

E Light Electric Services, Inc

Electrical Safety for DC and AC Solar Production

General Safety Procedures

E Light Electric Services, Inc

This policy and procedure is an addendum to the E Light Electric Services Energized Electrical Policy. The stricter requirement of either policy shall be used in the event of a conflict between the two policies.

This policy and procedure is to be used as base policy for all solar production plants and solar commercial installations. A specific process shall be written for each jobsite or project and shall detail exact processes to be used and PPE to be worn for that specific job site.

Purpose

This Electrical Safety program is designed to prevent electrically related injuries and property damage in Solar installations. Only employees qualified in this program may conduct adjustment, repair or replacement of electrical components or equipment. Electricity has long been recognized as a serious workplace hazard, exposing employees to such dangers as electric shock, electrocution, fires and explosions. References: NFPA 70E 2009, Electrical Safety Requirements for Employee Workplaces, National Electrical Code (NEC) 2011 and OSHA Standard (Electrical Safety) 29 CFR 1910.331 to 1910.339

Responsibilities

Management / Supervision /Corporate

- Provide training for qualified and unqualified employees

- Conduct inspections to identify electrical safety deficiencies

- Preplan all work, write job safety analysis, develop, review and approve energized work permits

- Guard and correct all electrical deficiencies promptly

- Ensure all new electrical installations meet codes and regulations

- Develop Site Specific procedure and policy for each project

Employees

Report electrical deficiencies immediately

Not work on electrical equipment unless authorized and trained

Properly inspect all electrical equipment prior to use

Hazard Control

Engineering Controls

- All electrical distribution panels, breakers, disconnects, combiner boxes, inverters, switches, junction boxes shall be completely enclosed
- Water tight enclosure shall be used where there is possibility of moisture entry either from operations or weather exposure
- Electrical distribution areas will be guarded against accidental damage by locating in specifically designed rooms, use of substantial guard posts and rails and other structural means
- Only approved personnel shall be allowed access to energized equipment and unqualified person shall not be allowed to enter an area closer than 10 feet from any energized and open panel, combiner box, inverter, etc.
- A one line diagram shall be developed that shows the feeders, disconnects, combiner boxes and inverters for the entire project. This diagram shall be developed in such a way that a qualified person may use it to determine all sources of energy on any given piece of equipment. This diagram will be turned over to the owner at the completion of the project. This diagram must be complete before any testing, troubleshooting or commissioning may proceed.

Administrative Controls

- All areas deemed to Electrically Hazardous- LIVE PARTS, by the Safety Manager, shall be marked on their entire perimeter with Red Rope. The rope shall be placed so that entry into the area cannot be accomplished without visibly and obviously crossing the red rope.
 - Only persons that have completed the projects LOTO and Electrical Hazard Training Course shall be permitted to cross into a red rope area. Personnel that have not completed this training that cross a red rope shall be permanently removed from the site.
 - All persons shall receive a pocket card signed by the instructor upon completion of the LOTO and Electrical Hazard Training and all

personnel shall have a LOTO sticker placed on their hard hat for fast identification.

- No person shall enter a RED ROPE area before submitting a RR ACCESS FORM to the Safety Manager and receiving back an approved authorization to enter a RR area. The approved authorization must be kept with any crew that has entered a red rope area. Safety team members may ask to review the authorization periodically. Any person that is in a Red Rope area that can not produce a written authorization form shall be escorted out of the red rope area and may be subject to further disciplinary action.
- Only trained and authorized employees may conduct repairs, testing, commissioning, or any work on energized electrical equipment in excess of 50 volts.
- Authorized personnel are those personnel that have a Colorado Journeyman Wireman's license **and** have completed the E Light Electric Services Energized Electrical Work course successfully.
 - The E Light Electric Services Energized Electrical Work course shall be developed and administered on Solar Projects specifically for each project. Personnel shall be required to complete the course for each project separately.
- Areas under new installation or repair will be sufficiently guarded with physical barriers and warning signs to prevent unauthorized entry. Only persons that have been approved and trained may enter into an area that contains energized equipment.
- Access to electrical distribution rooms is limited to those employees who have a need to enter and have received authorization from the E Light Wind and Solar competent person.
- All electrical control devices shall be properly labeled
- Work on energized circuits is prohibited unless the procedures of the E Light Electric Services Energize Work Policy and Procedure have been completed and all permits have been completed and approved.

