**Solar Electric Technician Training**

**Handouts: Module 2: Occupational health and safety**

1. **APPLY personal safety**

Similar to other professions, solar electric technicians must apply personal and workplace safety precautions to protect themselves and others from potential hazards during the course of their work. It is necessary to identify risks, use appropriate personal protective equipment (PPE), follow safety procedures, and create a safe working environment.

Solar electric technicians face various hazards while working with electrical systems at severe temperatures and heights. To be safe from these possible dangers, one must be aware of the associated risks. In addition to this, personal protection should be adopted without fail by making use of gloves, glasses, hard hats and protective harnesses. In order to comply with standard safety rules while working, they also should know how to use lockout/tagout procedures to avoid accidents during maintenance and other work that poses any risks.

* 1. **Importance of personal safety**

Personal safety is very important in all working fields, including the solar industry, for the following reasons:

* **Protects the physical health of workers**: Ensuring safety measures helps prevent accidents and injuries.
* **Ensures compliance with norms and standards**: Complying with the norms and standards for safety is essential for legal and operational reasons.
* **Contributes to business success:** A safe working environment can lead to higher productivity and employee satisfaction.
  1. **Hazards of using hand tools and power tools**

There are many hand tools and electrical tools that are used by field technicians. Presented in the table below are some examples of the potential dangers of using certain hand tools and electrical tools.

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| **SN** | **Tools** | **Possible hazard** |
| 1. | Screwdriver | Failing to use a screw-type screwdriver to install solar panels can result in the screwdriver slipping and causing injury. |
| 2. | Drill tool | Using a drill machine with damaged insulation, especially in wet conditions, to drill holes for solar panels can result in electric shock. |
| 3. | Cutting conduits with a grinder | Cutting conduits with a grinder without wearing safety glasses can cause eye injuries from flying wire fragments |
| 4. | Soldering rod | A hot soldering rod used to connect wires can cause severe skin tears and burns if not handled properly. |

* 1. **Hazards for solar electrical technicians**

The following are examples of the potential hazards of working in the field as a solar electrician**.**

* Direct contact with electrical circuits or equipment may result in electric shock.
* Leaning and falling from heights while working on roofs, ladders or elevated surfaces.
* Heavy lifting can lead to musculoskeletal injuries.
* There is a possibility of slipping, tripping and falling when working on potholed surfaces, slippery surfaces and roofs.
* Contact with various chemicals, dusts, or other hazardous materials can cause burns, itching, and sores.
* Improper connection of wires to each other or to equipment can cause fires.

To avoid such risks, proper training, use of appropriate PPE, adherence to safety protocols, and regular safety audits help reduce these hazards and ensure a safe working environment.

Personal Protective Equipment (PPE) is designed to protect different parts of the body. The following table showcases examples of safety gear.

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| Protection against head injuries (helmet) | Protection against leg and foot injuries (shoes) | Protection against eye and face injuries (face shield) |
|  |  |  |
|  |  |  |
| Protection from hearing loss (Ear muff) | Protection from hand injuries (Gloves) | Protection against full body injuries (full body suits) |

1. **Workplace safety**

Risk assessment is a critical process in ensuring workplace safety. It involves identifying potential hazards, evaluating the risks they pose, and implementing control measures to reduce or eliminate those risks. The first step is hazard identification, where all possible dangers in the workplace are recognized. For solar technicians, hazards can include electrical risks, the potential for falls when working at heights, chemical exposures, and improper use of hand or power tools. Identifying these hazards early allows technicians to address them before they lead to accidents, thereby creating a safer work environment.

* 1. **Control measures for workplace hazards**

1. **Elimination**: The most successful and effective control technique is to eliminate a specific hazard or hazardous work procedure, or prevent it from entering the workplace.
2. **Substitution**: Substitution is the process of replacing something harmful with something less hazardous. While this method may not eliminate all risks associated with the process or activity, it will reduce the overall harm or health impacts.
3. **Engineering controls**: These protect workers by eliminating hazardous situations, creating a barrier between the worker and the hazard, or removing the hazard from the working personnel.
4. **Administrative control**: To reduce exposure to hazards, administrative controls limit the length of time spent working on a hazardous task. This measure is often used in combination with other control measures.
5. **Personal protective equipment**: PPE protects users from health and safety hazards at work. It includes items like safety helmets, gloves, eye protection, etc.
   1. **Maintaining a safety culture**

