**The Pennsylvania State University**

**Energized Electrical Safety Program**

**Introduction:**

Electricity is a serious workplace hazard, capable of causing both employee injury and property damage. It is the policy of the Pennsylvania State University (PSU) to protect all employees, students, and other personnel from potential electrical hazards. This will be accomplished through compliance with the work practices described herein along with effective application of engineering controls, administrative controls, and the use of personal protective equipment.

The PSU electrical safety program is founded on the principle of avoiding energized work unless it is absolutely necessary. Live parts will be deenergized in accordance with the PSU Lockout/Tagout Program before an employee works on or near them unless one of the following conditions applies:

* **Deenergizing introduces additional hazards or increased risk.** Examples of “additional hazards or increased risk” would include interruption of life support equipment, deactivation of emergency alarm systems, or shutdown of hazardous location ventilation systems.
* **Deenergizing is not possible due to equipment design or operational limitations.** Examples of this situation would include diagnostic work such as voltage measurements, troubleshooting, and testing of electrical equipment.
* **Live parts are operating at less than 50 volts and there is no increased exposure to electrical burns or to explosion due to electrical arcs.**

**Purpose:**

This program has been established in order to:

* Ensure the safety of employees who may work on or near electrical systems.
* Ensure that work units understand and comply with safety standards related to electrical work.
* Ensure that work units follow uniform practices during the completion of electrical work.

**Scope & Applicability:**

This program contains requirements pertaining to the safeguarding of employees against the hazards associated with electrical energy during activities such as the installation, removal, inspection, operation, maintenance, and demolition of electric conductors, electric equipment, signaling and communications conductors and equipment, and raceways.

This program applies to all Penn State properties and work performed by Penn State employees regardless of job site location. The Hershey Medical Center and the College of Medicine are exempt from this program.

Electrical work conducted by laboratory/research personnel in any laboratory/research area (University Park and campus locations) for the purposes of conducting research/course work shall follow the requirements as stated in the “PSU Safety Risk Assessment for Lab Electrical Equipment” document.

**Table of Contents**

1. **References**
2. **Responsibilities**
3. **Definitions**
4. **Training**
5. **Working On or Near Live Parts**
   1. **Energized electrical work permit**
   2. **Approach boundaries to live parts**
   3. **Additional precautions for personnel activities**
6. **Personal Protective Equipment**
   1. **General requirements**
   2. **Arc flash PPE**
   3. **Arc rated clothing general requirements**
   4. **Rubber insulating equipment general requirements**
7. **Insulated Tools & Equipment**
8. **Labeling**
9. **Alerting Techniques**
10. **Evaluation**
11. **Recordkeeping**
12. **Contract Employees**

**Appendix A: Energized Electrical Work Permit**

**Appendix B: Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts**

**Appendix C: Arc Flash Hazard Identification – Alternating Current Equipment (AC) and Direct Current Equipment (DC)**

**Appendix D: Arc Flash Hazard PPE Categories for Alternating Current (AC) systems and direct current (DC) equipment**

**Appendix E: Personal Protective Equipment Requirements**

**Appendix F: Work Unit Electrical Tasks and PPE Requirements *(See the Energized Electrical Safety Program “Resources” webpage for a list of common electrical tasks. This will assist in completing Appendix F)***

**Appendix G: Inspection Schedule for Rubber Insulating Equipment**

**Appendix H: Equipment Label Example**

**Appendix I: Electrical Work Evaluation Checklist (LOTO & NFPA 70E)**

**Appendix J: Contractor / Host Employer Meeting**

**1.0 References:**

The following documents were used as references when developing this program:

* NFPA 70E, “Standard for Electrical Safety in the Workplace”, 2018 edition
* OSHA 29 CFR 1910.331 through 1910.335, “Electrical Safety-Related Work Practices”
* Pennsylvania State University Lockout/Tagout Program- SY35
* PSU Safety Risk Assessment for Lab Electrical Equipment

1. **Responsibilities:**
   1. **Budget Executives and Budget Administrators**

* Ensure that responsibilities assigned within this program are carried out within their administrative work unit.
* Designate individuals responsible for the implementation of the electrical safety program within their work unit.
* Actively support this program as part of the work unit’s overall safety effort.
  1. **Environmental Health and Safety Department**
* Assist work units in implementing the provisions of this program.
* Review and update as needed this written program, at least every three years.
* Provide or coordinate general training for work units on the content of this program.
* Evaluate the overall effectiveness of the electrical safety program on a periodic basis.
* Serve as chair of PSU Electrical Safety Committee.

