Electrical Safety Program (ESP)

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Purpose

The purpose of this policy is to ensure that electrical work around or on energized electrical equipment, parts, and circuits is performed only when necessary and only when it is a critical task or for the purposes of troubleshooting and testing. It is the intention of E Light Electric Services to work on equipment and systems while they are in an electrically safe work condition. We recognize that it is not always possible to achieve an electrically safe work condition and it is our intention to have all energized electrical work performed in a safe manner according to this policy and to be compliant with the requirements of The Standard for Electrical Safety in the Workplace (NFPA 70E) 2021 Edition.

Scope

This program applies to all electrical work (including testing and troubleshooting) performed by E Light Electric Services employees regardless of job site location. The Program has been established to ensure the safety of employees who may work on or near electrical equipment 600 volts or less. These employees must comply with 29 CFR 1910 Subpart S of the Occupational Safety and Health Administration (OSHA) and National Fire Protection Association (NFPA) 70E 2021 edition.

Employees working on voltages higher than 600 volts shall comply with the OSHA 29 CFR 1910 Subpart R, specifically 29 CFR 1910.269 (Electric Power Generation, Transmission, and Distribution), and the Institute of Electrical and Electronics Engineers (IEEE) 2007 National Electric Safety Code. All employees must understand and comply with safety standards related to electrical work and follow the uniform practices outlined in this document when engaged in electrical work.

Definitions

Arc Flash Hazard - A source of possible injury or damage to health associated with the release of energy caused be an electric arc. (NFPA 70E Art. 100)

Arc Flash Rating - The value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in Calories per square centimeter (cal/cm2). (NFPA 70E Art. 100)

Authorized Lockout/Tagout Employee - A person who locks or implements a tagout system procedure on machines or equipment to perform the servicing or maintenance on that machine or equipment. An authorized employee and an affected employee may be the same person when the affected employee’s duties also include performing maintenance or service on a machine or equipment, which must be locked out, or a tagout system implemented.

Balaclava - An arc-rated head-protective fabric that protects the neck and head except for a small portion of the facial area.

Boundary - Distance limits for various aspects of electrical work:

1. **Arc Flash Protection Boundary:** When an arc flash hazard exists, an approach limit at a distance from an arc source at which an incident energy level of 1.2 cal/cm2.
2. **Shock Boundaries:**
    a. Limited Approach Boundary: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.
    b. Restricted Approach Boundary: An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc-over combined with inadvertent movement. (NFPA 70E Art. 100)

Competent person - A person meeting all of the requirements of a qualified person, and, in addition, is responsible for all work activities or safety procedures related to custom or special equipment, and has detailed knowledge regarding the electrical hazard exposure, the appropriate controls for mitigating those hazards, and the implementation of those controls. (NFPA 70E Art. 350)

Critical Task - Any task requiring work to be performed on electrical equipment or systems where it has been determined that interrupting the electrical power to that equipment or system could create a greater hazard to persons or property.

De-energized. Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of earth. (NFPA 70E Art. 100)

Disconnecting (or Isolating) Switch (Disconnector, Isolator). A mechanical switching device used for isolating a circuit or equipment from a source of power. (NFPA 70E Art. 100)

Electrically Safe Work Condition. A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection. (NFPA 70E Art. 100)

Energized. Electrically connected to or is, a source of voltage. (NFPA 70E Art. 100)

For the purposes of this policy energized shall mean that equipment or wiring is a source of or connected to electrical energy in excess of 50 volts. Any equipment or wiring that has not been placed in an electrically safe work condition shall be considered to be energized.

- Electrical connections at Solar Panels, once connected and during anytime which the sun is shining shall be considered to be energized and under load. Only journeymen or authorized and qualified personnel shall be allowed to disconnect MC4 and other type connectors while in this condition and then only while wearing insulated rubber gloves.

Evidence of Impending Failure. Evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration. (NFPA 70E Art. 130)

Exposed electrical parts. Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated. (NFPA 70E Art. 100)

Fault Current, Available. The largest amount of current capable of being delivered at a point on the system during a short circuit condition. (NFPA 70E Art. 100)

Field Evaluated. A thorough evaluation of non-listed or modified equipment in the field performed by persons or parties acceptable to the Authority Having Jurisdiction (AHJ). The evaluation approval ensures that the equipment meets appropriate codes and standards or is similarly found suitable for a specified purpose. (NFPA 70E Art. 350)

Ground. A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth. (OSHA 29 CFR 1910.399)

Ground Fault Circuit Interrupt (GFCI). A device intended for the protection of personnel that functions to de-energize a circuit or a portion of a circuit within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit. (OSHA 29 CFR 1910.399)

Hazard Assessment. Process of identifying hazards and associated with a defined task and prescribing personal protective equipment (PPE) along with other relevant protection measures which must be employed to reduce the risk from the hazards.

Hazardous Location. An area in which an airborne flammable dust, vapor or gas may be present and would represent a hazard if a source of ignition were present (see NFPA Class I & II and Division 1 & 2). (NFPA 497)

Listed. Equipment, materials or services included in a list published by an organization that is acceptable to AHJ and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states they meet appropriate designated standards or has been tested and found suitable for a specific purpose. (NFPA 70E Art. 100)

Location, Damp. Partially protected locations subject to moderate degrees of moisture, such as some basements, barns and cold-storage warehouse. (OSHA 29 CFR 1910.399)

Location, Dry. Locations not normally subject to dampness or wetness. (OSHA 29 CFR 1910.399)

Location, Wet. Installations underground or in concrete slabs or masonry in direct contact with the earth, and locations subject to saturation with water or other liquids, such as vehicle-washing areas, and locations unprotected and exposed to weather. (OSHA 29 CFR 1910.399)

Lockout/Tagout. A standard that covers the servicing and maintenance of machines and equipment in which the unexpected re-energizing or startup of the machines/equipment or release of stored energy could cause injury to employees. It establishes minimum performance requirements for the control of such hazardous energy.

Maintenance, Condition of. The state of the electrical equipment considering the manufacturers' instructions, manufacturers' recommendations, and applicable industry codes, standards, and recommended practices. (NFPA 70E Art. 100)

Motor Control Center. A modular assembly specifically designed to plug in motor control units. Motor control centers are supplied by a common bus, usually straight from the switchboard. (NFPA 70E Art. 100)

Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent devices, and with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front. (NFPA 70E Art. 100)

Personal Protective Equipment (PPE). Equipment such as protective clothing, respiratory device, shields and barriers used to protect against hazards and irritants capable of causing injury or impairment through absorption, inhalation or physical contact.

Properly Installed. The equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. (NFPA 70E Art. 130)

Properly Maintained. The equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. (NFPA 70E Art.130)

Qualified Person. One who received training and has demonstrated skills and knowledge in the construction and operation of equipment or a specific work method and be trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method.

- **Notes:**
    - Whether a person is considered to be a "qualified" person will depend upon various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered "qualified" with regard to certain equipment or tasks in the workplace, but "unqualified" as to other equipment or tasks.
    - An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties. (NFPA 70E Art. 110, OSHA 29 CFR 1910.399)

- Example: Fourth-year apprentices that have completed E Light Electric Services Inc.'s "Energized Electrical Work" training program may participate in energized electrical work under the direct supervision of a qualified person.

- To be considered "Qualified" the person must also be familiar with NFPA 70E 2021 and have received training on finding and understanding the requirements of NFPA 70E 2021. The person must also have a current CPR/ First Aid certification. E Light Electric Services recognizes licensed Journeyman and Master Electricians who have successfully completed our "Energized Electrical Work" training program and have met the other requirements listed herein as qualified.

Risk. A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard. (NFPA 70E Art. 100)

Risk Assessment. An overall process that identifies hazards, estimates the potential severity of injury or damage to health, estimates the likelihood of occurrence of injury or damage to health, and determines if protective measures are required. (NFPA 70E Art. 100)

Service. The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served. (OSHA 29 CFR 1910.399)

Service Equipment. The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the entrance of supply conductors to the building and intended to constitute the main control and means of cutoff of the supply. (OSHA 29 CFR 1910.399)

Switchboard. A large single panel, frame, or assembly of panels on which are mounted, on the face or back, or both, switches, overcurrent and other protective devices, buses, and (usually) instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. (OSHA 29 CFR 1910.399)

Switching Devices. Devices designed to close and/or open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, interrupter switches, and oil (filled) cutouts. (OSHA 29 CFR 1910.399)

Voltage (of a circuit). The greatest root-mean-square (effective) difference of potential between any two conductors of the circuit concerned. (NFPA 70E Art. 100)

Voltage, nominal. An approximate value assigned to a circuit or system for the purpose of conveniently designating its voltage class, e.g., 120/240, 480/277, and 600. (NFPA 70E Art. 100)

Working Distance. The distance between a person's face and chest area and a prospective arc. (NFPA 70E Art. 100)

Working On (energized electrical conductors or circuit parts). Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment (PPE) a person is wearing. There are two categories of “working on”: Diagnostic (testing) is taking readings or measurements of electrical equipment, conductors, or circuit parts with approved test equipment that does not require making any physical change to the electrical equipment, conductors, or circuit parts. Repair is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Responsibilities

Management

Management shall:

- Provide leadership and support.
- Make necessary provisions to assist the Program Administrator, Supervisors, and Employees in their compliance with this program.

Program Administrator

The Director of Education and Loss Prevent shall function as the Program Administrator. The Program Administrator shall:

- Identify work tasks that require a Qualified Person
- Arrange, review, and periodically conduct electrical safety inspections
- Arrange training for employees.
- Review this program annually and make revisions as necessary.
- Maintain a list of all Qualified Persons.

Supervisors

Supervisors shall:

- Conduct periodic work inspections using the “Electrical Hazard Inspection” template on iAuditor.
- Ensure employees are provided with and use the appropriate PPE.
- Ensure employees comply with all aspects of this program.

Electrical Safety Principals

Electricity is the second most powerful force that mankind has learned to harness. As electricians, we are exposed to additional electrical hazards because we interface with electrical equipment and wiring with the normal protections removed. We must be ever vigilant to ensure that we are always safe. We are proud of what we do and what we do is vital to all of humanity but what we do is not worth risking our lives.

E Light Electric Services Inc. has developed the following electrical safety principles:

- Ensure every employee has been adequately trained and that only qualified electrical workers are used on tasks that require qualification.
- Plan Every Job – Any task requiring work on a live circuit must be planned and have a written procedure. Employees must be trained on the procedure along with the potential hazards and mitigations prior to executing the task. The procedure, hazards and mitigations must be discussed prior to the start of the task.
- Identify Hazards – A Job Hazard Analysis must be conducted for each task. Steps carrying the risk of electric shock or arc flash must be identified.
- Minimize Hazards – De-energize equipment unless doing so would introduce a greater hazard. Insulate or isolate exposed live parts to avoid contact. Use appropriate PPE and electrically safe tools.
- Energized Work Permit – **DE-ENERGIZE IF POSSIBLE** – An Energized Work Permit is required to do any energized work beyond testing and troubleshooting.
- Anticipate Problems – Have a contingency plan. Have the proper PPE and tools available.
- When energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts are not put into an electrically safe work condition all of the following requirements shall apply:
    - Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
    - An energized electrical work permit shall be completed.
    - A shock risk assessment shall be performed.
    - An arc flash risk assessment shall be performed.