Creating and maintaining a safety culture in the workplace requires continuous effort from all employees. It starts with leadership, where supervisors must model good safety practices by following procedures and wearing appropriate PPE. Encouraging open communication is equally important; workers must feel comfortable reporting unsafe conditions or near-misses without fear of retaliation. Regular safety meetings, drills, and refresher training on hazard identification and emergency response can help keep safety top of mind. Reporting hazards and unsafe conditions should be standard practice for all workers to prevent accidents before they occur.

By adhering to these key safety procedures and promoting a proactive safety culture, the likelihood of accidents and injuries in the workplace can be greatly reduced.

* 1. **Importance of training and drills**

Just knowing what need to be done at the time of emergency is not sufficient to act when it is in need. Most people are confused when they are in difficult situations. Regular training and practice drills are important following ensuring the person knows what to do in these situations. All technicians should know and practice how to handle emergencies. Practicing these steps helps them respond quickly and correctly, reducing the risk of further injuries or damage. Emergency numbers, evacuation routes, and safety equipment like fire extinguishers and first aid kits should be easy to find and use at all times.

* 1. **Overview of safety procedures (Lockout/Tagout, Fall protection, Electrical safety)**

In any solar electric installation or maintenance work, several safety procedures are essential to prevent accidents.

* **Lockout/Tagout (LOTO):** A critical procedure is **Lockout/Tagout (LOTO)**, which ensures that energy sources (electrical, mechanical, and hydraulic) are properly isolated and locked to prevent accidental startup during maintenance. Workers must follow these procedures before servicing equipment to avoid dangerous exposures to energized components.
* **Fall protection** is another vital safety measure. Solar electric work often involves working at heights, such as on rooftops. Fall protection systems, including harnesses, guardrails, and safety nets, must always be used to prevent serious injuries. It is essential to always inspect fall protection gear before use to ensure it is in proper working condition.
* **Electrical safety** involves using personal protective equipment (PPE) such as insulating gloves and boots to protect against electrical shocks. Electrical systems must be properly de-energized and verified before work begins. Workers should use tools that are properly insulated and regularly maintained to avoid equipment malfunctions that can lead to electrical hazards.
  1. **Emergency response plan**

The following table outlines the emergency response plan for electric shock and falls**:**

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|  | **Electrical shock** | **Fall** |
| Immediate Action : A 7-Day Plan to Overcome Procrastination and Regain Your  Motivation by Thibaut Meurisse | Goodreads | Turn off the power first if it's safe to do so. If not, use a non-conductive object like a wooden stick to move the person away from the electricity. | If a technician falls, make sure they are safe and do not move them unless there is immediate danger. Moving them could make their injuries worse. |
|  | Never touch the person while they are still in contact with the source of the electricity, as the shock could pass through you. | Check for signs of serious injuries like broken bones or head injuries. If they are unconscious, check to see if they are breathing and if they have a pulse. |
| Call For Help, HD Png Download - kindpng | Immediately call for medical help and provide the necessary details about the accident and the person’s condition. | Contact emergency services right away, providing details about the fall and any injuries. |
| First aid: Skills, recovery position, and CPR | After the person is free from the electricity, check if they are responsive and breathing. If needed, perform CPR and treat any burns until help arrives. | If trained, give first aid. If you suspect a spinal injury, keep them still and support their head and neck until help arrives. |

1. **Tools/equipment safety**
   1. **Importance of tools and equipment safety in solar electric work**

In the field of solar electric work, the proper use of tools and equipment is essential for both efficiency and safety. Many tasks involve handling delicate and heavy components like solar panels, batteries, and frames. Incorrect tool usage or failure to follow safety procedures can lead to injuries, damaged equipment, and costly delays.

To prevent these risks, it’s important to follow **safe handling, storage, and maintenance practices**. Tools should be stored properly after each use to prevent damage, and regular maintenance should be performed to ensure that they are in good working condition. For example, sharp tools like blades and cutters should be kept clean and sharpened regularly, while electrical tools must be checked for insulation wear.