**2.3** **Safety Officers**

* Determine the applicability of the electrical safety program to activities conducted within their work unit.
* Coordinate implementation of the electrical safety program within the work unit.
* Assist in the investigation of all injuries and incidents involving electrical work.
* Ensure that recordkeeping requirements outlined in this program are maintained for their work unit.

**2.4 Supervisors**

* Ensure employees comply with all provisions of the electrical safety program.
* Ensure that electrical equipment is labeled with appropriate arc flash warning labels.
* Ensure employees receive training appropriate to their assigned electrical tasks, a documented annual evaluation is performed on each qualified person and documentation of training is maintained.
* Develop and maintain a listing of all qualified employees under their supervision.
* Ensure employees are provided with and use appropriate PPE, instruments and tools.

**2.5 Employees**

* Follow the work practices described in this document, including the use and inspection of PPE.
* Attend all training required by this program.
* Immediately report any concerns related to electrical safety to supervision.

**2.6 OPP Electrical Engineering**

* Complete calculations required by this program when needed.
* Place an emphasis on controlling electrical hazards through the application of engineering and design controls.

**2.7 PSU Electrical Safety Committee**

* + - Review electrical safety issues and assist with program edits.
    - Review all energized electrical work permits submitted for approval.
    - Promote consistency in how electrical tasks are completed within the various work units of PSU.

1. **Definitions:**

The following terms are defined in order to allow a better understanding of this program:

* **Arc flash boundary**: When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm2. The onset of a second degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal/cm2 for one second.
* **Arc resistant equipment:** Equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee.
* **Arc flash hazard**: A source of possible injury or damage to health associated with the release of energy caused by an electric arc.
* **Arc flash suit**: A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet. (Such a suit may include pants or overalls, a jacket or a coverall, and a beekeeper-type hood fitted with a face shield).
* **Arc rating:** The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to “breaking open” or at the onset of a second-degree skin burn. This rating is expressed in calories per square centimeter (cal/cm2). Arc-rated clothing or equipment indicates that it has been tested for exposure to an electric arc. Flame-resistant (FR) clothing without an arc rating has not been tested for exposure to an electric arc. All arc-rated clothing is also flame resistant.
* **Barricade:** A physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning and to limit access.
* **Electrical Hazard**: A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or arc blast injury.
* **Electrically safe work condition:** A state in which the conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with PSU policy, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.
* **Energized:** Electrically connected to, or is, a source of voltage.
* **Equipment:** A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like, used as a part of, or in connection with, an electrical installation.
* **Exposed (as applied to energized electrical conductors or circuit parts):** Capable of being inadvertently touched or approached from closer than a safe distance by a person. It is applied to parts that are not suitably guarded, isolated, or insulated.
* **Fault Current:** The amount of current delivered at a point on the system during a short-circuit condition.
* **Fault Current-Available:** The largest amount of current capable of being delivered at a point on the system during a short-circuit condition.
* **Guarded:** Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.
* **Incident energy:** The amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. Incident energy is typically expressed in calories per square centimeter (cal/cm2).
* **Incident Energy Analysis:** A component of an arc flash risk assessment used to predict the incident energy of an arc flash for a specific set of conditions.
* **Limited Approach Boundary:** An approach limit at a distance from an exposed energized electrical conductor or circuit part live part within which a shock hazard exists.
* **Live parts:** Energized conductive components.
* **Luminaire:** A complete lighting unit consisting of a light source, such as a lamp or lamps, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light. A lamp holder itself is not a luminaire.
* **Nominal Voltage:** A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class. (e.g., 120/240 volts, 480Y/277 volts, 600 volts).
  + **Note:** Certain battery units are rated at nominal 48 volts dc but have a charging float voltage up to 58 volts. In dc applications, 60 volts is used to cover the entire range of float voltages.
* **PPE:** Means “Personal Protective Equipment”.
* **Qualified person:** One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.
* **Raceway:** An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars.
* **Restricted Approach Boundary:** An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.
* **Risk Assessment**:An overall process that identifies hazards, estimates the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if protective measures are required.
* **Shock hazard:** A source of possible injury or damage to health associated with current through the body caused by contact or approach to exposed energized electrical conductors or circuit parts.
* **Step Potential:** A ground potential gradient difference that can cause current flow from foot to foot through the body. Any current path through the body other than from foot to foot is touch potential.
* **Testing and Troubleshooting:** Process of analyzing the operation of a faulty piece of electrical equipment/circuit in order to determine why it is not functioning normally. The multimeter is a commonly used piece of testing equipment used to measure voltage and resistance. As soon as tools such as a screwdriver, wrench, pliers, etc are used on or near a live circuit, the task is no longer considered testing and troubleshooting.
* **Unqualified person:** Any person who does not meet the definition of a qualified person.
* **Working distance:** The distance between a person’s face and chest area and a prospective arc source.
* **Working near (energized electrical conductors or circuit parts):** Any activity within a Limited Approach Boundary.
* **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 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.)
  + Crossing the Restricted Approach Boundary is considered the same as making contact with energized parts. Appropriate PPE for the voltage is required. See Appendix B for approach boundary.
  + Employees shall not reach blindly into areas that might contain exposed live parts without wearing the appropriate PPE for the voltage.