Training Requirements

The training requirements contained in this electrical safety program shall apply to all employees exposed to an electrical hazard when the risk associated with that hazard is not reduced to a safe level as required by the **National Electrical Code** and **NFPA 70E** requirements. Such employees will be trained to identify and understand the relationship between electrical hazards and possible injury.

Such employees shall be trained to understand the specific hazards associated with electrical energy. They shall be trained in safety-related work practices and procedural requirements, as necessary, to provide protection from the electrical hazards associated with their respective job or task assignments. Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury.

The training for qualified and unqualified employees will involve both classroom and on-the-job-training. Training must be performed before the employee is assigned duties involving work around or on electrical systems.

General

1. All employees shall receive Electrical Safety training during new hire orientation.
2. Energized Electrical Work Practices and NFPA 70E training shall be included in the E Light Electric Service's apprentice curriculum as follows:
    a. Freshmen shall receive electrical safety training including LOTO requirements.
    b. Sophomores shall receive electrical safety training including grounding requirements.
    c. Juniors shall receive an Introduction to NFPA 70E.
    d. Seniors shall be trained in the use of PPE, completion of hazard analysis and work permits, and the requirements of NFPA 70E.
3. Journeymen and new hires shall receive and successfully complete NFPA 70E training and refresher training annually.
4. All employees working in the field shall be required to complete NFPA 70E refresher training annually.

Emergency Response - Supervisors and Qualified Persons

1. Contact Release Training. Employees exposed to shock hazards shall be trained methods of safe release of victims from contact with exposed energized electrical conductor or circuit parts, as well as site-specific emergency procedures.
2. First Responders. Supervisors and qualified persons shall be trained in the following:
    a. First aid and Emergency procedures.
    b. Cardiopulmonary Resuscitation (CPR)
    c. Automated External Defibrillator (AED); (if the emergency response plan includes the use of this device.)
    d. Site specific emergency procedures.

Unqualified Persons

Unqualified persons shall be trained in, and familiar with, any of the electrical safety-related practices necessary for their safety. Such training shall include:

1. Basic electrical safety awareness.
2. General electrical safety-related practices (i.e., damaged cords, exposed wiring, etc.).
3. Labeling requirements.

4. Using cord and plug equipment.
5. Limited approach boundaries and arc flash boundary.
6. Safe work practices for wet or damp environments.
7. Unqualified Persons who perform work on electrical equipment with capacitors shall be trained in the necessary safe work practices to safely perform the work.

Exception: Fourth year apprentices that have completed the "Energized Electrical Work" training program may participate in energized electrical work under the direct supervision of a qualified person.

Employees shall be trained to select an appropriate test instrument and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall include information that enables the employee to understand all limitations of each test instrument that might be used.

Qualified Persons

Qualified Persons shall be trained and knowledgeable in the construction and operation of equipment to be worked on and the safe work practices required.

Qualified electrical workers must know how to properly select and use:

1. Best work practices
2. Appropriate insulating and shielding materials.
3. Tools and equipment for working on or near energized parts.
    a. A device to verify the absence of voltage.
    b. An appropriate voltage detector
    c. PPE determined from the arc flash label, NFPA 70E Table 130.5(G), NFPA 70E Table 130.7(C)(15), and/or E Light PPE Policy.

In addition, qualified electrical workers must have knowledge and understanding as well as skills and techniques necessary to:

1. Interpret indications provided by a device to verify the absence of voltage.
2. Recognize the limitations of specific types of voltage detectors.
3. Determine the nominal voltage of exposed live parts.
4. Distinguish exposed live parts from other parts of electric equipment.
5. Determine the approach distances corresponding to the voltages specified in the following NFPA 70E tables:
    a. NFPA 70E Table 130.4(D)(a) Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection for Alternating-Current Systems

   b. NFPA 70E Table130.4(D)(b) Approach Boundaries to Energized Electrical Conductors or Circuit Parts for Shock Protection, Direct-Current Voltage Systems

6. Avoid the electrical hazards associated with work inside shock approach and arc flash boundaries of exposed energized parts.
7. Determine hazards, risks as well as appropriate protective clothing and equipment requirements using arc flash analysis labels or the following NFPA 70E tables:
   a. NFPA 70E Table 130.5(C) Estimate of the Likelihood of an Arc Flash Incident for AC and DC Systems
   b. NFPA 70E Table 130.5(G) Selection of Arc-Rated Clothing and Other PPE When the Incident Analysis Method Is Used
   c. NFPA 70E Table130.7(C)(15)(a) Arc-Flash Hazard PPE Categories for Alternating Current (ac) Systems
   d. NFPA 70E Table 130.7(C)(15)(b) Arc-Flash Hazard PPE Categories for Direct Current (dc) Systems
   e. NFPA 70E Table 130.7(C)(15)(c) Protective Clothing and Personal Protective Equipment (PPE)
8. Recognize the signs and symptoms of electric shock, heart fibrillation, electric burns and contact emergency personnel at 911.
9. Qualified Persons who perform work on equipment with capacitors shall be trained in the necessary safe work practices to safely perform the work.

   ONLY QUALIFIED PERSONS SHALL PERFORM WORK ON EQUIPMENT WITH CAPACITORS ANYTIME THE FOLLOWING HAZARD THRESHOLDS ARE EXCEEDED:

   a. Less than 100 volts and greater than 100 joules of stored energy.
   b. Greater than or equal to 100 volts and greater than 1.0 joule of stored energy.
   c. Greater than or equal to 400 volts and greater than 0.25 joules of stored energy.

The qualified person must also have a current CPR/ First Aid certification.

E Light Electric Services recognizes licensed Journeyman and Master Electricians who have successfully completed our “Energized Electrical Work” training program and have met the other requirements listed herein as qualified.

Retraining

Journeymen and new hires shall receive and successfully complete NFPA 70E training and refresher training annually.

Additionally, an employee must receive additional training (or retraining) when any of the following conditions are met:

- Supervision or annual inspections indicate that the employee is not complying with the established safety-related work practices.
- Safety-related work practices not normally used during regular job duties are employed.
- New technology, new types of equipment, or changes in procedures require using safety-related work practices different from those normally used.

Documenting Training and Experience

Electrical training and experience documentation shall be retained by the E Light Electric Services Inc. Safety Department.

Electrical System Requirements

1. All electrical equipment will be maintained in accordance with the manufacturer's instructions or industry consensus standards. Appropriate maintenance, testing, and inspection records will be documented.
2. Single-line diagrams for the electrical system shall be maintained in a legible condition and kept current.
3. Short circuit/coordination studies should be performed to ensure appropriate safety systems are in place for the electrical systems.
4. An arc flash risk assessment will be performed on the electrical system to determine if arc flash hazards exist. The arc flash risk assessment will contain the appropriate safe work practices, the arc flash boundary, and PPE requirements.

Two methods are allowed for the Arc Flash Risk Assessment. Either, but not both are allowed on the same piece of equipment:

A. **Incident Energy Analysis Method:** Incident energy exposures will be calculated in cal/cm2 and shall be based on the working distance of the employees' face and chest areas. The arc flash boundary will be calculated when using this method.

B. **Arc Flash PPE Categories Method:** When an incident energy analysis has not been completed the Arc Flash Table Method may be used to determine the Arc Flash PPE Category and the arc flash boundary. Tables can be requested by the Director of Education and Loss Prevention.

Electrical Protective Equipment

Electrical protective equipment must meet the criteria established by the **American Society of Testing and Materials (ASTM) and by the America National Standards Institute (ANSI)**.

Equipment shall include rated arc flash apparel, eye protection, head protection, hand protection, hearing protection, insulated footwear, and face shields where necessary. PPE must be maintained in a safe, reliable condition and be inspected by the qualified wearer for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage. Protective equipment that becomes damaged or contaminated with grease, oil-flammable liquids, or combustible liquids shall not be used.

E Light Electric Services Inc. shall provide any electrical protective equipment required by this program for employees working in areas where there are potential electrical hazards. The PPE must be appropriate for the specific work to be performed. Electrical tools and protective equipment must be specifically approved, rated, and tested for the levels of voltage of which an employee may be exposed. If an arc flash hazard is present, then additional PPE is required, including arc-resistant clothing and hardhat with arc-rated face shield is required.

Note: Where the estimated incident energy exposure is greater than the arc rating of commercially available arc-rated PPE, then for the purpose of testing for the absence of voltage, the following examples of risk reduction methods could be used to reduce the likelihood of occurrence of an arcing event or the severity of exposure:

- *Use noncontact proximity test instrument(s) or measurement of voltage on the secondary side of a low voltage transformer (VT) mounted in the equipment before using a contact test instrument to test for the absence of voltage below 1000 volts.*
- *If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.*
- *Increase the working distance. Typically, the incident energy is calculated from the source of contact to the torso and head. So, by increasing the working distance, the total incident energy will be lower.*
- *Consider system design options to reduce the incident energy level.*

Personal Protective Equipment

(For General PPE Policy, refer to E Light's PPE Program)

1. General - Personnel not wearing applicable protective clothing must stand at least 10 feet or the flash protection boundary from exposed energized conductors or circuit parts, whichever is greater. Employees working in areas where electrical hazards are present shall use protective equipment that is designed and constructed for the specific part of the body to be protected and for the work to be performed.

2. Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, body piercing, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed live parts.

3. Full Flash Protection will be required when performing the following: Racking in or out, with drawable electrical equipment (i.e., switchgear, breakers) from a fixed buss at voltages through 480 VAC or at voltages through 250 VDC.
4. Selection of Arc Flash PPE Arc rated clothing and PPE shall be used based on the exposure associated with the specific tasks to which employees are exposed.
    a. Incident energy analysis method – Annex D and 130.5(G), or
    b. Arc flash PPE category method – 130.7(C)(15)(a) or (b)
5. Selection of Shock PPE - The PPE requirements in this program are intended to protect a person from arc flash and shock hazards only, and not the physical trauma which could occur during some arc events. Selection of rubber insulating PPE and equipment will be based on voltage for which the equipment will be exposed. Examples of work requiring shock protection:
    a. Performing work on 110-volt control or logic circuits.
    b. Performing work in an MCC box that has an energized 110-volt circuit.
6. General - When an employee is working within the Restricted Approach Boundary or the Arc Flash Protection Boundary, he/she shall wear protective clothing and other personal protective equipment in accordance with NFPA 70E. All parts of the body in the arc flash boundary will be protected. Personal protective equipment will be inspected for damage before each use. Damaged personal protective equipment will not be used.