* 1. **Detailed overview of common tools used in solar electric work**

**Common tools** used by solar electric technicians include wrenches, screwdrivers, wire cutters, multimeters, and drills. Each tool has specific safety practices. For example, **drills** should always be used with safety goggles to protect the eyes from debris, and **wire cutters** should be used with insulated handles to avoid electrical shocks. Misuse of tools, such as using an improperly sized wrench or a dull cutter, can result in slips, cuts, or worse.

The table below provides an overview of common tools used in solar electric work:

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| **Tools name** | **Purpose** | **Photograph** |
| **Multimeter** | Used to measure voltage, current, and resistance in electrical circuits, essential for testing solar PV systems. | Republic New Basic compact Digital Multimeter Price in India - Buy Republic  New Basic compact Digital Multimeter online at Flipkart.com |
| **Solar power meter** | Measures the solar radiation to determine the best placement and angle for solar panels. | What is a Solar Power Meter & How Does It Work? |
| **Clamp meter** | Used to measure the current in a conductor without making direct contact. Important for ensuring safe operation. | UNI-T UT202A+ SERIES 400-600A DIGITAL CLAMP METERS – GL Electric Sdn Bhd |
| **Wire stripper** | Strips insulation from wires, allowing for proper connections during installation. | RS PRO Wire Stripper, 0.8mm Min, 2.6mm Max, 155 mm Overall | RS |
| **MC4 connector tool** | Specifically designed for assembling and disassembling MC4 connectors used in solar panel connections. | LY-2546B MC4 Solar Crimping Tools Crimper for 2.5-6.0mm2 Solar Panel PV  Connectors Cable | Daraz.pk |
| **Torque wrench** | Ensures that bolts and screws are tightened to the manufacturer's specifications to prevent damage or loosening over time. | Digital Adjustable Torque Wrench - DAW |
| **Battery tester** | Used to check the health and charge level of batteries in a solar power system. | BATTERY TESTER BT3554 (Bluetooth® not installed) | Hioki |
| **Screwdriver set** | A set of various screwdrivers used for assembling and securing different components of the solar PV system. | Buy Screwdriver Set 840 at Hardwarepasal.com || Online Shopping in  Kathmandu Nepal |
| **PV module tester** | Used to test the performance of individual solar panels, including voltage and current output. | Solar Module Analyzer |

* 1. **Tools and equipment safety practices, storage, common hazards, and maintenance**

Ensuring the safe use of tools and equipment in solar electric work is crucial for preventing accidents, injuries, and equipment damage. By understanding the specific hazards associated with each tool and following proper safety practices, solar electric technicians can maintain a safe working environment, improve the quality of their work, and reduce the risk of costly errors or incidents. Regular training, tool maintenance, and adherence to safety protocols are key components of effective tool and equipment safety.

By following these handling, storage, and maintenance practices, you can ensure the safety and longevity of your tools and equipment, so that they remain effective and reliable for solar electric work.