1. **Training:**
   1. Employees who are exposed to an electrical hazard that is not reduced to a safe level by the installation (panel cover, outlet cover, etc) must be trained.
   2. Training must be provided before the employee is assigned duties that involve work near or on electrical systems.
   3. The level of electrical safety training provided is dependent on whether the employee is classified as a “qualified person” or “unqualified person”.
   4. A “qualified person” shall be trained and knowledgeable in all of the following topics: *A person can be considered qualified with respect to certain equipment and methods but unqualified for other pieces of equipment and methods*.

1.) Construction and operation of equipment on which work is assigned.

2.) Skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.

3.) Skills and techniques necessary to determine the nominal voltage of exposed live parts.

* *An employee can obtain knowledge of #1, #2, and #3 listed above through a combination of methods including the individual’s education, electric license, past work experience, and on-the-job training.*

4.) The approach distances specified in this document and the corresponding voltages to which the qualified employee will be exposed.

5.) The process necessary to determine the degree and extent of electrical hazards along with the PPE and job planning necessary to perform the task safely.

6.) Methods of safe release of victims from contact with exposed energized electrical conductors or circuit parts.

* *An employee must attend an NFPA 70E training session approved by EHS to obtain the required knowledge of #4, #5, and #6 listed above.*

4.5 a) Employees who perform electrical work on electrical equipment 50 volts or higher must be trained in first aid, cardiopulmonary resuscitation (CPR) and automatic external defibrillator (AED) if medical services are not reasonably accessible or available within 4 minutes of the workplace.

*---As you conduct your assessment of your work groups typical electrical work locations/situations, keep in mind examples of the following that are more likely to be farther away from medical services: electrical work on rooftops, electrical work off campus/remote locations, mobility of the work group, and electrical work occurring at hard to physically access locations (gated/restricted access, confined space, etc.)---*

b) Attendants, and/or other employees who commonly/routinely provide job assistance during electrical work shall be trained in First Aid/CPR/AED (i.e. maintenance employees helping an electrician/employee who routinely conducts electrical work). Likewise, if a task is designated as being a two-person task, by either the work group or as a requirement of this program (Energized Electrical Work Permit), then both persons shall be trained.

c) First Aid/CPR/AED training course must be conducted by either the American Red Cross (ARC) or American Heart Association (AHA) certified trainer.

d) Training shall occur at a frequency that satisfies the requirement of the certifying body.