    See Personal Protective Equipment in E Light's Safety Manual.
7. Movement and Visibility - When arc rated clothing is worn to protect an employee, it shall cover all ignitable clothing and shall allow for movement and visibility. Clothing made from flammable synthetic materials that melt, such as nylon, polyester polypropylene and spandex may not be used.
8. Head, Face, Neck and Chin Protection - Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contract with live parts or from flying objects resulting from electrical explosion. Employees shall wear nonconductive protective equipment for the face, neck and chin whenever there is a danger of injury from exposure to electric arcs, flashes or from flying objects resulting from electrical explosion.
    a. Hard hats shall meet *ANSI Z89.1 2009 Class E.*
    b. Face shields shall be rated for the degree of exposure, and must provide wrap around protection for the face, chin, forehead, and neck area.
    c. An arc rated balaclava will be used with an arc rated face shield when the back of the head is within the arc flash boundary and the anticipated exposure is between 1.2 and 12 cal/cm2 or Arc Flash PPE Category 2. An

arc rated balaclava must protect the neck and head except for the facial area of the eyes and nose.

d. An arc rated hood shall be used when the anticipated incident energy exposure exceeds 12 cal/cm2 or Arc Flash PPE Category 3 or 4.

9. Eye Protection - Employees shall wear protective equipment for the eyes whenever there is danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion. Safety glasses shall meet ANSI Z87-2 2003 and be non-metallic frames. Safety glasses or goggles must be worn under faceshields and arc flash hoods.

10. Body Protection - Employees shall wear arc rated clothing wherever there is possible exposure to an electric arc flash hazard above the threshold incident energy level for a second degree burn or 1.2 cal/cm2. Clothing and equipment must be rated for the degree of exposure. Clothing and equipment required shall be permitted to be worn alone or integrated with flammable, non-melting apparel.

    Note: Protective clothing includes shirts, pants, coveralls, jackets, and parkas worn routinely by workers who, under normal working conditions, are exposed to momentary electric arc and related thermal hazards. Arc-rated rainwear worn in inclement weather is included in this category of clothing.

11. Fall Protection - Any time an employee will be performing an electrical task that requires an employee to perform a task at an elevated location and the risk of arc flash is present, the harness and lanyard shall meet both the marking requirements of **ANSI/ASSE Z359.11** and list compliance with **ASTM F887**.

    a. <u>In all cases, the Hierarchy of Controls shall be used to determine the safest method of protection.</u>

12. Note: Protective clothing includes shirts, pants, coveralls, jackets, and parkas worn routinely by workers who, under normal working conditions, are exposed to momentary electric arc and related thermal hazards. Arc-rated rainwear worn in inclement weather is included in this category of clothing.

13. Layering - Non-melting, flammable fiber garments shall be permitted to be used as underlayers in conjunction with arc-rated garments in a layered system. If non-melting, flammable fiber garments are used as underlayers, the system arc rating shall be sufficient to prevent break open of the innermost arc-rated layer at the expected arc exposure incident energy level to prevent ignition of flammable underlayers. Garments that are not arc rated shall not be permitted to be used to increase the arc rating of a garment or of a clothing system.

    Note: A typical layering system might include cotton underwear, a cotton shirt and trouser, and an arc-rated coverall. Specific tasks might call for additional arc-rated layers to achieve the required protection level.

14. Outer Layers - Garments worn as outer layers over arc-rated clothing, such as jackets, high visibility apparel, or rainwear, shall also be made from arc-rated material. The arc rating of outer layers worn over arc-rated clothing as protection from the elements or for other safety purposes, and that are not used as part of a layered system, shall not be required to be equal to or greater than the estimated incident energy exposure
15. Underlayers - Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers (underwear) next to the skin. Exception: An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted.

    Note 1: Arc-rated garments (for example, shirts, trousers, and coveralls) worn as underlayers that neither ignite nor melt and drip in the course of an exposure to electric arc and related thermal hazards generally provide a higher system arc rating than non-melting, flammable fiber underlayers.

    Note 2: Arc-rated underwear or undergarments used as underlayers generally provide a higher system arc rating than non-melting, flammable fiber underwear or undergarments used as underlayers.
16. Coverage - Clothing shall cover potentially exposed areas as completely as possible. Shirt and coverall sleeves shall be fastened at the wrists, shirts shall be tucked into pants, and shirts, coveralls, and jackets shall be closed at the neck.
17. Fit - Tight-fitting clothing shall be avoided. Loose-fitting clothing provides additional thermal insulation because of air spaces. Arc-rated apparel shall fit properly such that it does not interfere with the work task.
18. Interference - The garment selected shall result in the least interference with the task but still provide the necessary protection. The work method, location, and task could influence the protective equipment selected.
19. Arc Flash Suits - Arc flash suit design shall permit easy and rapid removal by the wearer. The entire arc flash suit, including the hood’s face shield, shall have an arc rating that is suitable for the arc flash exposure. When exterior air is supplied into the hood, the air hoses and pump housing shall be either covered by arc-rated materials or constructed of non-melting and nonflammable materials.
20. Hand and Arm Protection - Employees shall wear rubber gloves and or insulating sleeves, with leather protectors, where there is a danger of hand and arm injury from electric shock due to contact with live parts. Hand and arm protection shall be worn where there is possible exposure to arc flash burn as follows:
    a. Heavy duty leather gloves or arc rated gloves shall be worn where required for arc flash protection.
    b. Leather protectors shall be worn over rubber insulated gloves to provide additional arc flash protection for the hands. If rubber insulating gloves

with leather protectors are used, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

c. All rubber insulating gloves shall be electrically voltage tested before first issued and every 6 months thereafter.

d. The gloves require an air-test prior to each use to verify no air leakage.

   i. The air-test is done by rolling the cuff tightly toward the palm, so that air is trapped inside the glove, or you may use a mechanical inflator.

   ii. Examine the glove for punctures by listening for escaping air or hold the glove against the cheek to feel for escaping air. Look for any signs of deterioration.

e. Rubber insulating sleeves shall be electrically tested before first use and every 12 months thereafter.

21. Foot Protection - Dielectric overshoes shall be worn as primary shock protection against step and touch potentials where determined necessary by the hazard risk assessment (Job Briefing and Planning Checklist, i.e., performing electrical work while standing in water). In arc flash exposures greater than 4 cal/cm2, heavy duty leather footwear will be worn. Electrical Hazard (EH) Footwear shall meet ASTM F2413-05 will be considered a secondary source of protection, under dry conditions only.

    a. Footwear other than leather or dielectric shall be permitted to be used provided it has been tested to demonstrate no ignition, melting, or dripping at the estimated incident energy exposure.

22. Hearing Protection. Employees shall wear hearing protection whenever working within the arc flash boundary.

NFPA70E Table 130.7(C)(14)

Subject	Number and Title
Apparel-Arc Rate	ASTM 1506-10a Standard Performance Specification for Flame Resistant and Arc-Rated Textile Materials for Use by Electrical Workers Exposed to Momentary Electrical Arc and Related Thermal Hazards IEC 61482-1-1 “Live working – Protective clothing against the thermal hazards of an electric arc – Part 1-1: Test Methods – Method 1: Determination of the arc rating (ELIM, ATPV and/or EBT) of clothing materials and of protective clothing using an open arc. IEC 61482-2 “Live Working – Protective clothing against the thermal

	hazards of an electric arc – Part 2: Requirements.
Aprons-Insulating	ASTM 2677-08a Standard Specifications for Electrically Insulating Aprons
Eye and Face Protection - General	ANSI/ASSE Z87.1-2003 Practice for Occupational and Educational Eye and Face Protection
Face-Arc Rated	ASTM F 2178-08 Standard Test Method for Determining the Arc Rating and Standard Specification for Face Protective Products
Fall Protection	ASTM F 887-10 Standard Specifications for Personal Climbing Equipment
Footwear – Dielectric Specification	ASTM F 1117-03 (2008) Standard Specifications for Dielectric Footwear
Footwear - Dielectric Test Method	ASTM F 1116-03 (2008) Standard Test Method for Determining Dielectric Strength of Dielectric Footwear
Footwear - Standard Performance	ASTM F 2413-05 Standard Specification for Performance Requirements for Foot Protection
Footwear – Standard Test Method	ASTM F 2412-05 Standard Test Methods for Foot Protection
Gloves – Leather Protectors	ASTM F 696-06 Standard Specification for Leather Protectors for Rubber Insulating Gloves or Mittens
Gloves – Rubber Insulating	ASTM D 120-09 Standard Specification for Rubber Insulating Gloves
Gloves and Sleeves – In- Service Care	ASTM F 496-08 Standard Specification for In-Service Care of Insulating Gloves and Sleeves
Head Protection – Hard Hats	ANSI/ISEA Z89.1-2009 Personal Protection – Protective Headwear for Industrial Workers
Rainwear - Arc	ASTM F1891-06 Standard Specification for Arc and Flame-Resistant Rainwear
Rubber Protective Products - Visual Inspections	ASTM F 1236-96 (2007) Standard guide for Visual Inspection of Electrical Protective Rubber Products
Sleeves – Insulating	ASTM D 1051-08 Standard Specifications for Rubber Insulating Sleeves

Care and Maintenance of Arc-Rated Clothing and Arc Flash Suits

1. Arc rated apparel shall be inspected before each use. Work clothing or flash suits that are contaminated or damaged to the extent their protective qualities are impaired, shall not be used. Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used.

2. All arc rated clothing shall be laundered and repaired per each manufacturer instructions. E Light issues arc-rated clothing to help protect us from arc flash hazards that exist in the workplace. In addition to arc flash protection, the clothing also helps us stay warm in the cooler months. However, clothing can pose as a heat stress hazard in the warmer months. Methods of mitigating heat illness will be implemented as necessary.

Other Protective Equipment

1. All tools and equipment used within the restricted approach boundary shall be insulated. Insulated tools shall be protected from damage to the insulating material.

   Requirements for Insulated Tools:

   i. Insulated tools shall be rated for the voltage on which they are used and be designed and constructed for the environment to which they are exposed and the manner in which they are used.

   ii. Insulated tools shall be marked to indicate their voltage rating.

   iii. Insulated tools shall be inspected prior to each use. Inspections will look for damage to the insulation and other damage which can affect the function of the tool. (For example, worn jaws on pliers)

2. Fuse or Fuse Holding Equipment. Fuse or fuse holder handling equipment, insulated for the circuit voltage, shall be used to remove, or install a fuse if the fuse terminals are energized.
3. Ropes and Handlines. Ropes and handlines used near exposed live parts operating at 50 volts or more, or used where an electrical hazard exists, shall be nonconductive.
4. Fiberglass-Reinforced Plastic Rods. Fiberglass reinforced plastic rod and tube used for live line tools, shall meet the requirements of ASTM F 711, Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used: in Live Line Tools.
5. Portable Ladders. Portable ladders shall have nonconductive side rails if they are used where an employee or ladder could contact exposed live parts operating at 50 volts or more or where an electrical hazard exists.
6. Nonconductive ladders shall meet the requirements of ANSI standards for ladders. All E Light ladders are non-conductive fiberglass ladders rated Type 1A or 1AA.

