuit.
2. While you do this, have someone else call for help.
3. Do not touch the victim yourself if he or she is still in contact with a live electrical circuit. If you cannot shut system power off quickly, prying someone away from a live circuit should only be done with a non-conductive item such as a dry board. Be especially careful if the area is wet.
4. Do not leave the victim unless there is absolutely no other option. You should stay with the victim while Emergency Medical Services (EMS) is contacted by someone else. If the victim is not breathing, does not have a heartbeat, or is badly injured, quick response by a team of EMTs or paramedics gives the best chance for survival.
5. Administer first aid and CPR if required and you're trained. If you are not trained in CPR or first aid, *now* is the time to get trained—*before* you find yourself in this situation! Ask your instructor or supervisor how you can become certified in CPR.



Safety Tip: Learn first aid and CPR now!



Review quiz: Solar electrical safety

The following questions and true or false statements will help to ensure you understand the material presented in this module. Please print your name, sign and date the review when you are finished.

1. What are the three things to know the location of to be prepared for an emergency?
2. Overhead powerlines are dangerous and can kill. (T or F)
3. Solar PV panels can product electric current with very little sunlight or other light source. (T or F)
4. What is the minimum distance to stay away from overhead powerlines?
5. AC current is more dangerous than DC. (T or F)
6. DC current is more dangerous than AC. (T or F)
7. GFCI is required for contractors unless you are using extension cords. (T or F)
8. Working around electrical circuits when wet is more dangerous than when dry. (T or F)

Demonstrate the following to the trainer:

- Describe the company's GFCI policy
- Describe the company's lock out / tag out policy
- Properly use a multi-meter and current clamp to check a circuit prior to working on it

Training subject	Date	Location
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Trainee certification: I have received training on the above subject and completed the Review quiz. This training has provided me adequate opportunity to ask questions and learn safety guidelines to determine and correct skill deficiencies. I understand that using these guidelines and procedures safely is a condition of employment. I fully intend to comply with all safety and operational guidelines discussed. I understand that failure to comply with these guidelines may result in progressive discipline (or corrective actions) up to and including termination.

Employee name	Signature	Date
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Trainer certification: I have conducted training to the employee listed above. I have explained related procedures, practices, and policies. The employee was given the opportunity to ask questions and practice procedures taught under my supervision. Based on the employee's performance, I have determined that the employee has adequate knowledge and skills to safely perform these procedures and practices.

Trainer name	Signature	Date
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OSHA rules and general information

Oregon OSHA Services

Oregon-OSHA offers a wide variety of safety-and-health services to employers and employees:

Public Education & Conferences

- Conducts conferences, seminars, workshops, and rule forums.
- Coordinates and provides technical training on topics like confined space, ergonomics, lockout/tagout, and excavations.
- Provides workshops covering basic safety-and-health-program management, safety committees, accident investigation, and job-safety analysis.
- Manages the Safety and Health Education and Training Grant Program, which awards grants to industrial and labor groups to develop occupational-safety-and-health training materials for Oregon workers.

Consultative Services

- Offers no-cost on-site safety and health assistance to help Oregon employers recognize and correct safety-and-health problems in their workplaces.
- Provides consultations in the areas of safety, industrial hygiene, ergonomics, occupational-safety-and-health programs, new-business assistance, the Safety and Health Achievement Recognition Program (SHARP), and the Voluntary Protection Program (VPP).

Enforcement

- Offers pre-job conferences for mobile employers in industries such as logging and construction.
- Provides abatement assistance to employers who have received citations and provides compliance and technical assistance by phone.
- Inspects places of employment for occupational-safety-and-health hazards and investigates workplace safety-and-health complaints and accidents.

Appeals, Informal Conferences

- Provides the opportunity for employers to hold informal meetings with OR-OSHA on workplace safety-and-health concerns.
- Discusses OR-OSHA's requirements and clarifies workplace safety or health violations.
- Discusses abatement dates and negotiates settlement agreements to resolve disputed citations.

Standards & Technical Resources

- Develops, interprets, and provides technical advice on safety-and-health standards.
- Provides copies of all OR-OSHA occupational-safety-and-health standards.
- Publishes booklets, pamphlets, and other materials to assist in the implementation of safety-and health standards and programs.
- Operates a Resource Center containing books, topical files, technical periodicals, a video and film lending library, and more than 200 databases.

For more information, call the OR-OSHA office nearest you.
(All phone numbers are voice and TTY.)

Salem Central Office

350 Winter St. NE, Rm. 430
Salem, OR 97301-3882

Phone: (503) 378-3272

Toll-free: (800) 922-2689

Fax: (503) 947-7461

en Español: (800) 843-8086

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Salem, OR 97303

(503) 378-3274

Consultation: (503) 373-7819

Portland

1750 NW Naito Parkway, Ste. 112
Portland, OR 97209-2533

(503) 229-5910

Consultation: (503) 229-6193

Eugene

1140 Willagillespie, Ste. 42
Eugene, OR 97401-2101

(541) 686-7562

Consultation: (541) 686-7913

Bend

Red Oaks Square
1230 NE Third St., Ste. A-115
Bend, OR 97701-4374

(541) 388-6066

Consultation: (541) 388-6068

Medford

1840 Barnett Rd., Ste. D
Medford, OR 97504-8250

(541) 776-6030

Consultation: (541) 776-6016

Pendleton

721 SE Third St., Ste. 306
Pendleton, OR 97801-3056

(541) 276-9175

Consultation: (541) 276-2353

Where to find more information

Additional Safety Manual References for more information:

- *Emergency management guide for business and industry*, Federal Emergency Management Agency (FEMA); www.fema.gov/library/bizindex.htm
- *A Foundation for a Safe Workplace*; Oregon OSHA; www.cbs.state.or.us/osh/publications/safetymanagepubs.html
- *How to Plan for Workplace Emergencies and Evacuations*; U.S. Department of Labor Occupational Safety and Health Administration; www.osha.gov
- Oregon Emergency Management; www.osp.state.or.us/oem
- *Expecting the unexpected – What to consider in planning for workplace emergencies*, an OR-OSHA Standards and Technical Resources Section publication; <http://www.orosha.org/pdf/pubs/3356.pdf>
- *Climb it Safe!* brochure available at: www.aaos.org/
- <http://www.lni.wa.gov/wisha/publications/FallProtectionEmergencies.pdf> (contains a section on self rescue)
- *Electrical Safety: Safety and Health for the Electrical Trades*, a National Institute for Occupational Safety and Health (NIOSH) available at: <http://www.cdc.gov/niosh>

Review quiz answers

T = True; F = False

Module 1: General jobsite safety

1. Oregon OSHA requires employees to be trained in the work that they do? T
2. Why is it important to identify potential safety hazards at a jobsite?
Knowing how to identify potential safety hazards is critical to understanding potential injuries, preventing accidents, and recovering from accidents.
3. Why is it important to use a proper tool belt?
Using a proper tool belt will save many trips up and down the ladder. A tool belt will leave your hands free to hold onto the ladder. Prevents jobsite trip hazards.
4. It is important to plan for workplace accidents to increase your ability to act properly to avoid further injury. T
5. Effective emergency-response plans need to be elaborate. F
6. 911 is available in all areas. F
7. Not every jobsite needs first-aid supplies. F
8. Employers must have employees on hand who are trained in basic first aid and CPR unless a hospital or clinic is in near proximity. T
9. If 911 is not available in the jobsite area, what should be done before on-site work begins?
The telephone numbers of physicians, hospitals, or ambulances must be conspicuously posted.

Module 2: Lifting safety

1. Back injuries account for one of every five workplace injuries or illnesses. T
2. Most back injuries are the result of a single factor. F
3. Back belts are considered personal protective equipment (PPE) by OR-OSHA. F
4. Name three points of proper lifting technique.
Use your legs. Maintain your curves. Don't twist.
5. How many natural curves are in your back?
Three.
6. It is easier and safer to lift from an elevated surface. T
7. Stretching should be done once at the end of the day. F

Module 3: Ladder safety

1. Can a step ladder be used to access the roof?
No.
2. How can you tell if the ladder is set up at the proper angle?
4-1 rule or stand straight and reach rule.
3. When using a ladder during construction work, under what conditions is it required to be secure against tipping?
All.

4. How many points of contact should you have when working from a ladder?
Three .
5. The body should be centered between the rails of a ladder while climbing or working from the ladder. T
6. Ladders are safe in windy conditions. F
7. When should ladders be inspected?
Prior to use/after dropping...
8. You can safely carry objects while climbing a ladder. F
9. An aluminum ladder should not be used when?
When any electrical lines or energized equipment are present.

Module 4: Fall protection and jobsite trip hazards

1. Falls are the leading cause of work-related deaths among construction workers. T
2. A fall hazard is anything in the workplace that could cause an unintended loss of balance or bodily support and result in a fall. T
3. What is the purpose of identifying roof and fall safety hazards?
To determine how to eliminate or control them before they cause injuries.
4. What factors can increase the risk of falls? (e. is the correct answer.)
 - a. Tasks exposing workers to overhead power lines
 - b. Using scaffolds, ladders, or aerial lifts on unstable or uneven ground
 - c. Working during hot, cold, or windy weather
 - d. Working extended shifts that could contribute to fatigue
 - e. All of the above
5. What is fall protection? (e. is the correct answer.)
 - a. Eliminating fall hazards
 - b. Preventing falls
 - c. Safety equipment designed to prevent or reduce the impact of falls
 - d. Ensuring that workers who may fall aren't injured
 - e. All of the above
6. What does a personal fall-arrest system do?
Arrests a fall.
7. What does a personal fall-restraint system do?
Prevents a fall.
8. What does "prompt rescue" mean?
Rescuing without delay.
9. What can happen to a worker suspended in a harness after a fall?
The worker can lose consciousness if the harness puts too much pressure on arteries. A worker suspended in a body harness must be rescued in time to prevent serious injury.

Module 5: Solar plumbing safety

1. What plumbing activity is unique to solar contractors?
Working from rooftops and heat from solar collectors.
2. Solar collectors remain cool until fluid is added. F
3. Covering a solar collector with opaque material prevents sunlight from heating the elements inside. T
4. When choosing a fire extinguisher, a good option for most situations in solar plumbing is what type?
ABC
5. What are the most common plumbing hazards?
Burns and eye injuries.
6. The direct application of ice is not recommended for burns. T
7. When soldering joints above eye level, what are three ways to reduce risk of injury?
Try to position yourself above the joint, use eye protection gear, wear long-sleeved shirts and gloves.
8. Solar collectors that are exposed to direct sunlight cool down quickly when they are covered. F

Module 6: Solar electrical safety

1. What are the three things to know the location of to be prepared for an emergency?
Electrical shut off location, First aid supplies, telephone.
2. Overhead powerlines are dangerous and can kill. T
3. Solar PV panels can product electric current with very little sunlight or other light source.
T
4. What is the minimum distance to stay away from overhead powerlines?
10 ft.
5. AC current is more dangerous than DC. F
6. DC current is more dangerous than AC. F
7. GFCI is required for contractors unless you are using extension cords? F
8. Working around electrical circuits when wet is more dangerous than when dry?
Not necessarily. If you are sweating you are wet...

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