* 1. An “unqualified person” shall be trained and be familiar with any electrical safety-related practices necessary for their safety.
  2. Re-training pertaining to NFPA 70E shall occur every 3 years.

4.8 Additional training (or re-training) is required if any of the following conditions exist:

4.8.1 The supervision or annual evaluations indicate that the employee is not complying with safety-related work practices.

4.8.2 New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those that the employee would normally use.

4.8.3 The employee needs to review tasks that are performed less often than once per year.

4.8.4 The employee needs to review safety-related work practices not normally used by the employee during regular job duties.

* + 1. The employees job duties change.
  1. Use of 3rd party trainers (i.e. non-PSU employees).

Use of 3rd party trainers is not permitted without prior PSU EHS approval. The work group must contact the PSU EHS Energized Electrical Safety Program Manager. This is required to ensure the training content will cover PSU specific information.

**5 Working On or Near Live Parts:**

* 1. **Energized Electrical Work Permit:**

5.1.1 If live parts are not placed in an electrically safe condition, work to be performed shall be considered energized electrical work and will be performed by written permit only (Appendix A: Energized Electrical Work Permit).

* When working within the limited approach boundary.
* When interacting with equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

5.1.2 A permit is not required if the qualified person is provided with and uses appropriate safe work practices and PPE under the following conditions:

1) Testing, troubleshooting, or voltage measuring;

2) Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed;

3) 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;

4) General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed.

5.1.3 A copy of the “PSU Energized Electrical Work Permit” can be found in Appendix A of this document. The intent of this permit is to ensure that all appropriate safety precautions are taken prior to starting energized electrical work.

5.1.4 The permit is to be originated by the individual requesting that the energized work be completed. The requestor is responsible for completing Section I of the permit.

* The requestor will normally be the supervisor of the employees who will be completing the work.
* The requestor may also be an individual from a work unit where the work is to be completed. If this is the case, Section I of the permit must be completed by a unit administrator.

5.1.5 The qualified persons completing the task are responsible for completing Section II of the permit.

5.1.6 Members of the PSU Electrical Safety Committee must approve the permit prior to commencing work. An approval signature must be obtained from one committee member within each of the following three groups:

* OPP Electrical Engineer
* Member of EHS - Occupational Health & Safety Manager or Occupational Safety Program Manager.
* Safety Officer of Work Unit (if at University Park) or Commonwealth Services Representative (if at a campus location).

5.1.7 A job briefing is required before the start of each job involving energized electrical work. Each qualified person shall be briefed on the job. At a minimum the briefing must include the following: associated electrical hazards, work procedures, special precautions, isolation points and procedures, emergency response, PPE requirements, and other work in the immediate area. Additional job briefings shall be held if changes that might affect the safety of employees occur during the course of the work.

5.1.8 The permit must be posted in the area where the energized work is taking place for the duration of the task.

5.1.9 At least two qualified employees must be present for all energized work requiring a permit.

5.1.10 If both qualified employees are working on the circuit, an attendant is required to control any unqualified person from entering the limited approach boundary. The attendant can be an unqualified person as long as he or she remains outside the arc flash boundary.

5.1.11 Copies of all energized electrical work permits must be provided to both the work unit Safety Officer and the EHS Department upon completion of the task.

**5.2 Approach Boundaries to Live Parts:**

5.2.1 Observing a safe approach distance from exposed energized parts is an effective means of maintaining electrical safety. As the distance between an individual and live parts increases, the potential for an electrical injury decreases.



5.2.2 Safe approach distances will be determined for all tasks in which approaching personnel are exposed to live parts.

5.2.3 Safe approach distances to fixed live parts can be determined by referring to Appendix B: Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts. This appendix can be used to identify the Limited and Restricted Approach Boundaries associated with various system voltages.

5.2.4 Unqualified persons may only cross the Limited Approach Boundary into the Restricted Approach Boundary when they are under the direct supervision of a qualified person. Note: Arc-rated PPE is required for any employee crossing the arc flash boundary.