Test Instruments and Equipment

1. Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring within the limited approach boundary.

2. Prior to use:
    a. Test instruments, equipment, and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for expected external defects and damage before each use. If there is a defect or evidence of damage the item shall be removed from service and tagged **"Danger Do Not Use".** Damaged equipment may not be used until repaired by a person qualified to perform the repairs and necessary tests to render the equipment safe.
    b. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged equipment or item shall be removed from service (tagged out-of-service)
    c. No employee may use it until repairs are made and tests are completed.
3. Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.
4. Test instruments, equipment, and their accessories shall be designed for the environment to which will be exposed, and for the manner in which they will be utilized.
5. Calibration - Ensure all test instruments, equipment, and their accessories receive calibration, as required by manufacturer's instructions.
6. Test Equipment Verification - When test instructions are used for testing the absence of voltage on conductors or circuit parts operating at 50 volts or more, the operation of the test instrument shall be verified before and after an absence of voltage test is performed on a known voltage source.

Testing for Voltage

Prior to beginning work and before coming in working contact with electrical circuits, inspect the test equipment and determine that the voltage meter is operating satisfactorily. Equipment must be tested with an adequately rated voltage detector to verify that each phase conductor or circuit part is de-energized.

1. Ensure that all associated test leads, cables, power cords, probes and connectors are visually inspected for external defects and damage. Test the meter on a known energized source prior to each use to verify meter is reading properly.
2. Ensure the voltage meter and all accessories are properly rated for the circuits and equipment to which they shall be connected and are designed for the environment in which they will be used.
3. Qualified personnel need to make sure they know what type of voltage they are testing for, either AC or DC, and what level of voltage is in the circuits they are

testing. Pocket size light stick voltage detectors cannot be utilized as a primary testing device.

4. Once the qualified person has tested the circuits with the test equipment and determined the electrical state (energized or non-energized), the test equipment should be re-tested to confirm that it was working correctly.

Insulating Materials and Tools

Employees must use insulated tools and handling equipment rated for the voltages encountered when working inside the Limited Approach Boundary and Restricted Approach Boundary near exposed energized circuits, conductors, or parts. Insulated tools must be designed and constructed to meet the demands of use and the environment to which they are exposed. Insulating equipment made of materials other than rubber shall provide electrical and mechanical protection at least equal to that of rubber equipment. If the insulating capability of protective equipment is subject to damage during use, the insulating material must be protected by an outer covering of leather or other appropriate material.

Insulating rubber equipment such as gloves, sleeves, blankets, and matting must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that may cause damage. In addition to being tested according to the schedule supplied by the manufacturer, rubber insulated equipment must be

- Inspected for damage before each day's use
- Air tested before each use
- Inspected immediately following any incident that could have caused damage
- Dielectrically tested within 6 months of first use or 1 year of purchase if not used (rubber gloves used without the leather protectors must be removed from service until dielectrically tested)

Rubber-insulated equipment found to have defects that might affect its insulating properties must be removed from service until testing indicates that it is acceptable for continued use. Do not attempt to repair defective rubber-insulated equipment.

Fuse handling equipment insulated for the circuit voltage shall be used to remove or install a fuse if the terminals are energized. Ropes and hand-lines used near exposed energized parts shall be nonconductive and portable ladders used for electrical work shall have nonconductive side rails. Tools and handling equipment should be replaced if the insulating capability is decreased due to damage.

Access Limiting Equipment

Specific training and qualifications are required to work with electricity. Electrical work zones must always be secured to prevent access by unqualified individuals for their safety and the safety of the qualified personnel. Often, electrical work is performed in areas where the general public could be exposed to the hazards. The bullet points listed below shall be followed to reduce the hazards to unqualified people.

- Barricades shall be used in conjunction with safety signs to prevent or limit access to work areas containing live parts. Barricades must be of sturdy construction and discourage access. An example would be temporary fencing. Conductive barricades shall not be used where they might cause an electrical hazard. Barricades shall be placed no closer than the Limited Approach Boundary.
- If signs and barricades do not provide sufficient protection, an attendant will be assigned to warn and protect pedestrians. The primary duty of the attendant shall be to keep an unqualified person out of the work area where an electrical hazard exists. The attendant shall remain in the area as long as there is a potential exposure to electrical hazards.
- If any area accessible to unqualified people is left unattended, the area must be returned to an electrically safe condition (e.g., Panelboard covers replaced). Barricades and signs are not an acceptable safeguard.

Hazard Identification

Before any work, including testing and troubleshooting, can take place an electrical hazard assessment and risk assessment must be done. A Hazard Assessment for Electrical Work form can be found on iAuditor.

The hazard assessment includes identifying the following:

- Shock, arc flash, and arc blast hazards
- Non-electrical hazards (e.g., falls, confined space, chemical, biological, radiation, and environmental hazards)
- Means of mitigating hazards through engineering controls, administrative controls, and PPE
- If an Energized Electrical Work Permit is required.

The risk assessment will include the following:

1. Shock Risk Assessment - Employees shall perform a shock risk assessment to determine the:
    a. Voltage to which personnel will be exposed.
    b. Boundary requirements.
    c. PPE necessary in order to minimize the possibility of electric shock.

    During the Shock Risk Assessment, the following shall be considered:
    a. The Design of the electrical equipment.
    b. The electrical equipment operating condition and the condition of maintenance.
7. Arc flash risk assessment. Supervision shall perform an arc flash risk assessment to determine the:

a. Arc flash boundary,
b. Incident energy or Arc Flash PPE Category
c. The specific safety related work practices determined, before any person is exposed to electrical hazards

8. Updated and accurate labeling information can be used to gather the information necessary to complete the shock and arc flash risk assessments.
9. The condition of electrical equipment and systems will be considered when assessing the risks to perform electrical work.
10. Supervisors shall complete the Electrical Pre-Job Hazard Analysis when exposed to 50v or greater.
11. In addition to an Electrical JHA, any non-routine electrical work, emergency electrical work, electrical work without written procedures, temporary wiring work, or working on exposed energized electrical parts 480v or higher will require an Electrical Work Permit.
12. Pre-Job Briefing. Before starting electrical work, a Supervisor shall conduct a job briefing, with all employees involved. Additional job briefing will be held if changes which may affect safety occur during the course of the work. The briefing shall cover:
    a. Hazards associated with the job.
    b. Work procedures involved.
    c. Special precautions.
    d. Energy source controls.
    e. Personal Protective Equipment requirements.
    f. Information on any customer's energized electrical work permit.
    g. Review of the JHA and Electrical Work Permit if applicable.
    h. STOP WORK criteria and responsibility.

In addition to the electrical hazard assessment, a risk assessment of common electrical tasks must be done by rating the relative hazards of electrical tasks. The risk assessment can be used to:

- Identify hazards
- Assess risks
- Implement the hierarchy of risk controls:
    1. Elimination
    2. Substitution
    3. Engineering
    4. Warnings

5. Administration
6. PPE

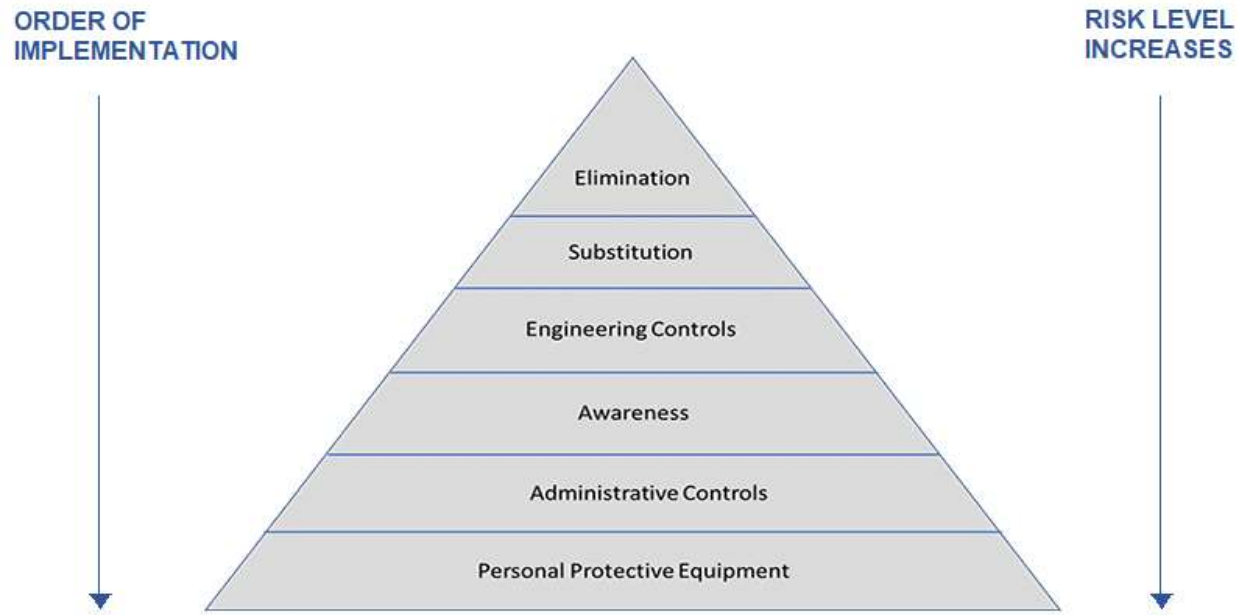
Hierarchy of Controls

The Hierarchy of Controls is a specific order you should follow when determining the most effective way to reduce risk. **NFPA 70E** outlines six rungs of the Hierarchy of Controls. The hierarchy starts with the controls perceived to be most effective and moves down to those considered least effective.