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| **Tools** | **Safe use practice** | **Storage** | **Common hazards** | **Maintenance** |
| Multimeter | * Always test on a known live circuit before use. * Use proper settings for voltage, current, or resistance. * Avoid contact with exposed metal parts. | * Store in a dry, dust-free environment. * Keep away from high temperatures. | * Electric shock due to improper handling. * Damage from incorrect settings. | * Regularly check leads and probes for wear or damage. * Calibrate periodically. |
| Crimping tools | * Use correct crimping tools die for the different cable size and shapes. * Apply even pressure when crimping. | * Store in a clean, dry place. * Avoid exposure to moisture. | * Poor connections from improper crimping. * Pinched fingers or hand injuries. | * Clean after use to remove debris. * Check for alignment and wear. |
| Wire strippers | * Adjust for wire size to avoid cutting conductors. * Use in a well-lit area. | * Store in a tool bag or box to prevent damage. | * Cutting fingers if not handled properly. * Damage to wire insulation. | * Sharpen blades as needed. * Lubricate pivot points periodically. |
| Cordless drill | * Use an appropriate bit for the material. * Hold securely to avoid kickback. | * Store in a case or on a tool shelf. * Keep batteries separate. | * Drill bit breakage. * Battery short-circuits or overheating. | * Charge batteries regularly. * Clean vents and check for bit wear. |
| Torque wrench | * Set the correct torque value before use. * Apply slow, steady pressure. | * Store in a protective case. * Avoid dropping. | * Over-tightening or under-tightening connections. * Strain injuries from improper use. | * Calibrate regularly to maintain accuracy. * Clean after use. |
| Safety harness and lanyards | * Inspect before each use. * Ensure proper fit and adjustment. | * Hang in a dry, cool place away from sunlight. | * Falls due to improper fit or damaged harness. * Tangling or tripping hazards. | * Inspect for wear, fraying, or damage. * Clean with mild soap and water. |
| Cable cutters | * Use for the intended cable size and type. * Keep hands clear of cutting area. | * Store in a tool bag or box. * Avoid contact with moisture. | * Hand injuries from improper handling. * Poor cuts leading to frayed cables. | * Sharpen blades regularly. * Check for alignment and wear. |
| Level and measuring tape | * Use the level on flat surfaces for accurate measurements. * Extend tape slowly to avoid snapping. | * Store in a tool box or on a hook. * Keep in a dry place. | * Inaccurate measurements due to damaged tools. * Injuries from retracting tape quickly. | * Clean after use. * Check for kinks or wear in the tape. |
| Insulated tools (Screwdrivers, Pliers) | * Use for electrical work only. * Ensure insulation is intact before use. | * Store separately from non-insulated tools. * Keep away from sharp objects. | * Electric shock if insulation is compromised. * Damage to insulation from improper storage. | * Inspect insulation for cracks or wear. * Clean with a non-conductive cleaner. |

1. **First aid**

First aid is the immediate treatment provided to a sick or injured person before professional medical services arrive. It involves using common equipment and readily available materials. First aid can help the sick or injured experience immediate or temporary relief until they are taken to a hospital. There are three main purposes of first aid:

1. To save lives.
2. To prevent the situation from worsening.
3. To improve the situation.

Principles of first aid:

1. Check whether the patient is breathing or not. Assess the patient for any respiratory distress.
2. Do not allow a crowd to gather around the injured person, as they need fresh air.
3. Identify injuries on the body as soon as possible. During this time the first aider should remain calm.
4. If the patient's breathing has stopped, begin artificial respiration immediately.
5. If there is profuse bleeding, it should be stopped.
6. Arrange for transportation to the health facility immediately, even if the condition of the injured is not critical.
7. Keep the injured person warm and in a comfortable position.
8. Inform the police about serious or complex incidents.
   1. **Electric Shock: Causes, symptoms, and dangers**

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| **Causes** | **Symptoms** |
| * Direct contact with electrical sources * Faulty electrical equipment * Improper wiring * Contacting electrical sources with wet hands or standing on a wet surface * Insufficient insulation | * Electrical **burns** on the skin where the current entered or exited the body. * **Breathing difficulties** if the shock affects the respiratory muscles. * **Possible loss of consciousness** or confusion. * **Irregular heartbeats** or cardiac arrest |

* + 1. **Rescuing the electric shock victim**
  1. Proceed with treatment as early as possible, without panicking or becoming emotional.
  2. Switch off the power, unplug the device or safely remove the cable.
  3. Move the victim away from contact with the live conductor using dry non-conducting materials like wooden bars.
  4. Keep the patient warm and ensure they are mentally at ease.
  5. Loosen clothing near the neck, chest and waist, and place the victim in a relaxed position if they are unconscious.
  6. Keep the victim warm and comfortable.
  7. Cool the burns with running water.
  8. Clean the burned area using a clean cloth/cotton.
  9. Send someone to call a doctor immediately.
  10. **Fracture**

A fracture is a break or crack in a bone, which can be classified as either closed (where the skin remains intact) or open (where the bone protrudes through the skin).