5.2.5 Qualified persons may not cross or take any conductive object closer than the Restricted Approach Boundary unless one of the following conditions applies:

* The qualified person is insulated or guarded from energized electrical conductors or circuit parts operating at 50 volts or more.
* The energized electrical conductors or circuit parts are insulated from the qualified person and from any other conductive object.

5.2.6 Crossing the Restricted Approach Boundary is considered the same as making contact with energized parts. Qualified persons may only cross this boundary to perform work on energized parts when all of the following precautions have been taken:

* The qualified person has specific training to work on energized parts.
* The qualified person has obtained an approved Energized Electrical Work Permit.
* The qualified person uses PPE appropriate for working on energized parts.

5.2.7 Arc Flash Boundary

5.2.7.1 Appropriate personal protective equipment shall be provided to and used by all employees working within the arc flash boundary.

* For AC systems that are 600 volts or less, the arc flash boundary shall be a minimum of 20 feet or the entire room if a boundary of 20 feet cannot be obtained (i.e. room is smaller than 20 feet).
* For DC systems refer to Appendix D: Arc Flash Hazard PPE Categories for Direct Current (DC) Equipment.
* If the equipment (AC or DC powered) has an NFPA 70E label attached its stated arc flash boundary should be used.

**5.3 Additional Precautions for Personnel Activities:**

5.3.1 Employees shall ensure that the rated test instrument is operating properly through verifying on a known voltage.

----The four categories that are typically used to indicate the location of use for test equipment are as follows----:

a) CAT I - Electronic Equipment.

This category is for measurements of voltages from specially protected secondary circuits. Voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

b) CAT II – Single-phase receptacle level.

This is sufficient for a receptacle outlet circuit or plug-in loads. This would also include measurements performed on household appliances, portable tools, and similar modules.

c) CAT III – Inside distribution (feeders and branch circuits)

Distribution wiring is qualified for this group, including “mains” bus, feeders, and branch circuits. Also, permanently installed or “hard-wired” loads and distribution boards. Other examples are higher voltage wiring, including power cables, bus bars, junction boxes, switches, and stationary motors with permanent connections to fixed installations.

d) CAT IV – Three-phase utility connections and outside.

This is “Origin of installation” or utility level applications such as any outside cable run.

5.3.2 Employees shall not reach blindly into areas that might contain exposed live parts.

5.3.3 Employees shall not enter spaces containing live parts unless illumination is provided that allows the work to be performed safely. Additional illumination may be needed when using arc rated face shields/hoods during electrical work.

5.3.4 Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, 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.

5.3.5 Conductive materials, tools, and equipment that are in contact with any part of an employee’s body shall be handled in a manner that prevents accidental contact with live parts. Such materials and equipment include, but are not limited to, long conductive objects such as ducts, pipes, tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, and chains.

5.3.6 When an employee works in a confined space or enclosed space (such as a manhole or vault) that contains exposed live parts, the employee shall use protective shields, barriers, or insulating materials as necessary to avoid contact with these parts. Doors, hinged panels, and the like shall be secured to prevent them from swinging into employees.

1. **Personal Protective Equipment:**
   1. **General Requirements**

6.1.1 Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment that is designed and constructed for the specific body part to be protected and for the work to be performed.

6.1.2 Work units will provide electrical protective equipment required by this program at no cost to employees, such as Arc Rated apparel, eye protection, head protection, hand protection, insulated footwear, and face shields. Work units are not responsible for providing non-Arc Rated underlayers to employees.

6.1.3 All protective equipment shall be maintained in a safe, reliable condition by the employee to whom it is issued.

6.1.4 Employees shall wear nonconductive head protection whenever there is a danger of head injury from electric shock or burns due to contact with live parts or from flying objects resulting from an electrical explosion.

• Class G (General) hard hats are rated for 2,200 volts.

• Class E (Electrical) hard hats are rated for 20,000 volts.

• Class C (Conductive) hard hats do not offer electrical protection.