CONTROL	IMPACT ON RISK ASSESSMENT	POTENTIAL FAILURE MODES
ELIMINATION: Eliminating the hazard completely is always the first choice. Elimination is the COMPLETE removal of the hazard or risk such that it does not exist at any time.	*The elimination of the hazard affects both the severity and likelihood of injury. Elimination of the risk of injury affects the exposure to the hazard.*	• *Component failure* • *Equipment defects* *Insufficient equipment maintenance.*
SUBSTITUTION: Substitution minimizes the hazard rather than eliminating it.	*Substitution can affect the severity of the injury, frequency of exposure, or the likelihood of avoiding or limiting injury.*	• *Unanticipated employee interaction with equipment* • *Inadequate control of component procurement*
ENGINEERING: If you can't eliminate the hazards or substitute safer alternatives, engineering controls are the next best option. These involve using work equipment or other means to prevent workers from being exposed to a hazard. Engineering controls isolate an employee from a hazard or minimize a	*Engineering controls can have a substantial impact on risk and some impact on the hazard.*	• *Unanticipated tasks* • *Production Pressure* • *Protective System Failure*

hazard, often without reliance on human interaction.		
Awareness: Documented Job Safety Plans, created by qualified personnel, must be in place and must identify the work tasks, electrical hazards associated with each task, a documented shock risk and arc flash risk assessment for each task, and define procedures involved with each task along with any special precautions. Signage is part of this control. Awareness controls include the use of warning labels, signs, or alarms.	*Awareness means can have an impact on avoiding injury and inadvertent exposure. Awareness often has no impact on the severity of injury and has no impact on the hazard.*	• *Desensitization due to too many warning signs* • *Lack of understanding of instructions or warning signs* • *Disregard of the provided instructions or warning signs*
Administrative Controls: Administrative Controls are typically employed when hazards are not otherwise controlled. Administrative Controls include procedures, employee training, risk assessment, job briefings, auditing, and the use of Energized Electrical Work Permits.	*With an Electrically Safe Work Condition, risks associated with electrical hazards have been temporarily reduced to an acceptable level, and the electrical hazards have been temporarily removed. Many other Administrative Controls have no impact on the hazard. Procedures have an impact on avoiding injury but have minimal impact on severity. Training has a great impact on avoiding injury with regard to interaction*	• *Desensitization due to too many warning signs* • *Lack of understanding of instructions or warning signs* • *Disregard of the provided instructions or warning*

	with the electrical system.	
Personal Protective Equipment (PPE): PPE is the least effective means of controlling hazards and risk. PPE can be damaged, worn improperly or incorrectly selected for the task/hazard at hand. PPE is the last line of defense before an incident occurs.	*PPE has an impact on limiting injury, but has no impact on the hazard or on the likelihood of an incident.*	• *Reasons for the need of PPE not understood* • *PPE selection inappropriate for the hazard* • *Employee neglect to use needed PPE*



NFPA 70E Hierarchy of Risk Control Methods

Hazard Effects of Electricity on the Human Body

Results of Power Frequency Current

- At 5 mA, shock is perceptible.
- At 10 mA, a person may not be able to voluntarily let go of the hazard.
- At about 40 mA, the shock, if lasting for 1 second or longer, may be fatal due to ventricular fibrillation.
- Increasing current leads to burns and cardiac arrest

Results of Direct Current (DC)

- A DC current of 2 mA is perceptible.
- A DC current of 10 mA is considered the threshold of the let-go current.

Results of Voltage

- A voltage of 30 V rms, or 60 V dc, is considered safe except when the skin is broken. The internal body resistance can be as low as 500 ohms, so fatalities can occur.

Results of Short Contact

- For contact less than 0.1 seconds and with currents just greater than 0.5 mA, ventricular fibrillation may occur only if the shock is in a vulnerable part of the cardiac cycle.
- For contact of less than 0.1 seconds and with currents of several amperes, ventricular fibrillation may occur if the shock is in a vulnerable part of the cardiac cycle.
- For contact of greater than 0.8 seconds and with currents just greater than 0.5 A, cardiac arrest (reversible) may occur.
- For contact greater than 0.8 seconds and with currents of several amperes, burns and death are probable.

Results of Alternating Current (AC) at Frequencies above 100 Hz

- When the threshold of perception increases from 10 kHz to 100 kHz, the threshold of let-go current increases from 10 mA to 100 mA.

Effects of Wave shape

- Contact with voltages from phase controls usually causes effects between those of ac and dc sources.

Effects of Capacitive Discharge

- A circuit of capacitance of 1 microfarad having a 10 kV capacitor charge may cause ventricular fibrillation.
- A circuit of capacitance of 20 microfarad having a 10 kV capacitor charge may be dangerous and probably cause ventricular fibrillation.

Power Electrical Equipment and Electricity

Supervisors and employees shall be aware of the hazardous effects of electricity on the human body and hazards associated with power electrical equipment

Power electrical equipment includes the following types of devices:

- Electric arc welding equipment

- High-power radio, radar, and television transmitting towers and antenna
- Industrial dielectric and radio frequency (RF) induction heaters
- Shortwave or RF diathermy devices
- Process equipment that includes rectifiers and inverters such as the following:
    - Motor drives
    - Uninterruptible power supply systems
    - Lighting controllers

Solar PV Modules

Electrical connections at Solar Panels, once connected and during anytime which the sun is shining shall be considered to be energized and under load. Only journeymen or authorized and qualified personnel shall be allowed to disconnect MC4 and other type connectors while in this condition and then only while wearing insulated rubber gloves.

Hazards Associated

Supervisors and employees shall be aware of the hazards associated with the work being performed.

Relationships with Host Employers and Other Contractors

When E Light employees are engaged in electrical work at worksites/facilities, Supervision shall conduct a meeting between the Host Employer and other Contractors, the following information shall be provided:

1. Known hazards that are covered by the current NFPA 70E Standard, that are related to the contract work, and that might not be recognized by the contractor or host employees.
2. Information about the Host Employer's installation needed to make assessments relating to the electrical hazards, and any existing electrical hazards from the Arc Flash Hazard Analysis, if one was conducted.
3. Electrical Personal Protective Equipment/Clothing requirements.
4. Emergency/evacuation procedures.
5. Report observed contractor employee violations of the written electrical safety program to the contractor.
6. Ensure that each of our employees is instructed in the hazards communicated by the Host Employer.
7. Ensure that each of our employees follows the work practices required by the written electrical safety program and the current NFPA 70E Standard.

8. Advise the Host Employer of any unique hazards presented by the contracted work, hazards identified during the course of work that were not communicated by the Host Employer, and measures taken to correct any violations reported by Host Employer. Ensure all of our employees are trained in appropriate electrical safe work practices as defined in the current NFPA 70E Standard and provide documentation if requested.

Other Precautions for Personnel

- **Alertness** - Employees shall remain alert at all times when working within the limited approach boundary. Work will cease when alertness is recognizably impaired due to illness, fatigue, or other reason. Employees shall be alert for changes in the scope of work which could expose the person to additional hazards.
- **Illumination** –
    - Employees shall not enter spaces where electrical hazards exist unless illumination is provided that enables the employees to perform the work safely.
    - Where lack of illumination or an obstruction precludes observation of the work to be performed, employees shall not perform any task within the Limited Approach Boundary of energized electrical conductors or circuit parts operating at 50 volts or more or where an electrical hazard exists.
    - Suitable temporary lighting equipment and/or headlamps will be provided, as needed
- **Blind reaching** - Employees shall not reach blindly into areas that might contain exposed energized electrical conductors or circuit parts.
- **Conductive Materials**
    - Conductive Articles Being Worn. Conductive articles of jewelry and clothing (such as watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear or metal frame safety glasses) shall not be worn with in the restricted approach boundary or where they present an electrical contact hazard with exposed energized electrical conductors or circuit parts.
    - Conductive Materials, Tools and Equipment Being Handled. Conductive materials in contact with any part of the employee’s body shall be handled in a manner that prevents accidental contact with energized electrical conductors or circuit parts. No conductive object shall be taken closer to exposed energized electrical conductors or circuit parts operating at 50V or more than the restricted approach boundary.

- Potential energized materials and equipment include but are not limited to long conductive objects such as ducts, pipes and tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffolds, structural members, bull floats and chains.

- **Confined or Enclosed Spaces**
  - When working in confined or enclosed spaces in which an electrical hazard exists, protective shields, protective barriers, or other insulating materials shall be used to prevent inadvertent contact with energized parts. Examples of confined or enclosed spaces may include: manholes, vaults, pull boxes or other enclosures. All hazards, including electrical, must be considered prior to entry into a confined or enclosed space.
- **Doors and Hinged Panels** shall be secured to prevent swinging into employees and causing contact with energized electrical conductors or circuit parts if movement of the door could create a hazard.
- **Housekeeping** - Appropriate safeguards (such as insulating material or barriers) will be provided for any housekeeping duties performed within the limited approach boundary. Electrically conductive cleaning material shall not be used unless a Job Hazard Analysis (JHA) and work plan establishes safe procedures.
- **Clear Spaces** - Working space will be kept clear to permit safe operation and maintenance of electrical equipment.
- **Flammable Material** - Electrical equipment will not be used in the presence of flammable material unless protective measures are taken. Flammable material includes flammable gases, vapors, liquids, combustible dusts, and ignitable fibers.
- Equipment which is anticipated to fail shall be de-energized and placed in an electrically safe work condition unless de-energizing introduces additional hazards or is infeasible due to equipment design or operational limitations. Employees shall be protected from hazards by suitable barricades and alerting techniques.
- **Routine Opening and Closing of Circuits** - Only devices specifically designed as disconnecting means shall be used for opening or closing of circuits under load conditions. Cable connectors, fuses, terminal lugs and cable splices shall not be permitted to be used to interrupt the load except in an emergency situation.
- **Reclosing Circuits After Protective Devices Operation** - After automatic operation of devices, circuits shall not be manually reenergized until it has been determined that the equipment can be safely re-energized. When it is determined from the design of the circuit and the overcurrent devices involved, that the automatic operation of a device was caused by an overload rather than a fault,

examination shall not be required. The repetitive manual reclosing of circuit breakers or reenergizing through fuse replacement is prohibited.

Minimizing Electrical Hazards

Arc flash hazard analysis consists of collecting data on the power distribution system. The arrangement of components is documented on a one-line drawing with nameplate specifications of every device and lengths and cross-section area of all cables.

For systems of 600 volts and less where an arc flash analysis has not been performed, NFPA 70E Arc Flash Category Classification tables 130.7(C)(15)(a) and 130.7(C)(15)(b) will provide arc flash boundary distance, provided it meets the maximum short circuit current and fault clearing time criteria. For other fault currents and clearing times greater than those listed in the NFPA 70E tables, an arc flash analysis must be performed as well.

Arc flash hazard analysis shall be done under the supervision of a licensed electrical engineer; for all major electrical system upgrades or renovations; and for all new electrical system installations.

Electrical Equipment Labeling

Switchboards, panel boards, industrial control panels, motor control centers, disconnects and any other equipment posing an arc flash hazard will be field marked (labeled) to warn workers of potential electric arc flash hazards. When arc flash and shock data are available for industrial control panels, labels shall include information on arc flash hazard boundary, the hazard category, required PPE, minimum arc rating, limited approach distances, restricted approach distances and prohibited approach distances.

Labeling is intended to reduce the occurrence of serious injury or death due to arcing faults to workers working on or near energized electrical equipment. Labels shall be located so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.

Working on or Near Energized Electrical Equipment

Energized Electrical Work

Any work on electrical equipment, circuits, devices, systems, or any other energized parts, where an employee is required to deliberately, or could accidentally, place any part of the body, tool or materials into or around electrical devices in excess of 50 volts. Work on electrical equipment or system installed in a building that has an energized service if the equipment or system has not been placed in an electrically safe work condition.

Energized Work Permit (Standard) must be reviewed and approved by the project manager responsible for the work, the Vice President of Operations or the Area

Manager responsible for the work, and by the Director of Education and Loss Prevention. In an emergency, approval may be obtained by voice communication. This is limited to extreme conditions. In the event a person that is responsible for approvals is not able to be reached, that person's direct supervisor may provide the approval necessary. If the direct supervisor cannot be reached the energized work must be postponed until review and approval can be obtained.