Protective Equipment

- Qualified employees will wear electrically rated safety shoes/boots.
- All tools used for electrical work shall be properly insulated
- All protective equipment shall be selected for each operation based on the conditions and the job safety analysis. The PPE shall be selected by using

Tables 130.7(C)(9) and Table 130.7(C)(10) from NFPA 70E, 2009 edition.

- Electrically rated matting will be installed in front of all distribution panels, inverters, combiner boxes, etc. before any energized work is performed.
- All work shall be done in accordance with Article 120 of NFPA 70E as much as possible and work that cannot be brought to an electrical safe work condition shall be done in accordance with Article 130 of NFPA 70E, 2009 edition.

Electrical Equipment

Examination

Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined using the following considerations:

- Suitability for installation and use in conformity with the provisions of this subpart. Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that identified purpose.
- Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.
- Electrical insulation.
- Heating effects under conditions of use.
- Arcing effects.
- Classification by type, size, voltage, current capacity, and specific use.
- Other factors which contribute to the practical safeguarding of employees using or likely to come in contact with the equipment.
- All factors shall be listed on the job safety analysis and energized work permit before any energized may be performed.

Identification of Disconnecting Means and Circuits

Each disconnecting means for solar panels, arrays, inverters, combiner boxes and transformers shall be legibly marked to indicate its purpose. Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose. These markings shall be of sufficient durability to withstand the environment involved.

The main disconnecting means for the utility shall be clearly marked and all personnel that will be working in energized areas shall be trained as to its location and operation.

Definition of Terms

Qualified Worker: An employee trained and authorized to conduct electrical work.

Unqualified: Employees who have not been trained or authorized by management to conduct electrical work.

Authorized Worker: An employee that has successfully completed the LOTO and Electrical Hazards Training and has been authorized to enter a red rope area after submitting an RR ACCESS Form and receiving back an approved authorization form.

Electrical Competent Person

A person that is licensed as a wireman, is experienced in electrical safety and supervision and who can meet all the requirements of an OSHA competent person and who has been designated by E Light Wind and Solar to be the electrical competent person on site.

The competent person shall inspect all energized work permits, inspect all electrical PPE before each use and shall conduct a safety briefing with the work crews before any energized electrical work is performed. The competent person shall review and if they approve, sign all RR ACCESS Forms. No RR ACCESS form may be approved without the approval of the Electrical Competent Person.

The competent person shall inspect daily:

All locked out areas and equipment

All areas of work where energized equipment is present

The disconnecting means at the utility

All areas of work where energized work may be performed

Energized Work

Any work that is in areas where solar panels have been installed and work is being performed on or near cables, equipment or panels and were all of the steps of an Electrically Safe Work Condition as defined by Article 120.1 of NFPA 70E, 2009 Edition cannot be successfully completed shall be considered energized work.

Training

Training for Unqualified Employees

Training for Unqualified Employees in general electrical safety precautions to provide an awareness and understanding of electrical hazards. No person may enter an area that has solar panels installed until they have completed this training. This training shall be a part of all employees orientation.

Electrical Safety Rules for Non-Qualified Workers

1. Do not conduct any repairs to electrical equipment
2. Report all electrical deficiencies to your supervisor
- 3 Do not operate equipment if you suspect and electrical problem
4. Water and electricity do not mix.
5. Even low voltages can kill or injure you
6. Solar panels do not have an off switch. Cables, equipment and panels are energized all the time and there is a great potential of arc blast and severe electrical shock.
7. Introduction to Electrical Hazards
8. Introduction to NFPA 70E
9. Introduction to Lock Out and Tag Out

LOTO and Electrical Hazards Training for Qualified Personnel

1. Site specific requirements for Lock out and Tag Out
2. Site specific electrical hazards
3. Site one line diagram to include all disconnecting means locations, circuits, isolation of AC and DC and isolation of circuits
4. Site specific additional hazards
5. Electrical Hazards Refresher including Arc Blast

Electrical Lockout & Tagout Requirements

Application of locks and tags.