6.1.5 Employees shall wear nonconductive protection for the face, neck, and chin whenever there is danger of injury from exposure to electric arcs or flashes or from flying objects resulting from an electrical explosion.

6.1.6 Employees shall wear protective equipment for the eyes whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from an electrical explosion.

6.1.7 Employees shall wear arc rated clothing (body) whenever there is possible exposure to an electrical arc flash. See section 6.3 for more information.

6.1.8 Employees shall wear hand and arm protection as follows:

Rubber insulating gloves and heavy duty leather protectors where there is danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts.

Employees shall wear rubber insulating gloves with heavy duty leather protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts.

Rubber insulating gloves shall be permitted to be used without heavy duty leather protectors, under the following conditions:

1. There shall be no activity performed that risks cutting or damaging the gloves.
2. The rubber insulating gloves shall be electrically retested before reuse (by third party).
3. The voltage rating of the rubber insulating gloves shall be reduced by 50% for class 00 and by one whole class for classes 0 through 4.

Maximum Use Voltage for Rubber Insulating Gloves:

|  |  |  |  |
| --- | --- | --- | --- |
| **Class Designation of Glove or Sleeve** | **Maximum *ac* Use Voltage (volts)** | **Maximum *dc* Use Voltage (volts)** | **Distance Between Gauntlet and Cuff (minimum)** |
| **00** | **500** | **750** | **0.5 inch** |
| **0** | **1,000** | **1,500** | **0.5 inch** |
| **1** | **7,500** | **11,250** | **1 inch** |
| **2** | **17,000** | **25,500** | **2 inch** |
| **3** | **26,500** | **39,750** | **3 inch** |
| **4** | **36,000** | **54,000** | **4 inch** |

Note: heavy duty leather gloves are made entirely of leather with minimum thickness of 0.03 in. (0.7 mm) and are unlined or lined with nonflammable, non-melting fabrics.

6.1.9 Where insulated footwear is used as protection against step and touch potential, dielectric footwear shall be required.

Insulated soles shall not be used as the primary electrical protection. *The integrity of the insulating quality of footwear with insulated soles cannot be easily determined after they have been worn in a work environment. EH (Electrical Hazard) rated footwear meeting ASTM F 2413 can provide a secondary source of electric shock protection under dry conditions.*

* + 1. Employees shall wear face shields with an arc rating for the face and eyes whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from an electrical explosion.

Face shields with a wrap around guarding to protect the face, chin, forehead, ears, and neck area shall be used.

Safety glasses or safety goggles must always be worn underneath face shields.

An arc rated hood or an arc rated balaclava with an arc rated face shield shall be used when the back of the head is within the arc flash boundary.

* + 1. Employees shall wear hearing protection whenever working within the arc flash boundary. Ear canal inserts are the form of hearing protection that is required.

**6.2 Arc Flash PPE**

Arc flash PPE must be used when working inside the arc flash boundary.

One of the following methods shall be used for the selection of arc flash PPE:

1. Complete a detailed flash risk assessment under engineering supervision that determines the incident exposure energy of each employee. Appropriate protective clothing can then be selected based on the calculated exposure level. Criteria for completing such an analysis can be obtained from the EHS Department.
2. Use the contents of this document or the NFPA 70E 2021 standard:
   * STEP 1: To determine if arc flash PPE is required for the task refer to NFPA 70E 2021 Table 130.5 (C), OR Appendix C of this document.
   * STEP 2: If PPE is required for the task the Arc Flash PPE Category can be found by referring to NFPA 70E 2021 Table 130.7 (C)(15~~)~~(a) & 130.7 (C)(15)(b), OR Appendix D of this document.
   * STEP 3: To determine the arc flash PPE for a given arc flash PPE Category refer to Appendix E of this document.
   1. **Arc Rated Clothing General Requirements**

6.3.1 Arc rated apparel shall be visually inspected before each use. Arc rated apparel that is damaged or becomes contaminated with grease, oil, flammable liquids, or combustible liquids shall not be used.