A testing a troubleshooting plan detailing the hazards, mitigations and procedures for standard testing and troubleshooting for the project shall be developed and submitted for approval before the building service is energized or at the start of the project if the service is already energized.

Testing and troubleshooting plans shall be developed by the superintendent and approved by the project manager or service manager responsible for the project prior to submission to the Director of Education and Loss Prevention for final approval.

Once approved, the testing and troubleshooting shall be prominently posted in all electrical rooms on the project and only those persons who are qualified and have been trained on the testing and troubleshooting plan shall be allowed to perform testing and troubleshooting without an energized work permit submittal.

The most important principle of electrical safety is to assume all electric circuits are energized unless each involved worker ensures they are not. Every circuit and conductor must be tested every time work is done on it. Proper PPE must be worn until the equipment is proven de-energized. The process of de-energizing is "energized" work and can result in an arc flash due to equipment failure.

- Live parts to which an employee may be exposed must be de-energized before the employee works on or near them. (See lock out tag out section)
- LOCK OUT MUST BE DONE IN ACCORDANCE WITH THIS POLICY. NO SHORTCUTS OR EXCEPTIONS MAY BE USED
- When this is not possible or certain conditions may cause additional hazards, other safety-related work practices must be used to protect employees from any contact and these measures must be specifically approved by the Director of Education and Loss Prevention or the Vice President of Operations in advance of applying them.
- The practices must be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electrical conductors or circuit parts.

Both NFPA 70E 130.1 and OSHA 1910.333 state:

Energized electrical conductors and circuit (live) parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee works (on or near) within the Limited Approach Boundary of those conductors or parts, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Energized electrical conductors and circuit (live) parts that operate at less than 50 volts to ground

need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

Examples of increased or additional hazards include, but are not limited to:

- Interruption of life support equipment
- Deactivation of emergency alarm systems
- Shutdown of hazardous location ventilation equipment

Supervisors must provide training and adopt written standard operating procedures (SOPs) for tasks where work on or near live circuits may be required. When working on live circuits an employee is actually touching energized parts with tools. When working near live circuits, an employee inside the restricted approach boundary is close enough to energized parts to pose a risk, even though other parts are de-energized. Common tasks include:

- Opening electric equipment doors for inspection.
- Opening and closing disconnects and breakers.
- Taking voltage measurements.
- Racking breakers on and off the bus.
- Removing panels and dead fronts.

Example SOP statement:

"When opening and closing disconnects, use the "left-hand rule" when possible. Stand to the right side of the equipment and operate the disconnect switch with the left hand."

Normal Operation of Electric Equipment

Normal Operation of electrical powered equipment shall be permitted where all of the following conditions are satisfied:

1. The equipment is properly installed.
2. The equipment is properly maintained
3. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
4. The equipment doors are closed and secured.
5. All equipment covers are in place and secured.
6. There is no evidence of impending failure such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

Use of the information on the arc flash hazard label and Table 130.5(C) provides guidance on assessing criteria for Normal Operation and the likelihood of an arc flash occurrence.

For any electrical equipment where an arc flash hazard may be present, a hazard assessment shall be performed by an electrically qualified worker on the equipment to ensure it meets the criteria for Normal Operation.

Conditions that do not meet the criteria of Normal Operation are consider abnormal operation and an electrical hazard assessment should be performed to determine necessary electrical safe work practices and PPE.

Energized Electrical Work Permits

When energized work is authorized, an energized electrical work permit shall be required under the following conditions:

- When work is performed within restricted approach boundary of exposed energized parts.

Before any work can be done on energized electrical equipment, a work permit must be completed and approved. E Light Electric Services has a Standard Work Permit and a Troubleshooting and Testing Work Permit. The Troubleshooting and Testing Work Permit may only be used for specific tasks involving troubleshooting and testing. Once a problem has been identified and it is determined that further energized work will be necessary to repair the problem a Standard Work Permit will need to be completed and approved. Both of these forms are available on iAuditor.

The intent of the permit is to ensure that all appropriate safety precautions are taken prior to performing energized electrical work.

Use of Energized Work Permit

Before any work can be done on energized electrical equipment, a work permit must be completed by a qualified person and approved. The Energized Work Permit is available on iAuditor.

Exemptions:

An Energized Electrical Work Permit shall not be required for the following:

- Testing, Troubleshooting, and Voltage Measuring.
    - An approved testing and troubleshooting plan/permit must be in place. E Light Electric Services has a Standard Work Permit and a Troubleshooting and Testing Work Permit. The Troubleshooting and Testing Work Permit may only be used for specific tasks involving troubleshooting and testing. Once a problem has been identified and it is determined that further energized work will be necessary to repair the problem a Standard Work Permit will need to be completed and approved. The Troubleshooting and Testing Permit is available on iAuditor.
- Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed.

Approach Distances to Exposed Energized Parts

NFPA 70E defines three (3) boundaries for electrical work. Two (2) boundaries are approach distances related to shock hazards and the third boundary is related to arc flash protection.

Shock Protection Boundaries

The distance for the Limited and Restricted Approach boundaries are found in NFPA 70E tables 130.4(D)(a) and (b).

Within the limited approach boundary, unqualified persons should not be inside the boundary unless escorted by a qualified person and informed of potential safety hazards. Within the restricted approach boundary, only qualified persons with proper PPE and tools may cross. Inside this boundary, accidental movement can put a part of the body or conductive tools in contact with live parts or inside the prohibited approach boundary.

To cross the restricted approach boundary, the qualified person must:

1. Perform hazard identification and risk assessment
2. Have an energized work permit that is approved by the supervisor when performing work beyond testing and troubleshooting
3. Use PPE rated for working near exposed energized parts and rated for the voltage and energy level involved
4. Ensure that no part of the body enters the prohibited space
5. Minimize risks from unintended movement by keeping as much of the body as possible out of the restricted space (body parts in the restricted space should be protected)

Arc Flash Protection Boundary

When interacting with electrical equipment within the Arc Flash Protection Boundary, protective equipment and measures are required. The qualified person must:

1. Determine if interaction meets the criteria for Normal Operation of electric equipment. A hazard identification assessment should be done with the arc flash hazard label and Table 130.5(C) to provide guidance on assessing the likelihood of an arc flash occurrence. Arc – rated PPE may not be required for Normal Operation of electric equipment.
2. If criteria for Normal Operation is not met, arc flash PPE is necessary to continue work.
3. Use PPE appropriate for working near exposed energized parts and rated for the voltage and energy level involved.

If an arc flash analysis has been performed, a qualified person can use the incident energy value on the arc flash analysis label and the arc flash hazard Table 130.5(G) to specify arc – rated clothing and other PPE.

Arc Flash Analysis has not been performed

For systems of 600 volts and less where an arc flash analysis has not been performed and no incident energy levels are listed:

1. Use Table130.7(C)(15)(a) and/or Table 130.7(C)(15)(b) to determine the arc-flash PPE category.
2. Use Table 130.7(C)(15)(c) to choose the appropriate clothing and PPE
3. Table 130.4(D)(a) and/or Table 130.5(D)(b) will provide the limited and restricted approach boundaries.
4. Table130.7(C)(15)(a) and/or Table 130.7(C)(15)(b) will provide arc flash boundary distance, provided the equipment meets the maximum short circuit current and fault clearing time criteria in the tables

For copies of NFPA 70E tables contact Ted Smith.

Interlocks

Only a qualified person following the requirements of this policy may defeat an electrical safety interlock, and then only temporarily, when working on the equipment. The interlock system must be returned to its operable condition when work is complete. Personnel shall be wearing appropriate PPE before defeating an electrical interlock. An energized work permit shall be completed before defeating an electrical interlock.

Means of Egress

A means of egress must be established, and all employees must know the means of egress before any energized work is performed.

Employees involved in energized work shall be informed of emergency contact numbers for medical and fire personnel and shall be briefed on how to direct emergency responders to the work site and work area should they be required.

A back out plan must be established and all personnel must be briefed on the back out plan before any energized work is performed.

- A back out plan is a pre-planned process that will be used in the event the energized work must be stopped prior to completion and will be used to return the system to its condition before the energized work began.

Overhead lines

Any work performed near overhead power lines shall be energized electrical work if it is performed within the distances listed on the following table.

Approach distances for qualified employees	
VOLTAGE RANGE) (Phase to Phase)	**MINIMUM APPROACH DISTANCE**
300v and less	2 feet
Over 300V, not over 750V	4 feet
Over 750V, not over 2kV	10 feet
2kV, not over 15kV	15 feet
15kV, not over 37kV	20 feet
37kV, not over 87.5kV	20 feet
87.5kV not over 121kV	25 feet
121kv not over 140kV	30 feet

If any vehicle or mechanical equipment is capable of having parts of its structure elevated within the limited approach boundary of exposed movable conductors of energized overhead lines and is intentionally grounded, employees working on the ground near the point of grounding shall not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades, dielectric overshoe footwear, or insulation shall be taken. (step and touch potential).

Underground Electrical Lines and Equipment

Before excavation of any depth starts, the appropriate owner or authority (utility locate service) will be notified to identify and mark the location of electrical lines or equipment. If it is determined that there is a reasonable possibility for contacting electrical lines or equipment, appropriate safe work practices, and PPE shall be used during the excavation. In all cases, state excavation requirements will be adhered to.

Working on De-Energized Electrical Equipment

Electrically Safe Work Condition (De-energized)

Equipment and circuitry shall be de-energized and in an electrically safe work condition if all of the following steps have been successfully completed:

1. All sources of potential power have been identified.
2. All sources of power must be de-energized.
    a. If applicable, disconnects shall be visually verified that the disconnecting means have operated correctly and are in the open position.
    b. All sources of potential power have been locked out and tagged according to company lock out and tag out procedures
    c. All circuitry and equipment has been tested to ensure that it is de-energized and no voltage is present.

Achieving an Electrically Safe Work Condition may involve additional steps depending on the situation. Refer to NFPA 70E, Article 130 for precise steps and requirements for achieving an electrically safe work condition.

The test to determine the absence of voltage is to be done utilizing an approved and correctly rated multimeter designed for the purpose. The meter must also be verified by using the **LIVE-DEAD-LIVE** method prior to testing for the absence of voltage. Proximity testers, solenoid testers and other types of testers that do not indicate the exact level of RMS voltage present shall not be used.

The NFPA 70E lists six steps to ensure for electrically safe work conditions. Always follow these steps.

1. Identify all sources of power to the equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
2. Remove the load current, and then open the disconnecting devices for each power source.
3. Where possible, visually verify that blades of disconnecting devices are fully open or that draw out-type circuit breakers are fully withdrawn.
4. Apply lockout/tagout devices in accordance with E Light's Lockout/Tagout Program.
5. Test each phase conductor or circuit part with an adequately rated voltage detector to verify that the equipment is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Check the voltage detector before and after each test to ensure it is working.
6. Properly ground all possible sources of induced voltage and stored electric energy (such as capacitors) before touching. If conductors or circuit parts that are being de-energized could contact other exposed conductors or circuit parts, apply ground-connecting devices rated for the available fault current.