* + 1. **Types of fractures**

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| **Basis to identify** | **Closed fracture (Simple fracture)** | **Open fracture (Compound fracture)** |
| **Description** | The bone is broken but does not penetrate the skin. | The bone breaks and protrudes through the skin, creating an open wound. |
| **Symptoms** | Pain, swelling, bruising, and difficulty moving the affected limb. There is no visible open wound. | Severe pain, visible bone through the skin, heavy bleeding, and increased risk of infection. |

* + 1. **Symptoms of fractures**
* Intense **pain** at the site of the fracture, which may worsen with movement.
* **Swelling** around the injured area.
* Discoloration or **bruising** near the fracture site.
* Visible **deformity** or abnormal angling of the limb.
* Difficulty or **inability to move** the affected limb.
  + 1. **First aid measures for fractures**

Understanding the types of fractures, their symptoms, and appropriate first aid measures is crucial for effectively managing fractures in emergency situations. Immediate and correct first aid can significantly impact the outcome and recovery process, making it essential for individuals to be prepared and knowledgeable about these procedures.

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| 1. Do not move the victim unless they are in danger. |  |
| 1. Examine the victim closely for the presence of other injuries and call for professional medical help. | Ambulance Car Vector Art, Icons, and Graphics for Free Download |
| 1. If there is a break in the surface of the skin, rinse it gently to remove any visible dirt or other potential contaminants. Avoid vigorous flushing or scrubbing of the wound. |  |
| Rigid Splints & Triangular Bandages (Set) | Red Cross Store |  |
| 1. Immobilize the broken bone using splint or string as shown above. You can use rolls of newspaper or strips of wood for this purpose. | |

* 1. **Burns**

A burn is tissue damage caused by heat or a corrosive chemical substance, in which damage is caused to the skin and possibly the tissues beneath it. If the skin is not cooled, the injury will spread to deeper layers. Tissue or skin damage can be caused by a hot object, liquid or steam. Other causes include a corrosive substance, radiation and electricity.

* + 1. **Symptoms of a burn**
* Superficial burn injury: The skin is red, dry, swollen, and sore
* Deep burn injury: The skin is red and swollen, blisters form in the area. Extremely burned skin is dry, hard, charred, and numb.
  + 1. **First aid for a burn**
* Cool the burn immediately with cool water for approximately 20 minutes.
* If the injured area is extensive or the injured person is a child, be sure not to cool too much and keep the injured person otherwise warm.
* A burn can be covered lightly using a clean bandage. Do not break the blisters. Superficial burns usually heal by themselves in a few weeks.
  + 1. **Medical care is needed if the burn is**
* Extensive or deep.
* Blistered and larger than the palm of the injured person.
* On the face, joint areas, mucous membranes, or in the respiratory tract.
* Caused by electricity, a chemical substance, radiation or steam.
  1. A young child and child looking at a bandage on a hand

     Description automatically generated**Cuts and wounds (or lacerations)**

A wound is a form of damage in the skin or mucous membrane, which may be associated with profuse bleeding. The right kind of first aid can reduce bleeding and help a wound heal. The healing of the wound is affected by its size and location, cleanliness, and the injury mechanism (wound type). Tattered or dirty wounds or wounds on mobile areas heal slower.

* + 1. **Common causes of wounds**
* Scratch, or flesh wound: graze, falling.
* Puncture wound: needle, nail, or another sharp object.
* Cut: paper, knife.
* Bruise: falling, being hit, being squeezed.
* Bite: the bite of a human or animal.
* Gunshot wound: firearm, nailer, or similar.
  + 1. **Symptoms of a wound**
* Symptoms of a wound include bleeding, tattered or neat edges of the wound and a foreign object or dirt in the tissue.
  + 1. **First Aid for a wound**
* Stop the visible bleeding by applying pressure to the wound.
* Clean the wound under cool running water.
* If the wound is a small cut (made by a knife or paper, for example) press the edges together and close the wound with surgical tape.
* If there is a foreign object attached to the tissue (for example a splinter or a knife), do not remove it.
* Cover the wound with a protective bandage.
* Ensure that your tetanus vaccine is valid.
  + 1. **Medical care is needed if**
* The wound is tattered, deep, or several centimeters long.
* Bone, muscle, or other tissue is visible in the wound.
* There is a foreign object in the wound.
* Bleeding cannot be stopped.
* There is dirt in the wound and you are unable to clean it.
* The wound is a bite wound.
* You need a tetanus vaccination.
* The wound is in a joint area or on the face.
* The wound is infected.