A lock and a tag shall be placed on each disconnecting means used to de-energize circuits and equipment on which work is to be performed. Except as provided for

below, a single lock shall be placed for each potentially exposed employee. Lock boxes and complex lock out procedures shall be developed for each situation where a single lock for each employee cannot be achieved due to multiple power sources. The plan shall be approved by the Vice President of Operations and the Director Education and Loss Prevention.

1. Locks shall be attached so as to prevent persons from operating the disconnecting means.
2. Each tag shall contain a statement prohibiting unauthorized operation of the disconnecting means and removal of the tag.
3. A tag or label shall be placed on each lock to identify when it was placed and by whom.
4. A supervisor's lock may be placed on equipment as a shift continuation lock only. It may not be used as a LOTO device. Each employee must place their individual lock on the disconnecting means.
5. Each employee shall remove their lock from the disconnecting means when they are no longer exposed to the hazard. Employees may not leave their locks in place overnight or between shifts.

Working at Elevated Locations

Any person working on electrical equipment on a crane or other elevated must take necessary precautions to prevent a fall from reaction to electrical shock or other causes. A second person, knowledgeable as a safety watch, must assume the best possible position to assist the worker in case of an accident. Portable ladders shall have non-conductive side-rails if they are used where the employee or the ladder could contact exposed energized parts.

General Protective Equipment and Tools

General Protective Equipment and Tools shall be used when in the proximity of, or working on, exposed energized parts. The following rules apply:

1. When working on or near exposed energized parts, Qualified Employees shall use insulated tools or handling equipment suitable for the voltage present and working environment. In cases where the insulation may be damaged, a protective outer layer should be employed.
2. Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install fuses when the terminal is energized.
3. Ropes and other hand-lines used near exposed energized equipment shall be non-conductive.
4. Discharge sticks and proximity testers shall be used to ground conductors that have been energized if the conductors operate at over 600Vs.

5. Each conductor shall be tested with an operable and verified meter to ensure it is de-energized before discharging the conductor to ground.
6. Work on de-energized equipment that normally operates at 600V or greater requires the use of grounding chains and each phase shall be grounded in accordance with recognized safety practices as defined by American Lineman's Handbook prior to any work being done.
7. A written procedure shall be submitted and approved by the Director of Education and Loss Prevention and the Vice President of Operations before any work may be done on energized equipment or cables may be performed.

Warnings and Barricades

Warnings and barricades shall be employed to alert unqualified Employees of the presence of dangers related to exposed energized parts. The following rules apply:

1. Safety signs, warning tags, etc., must be used to warn Unqualified Employees of the electrical hazards present, even temporarily, that may endanger them.
2. Non-conductive barricades shall be used with safety signs to prevent Unqualified Employees access to exposed energized parts or areas.
3. Where barricades and warning signs do not provide adequate protection from electrical hazards, an Attendant shall be stationed to warn and protect Employees.
4. Red Rope shall be used to barricade all areas that have been determined to be Hazardous and Live by the Site Safety Manager.

Standard Operating Procedure

Electrical Pre-Work Procedure

Except in extreme cases, work on electrical equipment will be done with all electrical circuits in the work area de-energized by following the Lockout/Tagout procedure. When working on or near energized electrical circuits with less than 50 volts to ground, the equipment need not be de-energized if there will be no increased exposure to electrical burns or to explosion from electric arcs.

To prepare for work on electrical systems or components, the following procedure applies:

Caution: Treat all electrical circuits as "Live" until they have been Tagged and Locked Out and tested by the following procedure.