Where conductors are deenergized in order to cut, remove, or reroute them and the conductor terminations are not within sight from the point of work, such as where the conductors are remote from the source of the supply in a junction or pull box, additional steps to verify absence of voltage or identify the conductors shall be taken prior to cutting, removing, or rerouting the conductors.

Lockout/Tagout Program

All employees shall follow E Light Electric Services Inc's Lockout/Tagout Program.

The LOTO program is available at www.elightinformation.com.

Troubleshooting and Testing Plans

All construction sites shall have in place an approved troubleshooting and testing plan. This plan shall be submitted for approval prior to applying power to the building service. This plan must be approved by the Project Manager with review by the Director of Education and Loss Prevention. All troubleshooting and testing on that project shall be

done in accordance with the approved troubleshooting and testing plan. All personnel on the jobsite shall be briefed on the troubleshooting and testing plan for the jobsite. The approved Testing and Troubleshooting plan shall be posted in all electrical rooms. Only qualified personnel that have been trained on the Testing and Troubleshooting may participate in Testing and Troubleshooting.

Employees are required to exhaust every possible means to accomplish work in an electrically safe work condition and only after careful planning shall they attempt any energized work.

Employees shall consult NFPA 70E, Table 130.7(C)(15)(a) for ac systems and Table 130.7(C)(15)(b) for dc systems to determine the Arc-Flash PPE Category and record the Arc-Flash PPE category on the Work Permits.

Employees shall consult NFPA 70E, Table 130.7(C)(15)(c) to determine the protective clothing that will be used for the energized work based on the Arc-Flash PPE category. The specific equipment that will be used including the Arc Rating of the Equipment shall be recorded on the Work Permit.

All potential sources of power shall be identified and recorded on the Work Permit.

The reason the work must be performed in an energized state shall be recorded on the work permit. All potential hazards and risks shall be recorded on the work permit, including but not limited to the following:

- Shock
- Burn
- Arc Blast
- Uncontrolled shut down of system
- Potential damage to equipment
- Potential damage to personnel

The building owner or their designated representative shall sign the work permit to acknowledge they understand the risks involved and authorize the work to proceed.

All electricians and persons involved in the work shall be briefed on the work to be performed, the safe process, the hazards involved and the personal protective equipment required and shall sign the work permit acknowledging this briefing and their understanding of the work to be performed.

All non-qualified personnel and those not directly involved in the energized work shall be kept a minimum of 10 feet from the energized work. Any person coming within 10 feet of the energized work shall be required to wear the same protective equipment as those performing the work. Caution Red Tape and barricades should be used around energized work wherever possible.

Notification must be made that energized work will be in progress and that an uncontrolled shut down could happen. This notification shall be given to all persons that

operate equipment powered by the electrical system on which energized work is to be performed. They are to be given instructions on the procedures to follow in the event of an uncontrolled shut down. A single notification given to a building owner or their designated representative shall be sufficient to meet this requirement.

Capacitors

Employees performing work on equipment with capacitors shall be appropriately trained according to this policy.

ONLY QUALIFIED PERSONS SHALL PERFORM WORK ON EQUIPMENT WITH CAPACITORS ANYTIME THE FOLLOWING HAZARD THRESHOLDS ARE EXCEEDED:

- Less than 100 volts and greater than 100 joules of stored energy.
- Greater than or equal to 100 volts and greater than 1.0 joule of stored energy.
- Greater than or equal to 400 volts and greater than 0.25 joules of stored energy.

Risk Assessment

Risk Assessment shall be conducted as provided outlined in this policy. If additional protective measures are required, they shall be implemented according to the Hierarchy of Controls.

Anytime protective measures include the use of PPE, the following shall be determined:

1. Capacitor voltage and stored energy for the worker exposure. An exposure shall be considered to exist when a conductor or circuit part that could potentially remain energized with hazardous stored energy is exposed.
2. Thermal Hazard. The appropriate thermal PPE shall be selected and used if the stored energy of the exposed part is greater 100 joules.
3. Shock Hazard. The appropriate shock PPE shall be selected and used if the voltage is greater than or equal to 100 volts.
4. Arc flash and arc blast hazard at the appropriate working distance. The appropriate protection for the arc flash and arc blast hazard shall be selected, as follows:
    a. Arc flash PPE in accordance with 130.7 shall be selected and used if the incident energy exceeds 1.2 cal/cm2 (5 J/cm2) at the working distance.
    b. Hearing protection shall be required where the stored energy exceeds 100 joules.
    c. The lung protection boundary shall be determined if stored energy is above 122 kJ. Employees shall not enter the lung protection boundary.

   d. Alerting techniques in accordance with 130.7 (E) shall be used to warn employees of the hazards.

5. Required test and grounding method. Soft grounding shall be used for stored energy greater than 1000 joules. If capacitors are equipped with bleed resistors, or if using a soft grounding system, the required discharge wait time shall be determined where applicable.
6. A written procedure shall be required. The procedure shall include:
   a. Amount of stored energy available.
   b. How long to wait after de-energization before opening the enclosure.
   c. Testing for absence of voltage and steps to take if voltage is still present.

Establishing an Electrically Safe Work Condition for a Capacitor(s)

When a conductor or circuit part is connected to a capacitor(s) operating at or above the above listed thresholds, a written procedure shall be required and written by a qualified person.

The following process shall be used to establish and verify a safe work condition:

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up- to-date drawings, diagrams, and identification tags.
2. After properly interrupting the load current, open the disconnecting device(s) for each source.
3. Whenever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.
4. Apply lockout/tagout devices in accordance with E Light's LOTO policy.
5. If bleed resistors or automatic discharge systems are applicable, wait the prescribed time for the capacitors to discharge to less than the thresholds listed above and proceed to step (6). For systems without bleed resistors or automatic discharge systems, discharge the capacitors with an adequately rated grounding device (e. g. ground stick). Soft grounding shall be performed above 1000 joules, and remote soft grounding shall be performed above 100 kJ.
6. Verify that the capacitors are discharged. For capacitors less than 1000 joules, verification shall be permitted to be done either by testing or by grounding. For capacitors between 1000 joules and less than 100 kJ, verification shall be done using testing or soft grounding, then hard grounding. Above 100kJ, an engineered and redundant system shall be used for remote testing and grounding. An adequately rated portable test instrument shall be used to test

between each capacitor terminal and from each terminal to ground to assure that the capacitor is deenergized.

7. Before and after each verification,determine that the test instrument is operating satisfactorily through verification on a known dc voltage source. If voltage remains,determine and correct the cause, and repeat step (5) to discharge the capacitors. Where recharging can occur due to dielectric absorption or induced voltages, all the capacitor terminals shall be connected together and grounded with bare or transparent-insulated wire.
8. For series capacitors the shorting wires shall be attached across each individual capacitor, and to case.

For single capacitors or for a parallel capacitor bank, the grounding device shall be permitted to be left attached to the capacitor terminals for the duration of the work (e. g., a ground stick).

Grounding Sticks

1. Grounding sticks shall be provided for qualified persons to safely discharge any residual stored energy contained in capacitors or to hold the capacitor potential at 0 volts.
2. Grounding sticks shall be designed, constructed, installed, and periodically inspected so that the full energy and voltage of the capacitors can be safely discharged.
3. Visual Inspection:
    a. Ground sticks shall be visually inspected for defects before each use. All mechanical connections shall be examined for loose connections. Resistors shall be visually inspected for cracks or other defects and electrically tested for proper resistance. The following shall occur if defects or contamination are found:
        - If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the ground stick is present, the tool shall be removed from service.
        - If the defect or contamination exists on the grounding stick, then it shall be replaced or repaired and tested before returning to service.
        - If the defect or contamination exists on the cable, then it shall be replaced or repaired and tested before returning to service.
4. Electrical Testing - All ground sicks shall be electrically tested as follows:
    a. The ground stick cable shall be tested to verify that the impedance is less than 0.1 ohms to ground every 2 years.

b. The testing shall be documented.

   - *Exception: The test shall be performed annually if the ground stick is utilized outdoors or in other adverse conditions.*

c. Soft grounding (High Z) ground sticks with resistors shall be measured and compared to the specified value before each use.

5. Storage and Disposal

   a. Any residual charge from capacitors shall be removed by discharging before servicing or removal.

   b. All uninstalled capacitors capable of storing 10 joules or greater at their rated voltage shall be short- circuited with a conductor of appropriate size.

   c. When an uninstalled capacitor is discovered without the shorting conductor attached to the terminals, it shall be treated as energized and charged to its full rated voltage until determined safe by a qualified person.

Flexible Cords and Portable Electrical Equipment

The following requirements apply to the use of cord-and-plug-connected equipment and flexible cord sets (i.e., extension cords).

General

All cords must be inspected before each use. Employee's hands must be dry when plugging and unplugging flexible cords and cord and plug-connected equipment. If the connection could provide a conducting path to employees' hands (for example, a cord connector is wet from water immersion), insulating protective equipment must be used to handle the energized plug and receptacle connections.

Flexible cords must be protected from damage. They must be designed for hard or extra hard usage (for example, types S, ST, and SO). The rating or approval must be visible. Sharp corners and projections must be avoided. They may not be run through windows or doors unless protected from damage, and then only on a temporary basis. They may not be run above ceilings; inside or through walls, ceilings, or floors; and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.

Flexible cords may only be plugged into grounded receptacles. Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Locking connectors must be properly locked together and must not be altered to allow the grounding pole to be inserted into current connector slots.

It is recommended that two-prong outlet receptacles be replaced with three-prong outlet receptacles. Adapters that interrupt the continuity of the equipment grounding connection may not be used. Clipping the grounding prong from an electrical plug is prohibited.

All electrical cords must be inspected for defects and damage prior to use. Refer to the following list of guidelines to determine a flexible cord's suitability for use:

- Do not use defective or damaged cords.
- Never use an extension cord without a ground pin.
- Do not exceed the rating of the cord.
- Do not run cords across an aisle, walkways, or paths of travel in normal work areas.
- Do not run cords through doorways, ceilings, walls, or floors.
- Do not run cords above ceilings, under floors or inside walls.
- Flexible cords must remain flexible, do not permanently attach cords to any building
- structure.
- Do not fasten cords with staples or hang in a way that could damage the outer
- insulation.
- Turn off devices prior to plugging them in.
- Fully insert plug into outlet and devices into cord, keeping fingers away from metal prongs.
- Do not remove, bend, or modify any metal prongs or pins on the cord.
- Do not use excessive force to make a connection.
- Do not pull on the cord to disconnect, hold the plug to pull from outlet.
- Do not connect a three prong plug into a two-prong cord outlet.

Extension Cords

Extension cords are considered temporary wiring and must comply with the Flexible Cords and Portable Electrical Equipment and Temporary Wiring requirements of this program. They may only be used for temporary power and be of the three-wire type. They should be of equal or greater thickness to the equipment cord they are plugged into.

When used with grounding type equipment extension cords must contain an equipment-grounding conductor (i.e., must accept a three-prong grounded plug). Operating equipment with an extension cord that lacks a grounding plug is prohibited. Job-made extension cords must use UL listed components and assembled by a qualified person.

Extension cords must be inspected for defects and damage prior to use. Refer to the following list of guidelines to determine an extension cord's is suitability for use:

- Do not connect extension cords in series with another extension cord or multi-tap outlet.

- Use extension cords with Ground Fault Circuit Interruption (GFCI) protection during maintenance and construction activities and in damp or wet locations.
- When not in use, store extension cords in a manner to prevent damage.
- Extension cords must be of equal or greater thickness to the device power cord they are plugged into.
- Multi outlet extension cords without circuit protection are not permitted.
- Household use extension cords are not permitted.
- Do not keep unused extension cords plugged in and energized.
- E Light Electric Services Inc. has established an Assured Grounding Program which can be found at www.elightinformation.com.

Temporary Wiring

Temporary electrical power and lighting installations 600 volts or less, including flexible cords, extension cords, and cables may only be used during and for construction, renovation, maintenance, or repair work. Temporary wiring shall be removed immediately following the completion of the project or the purpose for which the wiring was installed. The following additional requirements apply:

Grounding and Electrical Connections

Ground-fault protection (i.e., GFCI) must be on all temporary-wiring circuits, including extension cords, used for construction or maintenance activities. In addition, equipment and tools connected by cord and plug must be grounded unless they are listed or labeled as “double insulated” tools and appliances.

Receptacles must be of the grounding type unless installed in a complete metallic raceway. Each branch circuit must contain a separate equipment-grounding conductor, and all receptacles must be electrically connected to the grounding conductor.

Feeders must originate in an approved distribution center, such as a panel board rated for the voltages and currents the system is expected to carry. Branch circuits must originate in an approved power outlet or panel board and suitable disconnecting switches must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit. Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.

Temporary Flexible Cords and Cables

Flexible cords and cables must be of a listed type and rated for the location and intended use. They may only be used for pendants, wiring of fixtures, connection of portable lamps or appliances, elevators, hoists, connection of stationary equipment where frequently interchanged, prevention of transmission of noise or vibration, data processing cables, or where needed to permit maintenance or repair.

They may not be used as a substitute for the fixed wiring where run through holes in walls, ceilings, or floors; where run through doorways, windows, or similar openings; where attached to building surfaces; or where concealed behind building walls, ceilings,

or floors. They must be protected from accidental damage when they pass through doorways or other pinch points. Avoid sharp corners and projections.

Assured Grounding Program

E Light Electric Services Inc. has established an Assured Grounding Program which can be found at www.elightinformation.com.

Working Space Around Electric Equipment

Sufficient access and working space shall be provided and maintained for all electric equipment to permit ready and safe operation and maintenance of such equipment. Enclosures that house electric apparatus and are controlled by lock and key shall be considered accessible to qualified persons. Working space for equipment operating at 600 volts, nominal, or less to ground and likely to require examination, adjustment, services or maintenance while energized shall comply with the dimensions of OSHA standard 29 CFR 1910.303(g) and OSHA Table S-1 (Table 10.1) or as required or permitted elsewhere in OSHA 1910 Subpart S (29 CFR 1910.303). The depth of the working space in the direction of access to live parts may not be less than indicated in OSHA Table S-1. Distances shall be measured from the live parts if they are exposed or from the enclosure front or opening if they are enclosed. The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be 1.91 m (6.25 ft.) for installations built before August 13, 2007. For installations built on or after August 13, 2007, 1.98 m (6.5 ft.), except that where the electrical equipment exceeds 1.98 m (6.5 ft.) in height, the minimum headroom may not be less than the height of the equipment. [29 CFR 1910.303(g)(1)(vi)] The minimum depth of clear working space at electric equipment, 600 V or less is provided in OSHA Table S-1 from 29 CFR 1910.303 (g)(1)(vi)(B).

OSHA Table S-1

Nominal voltage to ground	Minimum clear distance for condition [2 3]					
	Condition A		Condition B		Condition C	
	m	ft.	m	ft.	m	ft.
0-150	[1]0.9	[1]3.0	[1]0.9	[1]3.0	0.9	3.0
151-600	[1]0.9	[1]3.0	1.0	3.5	1.2	4.0

Notes:

1. Minimum clear distances may be 0.7 m (2.5 ft.) for installations built before April 16, 1981.
2. Conditions A, B, and C are as follows:
    a. Condition A -- Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts.
    b. Condition B -- Exposed live parts on one side and grounded parts on the other side.

c. Condition C -- Exposed live parts on both sides of the work space (not guarded as provided in Condition A) with the operator between.

3. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back. Where rear access is required to work on deenergized parts on the back of enclosed equipment, a minimum working space of 762 mm (30 in.) horizontally shall be provided.

Low Voltage: Smaller working spaces can be permitted where all uninsulated parts operate at

not greater than 30 volts rms, 42 volts peak, or 60 volts DC.

Existing Buildings: In existing buildings, where electric equipment is being replaced, Condition B is permitted between dead-front switch boards, panel boards, or motor control centers located across the aisle from each other where maintenance conditions and supervision ensure that written procedures have been adopted to prohibit equipment on both sides of the aisle from being open at the same time. Only qualified electrical workers who are authorized will service the installation.

Width of Working Space: The width of the working space in front of electrical equipment shall be the width of the equipment or 750 mm (30 in.) whichever is greater. In all cases, the working space shall permit at least a 90-degree opening of equipment doors or hinged panels. [29 CFR 1910.303(g)(1)(i)(B)]

Height of Working Space: The workspace shall be clear and extend from the grade, floor, or platform to the height required by paragraph 29 CFR 1910.303(g)(1)(vi). However, other equipment associated with the electrical installation and located above or below the electric equipment may extend not more than 153 mm (6 in.) beyond the front of the electric equipment. [29 CFR 1910.303(g)(1)(i)(C)]

Clear Spaces: Working space required by 29 CFR 1910.303(g) Table S-1 shall not be used for storage. When normally enclosed energized parts operating at 50 volts and more are exposed for inspection or service, the working space, if in a passageway or general open space shall be suitably guarded. [29 CFR 1910.303(g)(1)(iii)]

Access and Entrance to Working Space

Minimum Required: At least one entrance not less than 610 mm (24 in.) wide and 1.98m (6.5ft.) high shall be provided to give access to the working space about electric equipment. [1910.303(g)(1)(iii) and 1910.303(g)(1)(iv)]

Large Equipment: On switchboard and control panels exceeding 1.83 m (6.0 ft.) in width, there shall be one entrance at each end of such boards unless the location of the switchboards and control panels permits a continuous and unobstructed way of exit travel from the work space. [1910.303(g)(1)(iv)]

Unobstructed Exit: Where the location permits a continuous and unobstructed way of exit travel, a single entrance to the working space shall be permitted. [1910.303(g)(1)(iv)(A)]

Illumination

General

Employees shall not enter spaces containing electrical hazards unless illumination is provided that enables the employees to perform the work safely. [1910.303(g)(1)(v)]

***Obstructed View of Work Area*:** Employees shall not perform any task within the Limited Approach Boundary of energized electrical conductors or circuit parts operating at 50 volts or more; or where an electrical hazard exists, when there is a lack of illumination or an obstruction that prevents observation of the work to be performed.

Headroom

The minimum headroom of working spaces about service equipment, switchboards, panel boards, or motor control centers shall be 1.98 m (6.5 ft.). Where the electrical equipment exceeds 1.98 m (6.5 ft.) in height, the minimum headroom shall not be less than the height of the equipment. [1910.303(g)(1)(vi)]

Dedicated Equipment Space

All switchboards, panel boards, distribution boards, and motor control centers shall be located in dedicated spaces and protected from damage. Exception: Control equipment that by its very nature or because of other rules of the standard must be adjacent to or within sight of the operating machinery shall be permitted in those locations. [1910.303(g)(1)(vii)]

Critical Task

Any task requiring work to be performed on electrical equipment or systems where it has been determined that interrupting the electrical power to that equipment or system will cause greater hazard to persons or property. The designation of work as a critical task must be approved by the electricians performing the work, the electrician's supervisors and project manager, the Director of Education and Loss Prevention, and the Vice President of Operations.

Exception: In an emergency outside of normal working hours, approval may be granted by the electrician's project manager and one other member of management. Notification must be made to the Vice President of Operations and the Director of Education and Loss Prevention via voice mail. This exception may only be utilized if attempts to contact the Director of Education and Loss Prevention and the Vice President of Operations have been unsuccessful.

Electrically Safe Work Condition (De-energized)

Equipment and circuitry shall be de-energized and in an electrically safe work condition if all of the following steps have been successfully completed:

1. All sources of potential power have been identified.
2. All sources of power must be de-energized.
    a. If applicable, disconnects shall be visually verified that the disconnecting means have operated correctly and are in the open position.
    b. All sources of potential power have been locked out and tagged according to company lock-out and tag-out procedures.
    c. All circuitry and equipment has been tested to ensure that it is de-energized and no voltage is present.

Achieving an Electrically Safe Work Condition may involve additional steps depending on the situation. Refer to NFPA 70E, Article 130 for precise steps and requirements for achieving an electrically safe work condition.

The test to determine the absence of voltage is to be done utilizing an approved and correctly rated multimeter designed for the purpose. The meter must also be verified by using the **LIVE-DEAD-LIVE** method prior to testing for the absence of voltage. Proximity testers, solenoid testers and other types of testers that do not indicate the exact level of RMS voltage present shall not be used.

Program Audits

This electrical safety program shall be audited to help ensure that the principles and procedures of the electrical safety program are still in compliance with the latest requirements and regulations. The frequency of the audit shall not exceed three years.

Auditing of field work shall be performed to help assure that the requirements contained in the procedures of the electrical safety program are being followed. Where the auditing determines that the principles and procedures of the electrical safety program are not being followed, the appropriate revisions to the training program or revisions to the procedures shall be made.

When auditing, determine procedures are not being followed, appropriate revisions to the procedures and training program will be made.

Annual audits shall be performed by reviewing the SOPs, JHA’s and Electrical Permits completed in the field. These documents will be saved for a minimum of one (1) year. Documentation of the audits will be maintained by the E Light Safety Department.

Enforcement

Any employee found to be in violation of this policy will be subjected to disciplinary action up to and including termination.

Electricity is the second most powerful force that mankind has learned to harness. As electricians, we are exposed to additional electrical hazards because we interface with electrical equipment and wiring with the normal protections removed. We must be ever vigilant to ensure that we are always safe. We are proud of what we do and what we do is vital to all of humanity but what we do is not worth risking our lives. You all have someone who cares about you and who depends on you. You owe it to them to make sure that you come home after every shift. It only takes a split second to cause a terrible loss that lasts a lifetime for your loved ones. Most electrical accidents happen when we are doing quick, simple tasks and we are not thinking about the potential hazards. Always take a moment to consider the risks. A short cut can have lifelong impacts.

Pay attention, watch what you are doing and watch what your fellow employees are doing and let’s all be safe.