1. Obtain permission from supervisor to conduct work

2. Prepare a Job Safety Analysis and brief the crew on the hazards
3. Lockout and Tagout all sources of electrical power in accordance with site procedures and log all Lockout devices in the Lock-Out Log.
4. Verify de-energized condition before any circuits or equipment are considered and worked as de-energized.
 - A. A qualified person shall operate the equipment operating controls or otherwise verify that the equipment cannot be restarted.
 - B. Verify proper operation of the Voltmeter at a live electrical source of the same rated voltage as the circuit to be worked.
 - C. Using the Voltmeter, check all exposed circuits phase to phase and phase to ground for evidence of voltage/current in the circuit.
 - D. Conduct work on the circuit only after determining that there is no voltage in any of the exposed circuits.
 - E. If the conductors or equipment are operating at over 600V, the conductors must be grounded to ensure any stored charges are discharged.
 - F. If voltage is detected in any exposed circuit, STOP, inform supervisor and determine source and procedure to eliminate voltage.
4. Conduct work
5. Close up all exposed circuits, boxes, controls, equipment.
6. Remove Lockout/Tagout devices and record on the Lock Out Log
7. Obtain supervisor permission to energize circuits

Standard Operating Procedure

Working on or Near Exposed Energized Circuits

In the rare situation when energized equipment or working in near proximity to energized equipment that cannot be de-energized, the following work practices must be used to provide protection:

Caution: Unqualified Employees are prohibited from working on or near exposed energized circuits.

1. Obtain permission from Manager to work on or near energized electrical circuits by completing an energized work permit and obtaining all reviews and approvals as required by energized work practices policy.
2. Lockout and Tagout all circuits possible

3. Treat all circuits as energized.
4. Remove all conductive clothing and jewelry (rings, watches, wrist/neck chains, metal buttons, metal writing instruments, etc.).
5. Use proper personal protective equipment, shields and/or barriers to provide effective electrical insulation from energized circuits. This may include electrically rated insulated gloves, aprons, rubber soled shoes, insulated shields, insulated tools, etc.
6. Provide adequate lighting. Do not enter areas with exposed energized parts unless illumination (lighting) is provided so that Employee may work safely. Do not reach around obstructions of view or lighting (blindly) into areas where exposed energized parts are located.
7. Employees entering a Confined Space with exposed energized parts, must use protective barriers, shields, or equipment or insulated materials rated at or above the present voltage to avoid contact.
8. Doors or other hinged panels shall be constructed and secured to prevent them from swinging into an Employee and causing contact with exposed energized parts.
9. Housekeeping in areas of exposed energized parts may not be completed in areas with close contact unless adequate safeguards (insulation equipment or barriers) are present. Conductive cleaning material (Steel Wool, Silicon Carbide, etc.) or liquids may not be used unless procedures (Lock and Tag Out, etc.) are in place and followed.
10. Station a safety observer outside work area. The sole function of this person is to quickly de-energize all sources of power or pull worker free from electrical work area with a non-conductive safety rope if contact is made with an energized electrical circuit.
11. A person qualified in CPR must be readily available to the scene.

Standard Operating Procedure

Re-energizing Electrical Circuits After Work Completed

These requirements shall be met, in the order given, before circuits or equipment may be reenergized, even temporarily.

1. A qualified person shall conduct tests and visual inspections, as necessary, to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed, so that the circuits and equipment can be safely energized.
2. Warn employees exposed to the hazards associated with reenergizing the circuit or equipment to stay clear of circuits and equipment.

3. Remove each lock and tag. They shall be removed by the employee who applied it or under his or her direct supervision. However, if this employee is absent from the workplace, then the lock or tag may be removed by a qualified supervisor designated to perform this task provided that:

A. The supervisor ensures that the employee who applied the lock or tag is not available at the workplace, and

B. The supervisor ensures that the employee is aware that the lock or tag has been removed before he or she resumes work at that workplace.

4. Conduct a visual determination that all employees are clear of the circuits and equipment.