6.3.2 The garment manufacturer’s instructions for care, maintenance and cleaning of arc rated apparel shall be followed.

6.3.3 When Arc Rated apparel is worn to protect an employee, it shall cover all ignitable clothing and allow for movement and visibility.

6.3.4 Arc Rated apparel must 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.

6.3.5 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.

6.3.6 Apparel made from materials that are not arc rated must not be worn. Example: hair nets, ear warmers, or head covers could melt onto an employee’s hair and head unless properly rated.

6.3.6 Non-melting, flammable fiber garments (i.e. cotton, wool, rayon, silk, or blends of these materials) may be used as underlayers beneath Arc Rated apparel.

6.3.6.1 Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers. (An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted).

6.3.7 Garments worn as outer layers over Arc Rated clothing (i.e. jackets, rainwear, high-visibility safety apparel) must also be made from Arc Rated material. The arc rating of outer layers worn over are-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.

* + 1. Flash suits must permit easy and rapid removal by the user.

**6.4 Rubber Insulating Equipment General Requirements**

6.4.1 Rubber insulating equipment includes protective devices such as gloves, sleeves, blankets, and matting.

6.4.2 Insulating equipment must be inspected for damage before each day’s use and immediately following any incident that could have caused damage.

6.4.3 An air test must be performed on rubber insulating gloves before each use. To complete an air test, manually fill the glove with air. Fold over the cuff to seal the air inside the glove. Detect any leaking air by either listening for escaping air or feeling the escaping air by holding the glove near the face.

6.4.4 Insulating equipment found to have defects that might affect its insulating properties must either be replaced or removed from service until testing indicates that it is acceptable for continued use.

6.4.5 Where the insulating capability of protective equipment is subject to damage during use, the insulating material shall be protected by an outer covering of leather or other appropriate material.

6.4.6 Rubber insulating equipment must be tested according to the schedule in Appendix G.

6.4.7 Rubber insulating equipment must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that may cause damage.

* + 1. No repairs to rubber insulating equipment shall be attempted.

1. **Insulated Tools & Equipment:**
   1. Employees shall use insulated tools or handling equipment, or both, when working inside the restricted approach boundary of exposed energized electrical conductors or circuit parts.
   2. The term “insulated” means that the tool manufacturer has assigned a voltage rating to the insulating material. Only tools with a defined voltage rating are considered insulated. Tools with unmarked rubber grips and plastic handles must not be used for electrical work.
   3. The following requirements apply:

* Insulated tools shall be rated for the voltages on which they are used.
* Insulated tools shall be designed and constructed for the environmental to which they are exposed and the manner in which they are used.
* Insulated tools and equipment shall be inspected prior to each use. The inspection shall look for damage to the insulation or damage that can limit the tool from performing its intended function or could increase the potential for an incident (e.g., damaged tip on a screwdriver).

7.4 Employees shall use portable ladders that have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts.

1. **Labeling:**

* 1. Electrical equipment such as switchboards, panel boards, industrial control panels, meter socket enclosures and motor control centers that are in other than dwelling units, and are likely to require examination, adjustment, servicing, or maintenance while energized, shall be labeled using a label similar to the one found in Appendix I.
* *Labels applied prior to September 30, 2011 are acceptable if they contain the available incident energy or required level of PPE.*
  1. Labels shall include at least one of the following:
     1. Available incident energy and the corresponding working distance, OR the arc flash PPE category, BUT NOT BOTH.
     2. Minimum arc rating of clothing
     3. Site-specific level of PPE
     4. **And**; Nominal system voltage
     5. **And**; Arc flash boundary

1. **Alerting Techniques:**
   1. Barricades shall be placed no closer than the arc flash boundary.
   2. Barricades: shall be used in conjunction with safety signs (or equivalent) to prevent or limit access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where they might increase the likelihood of exposure to an electrical hazard.
   3. Attendants: If signs and barricades do not provide sufficient warning and protection, an attendant shall be assigned to warn and protect pedestrians. The primary duty of the attendant shall be to keep unqualified persons 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.
2. **Evaluation:**
   1. An annual documented evaluation of each qualified person shall be conducted to ensure adherence to the electrical safety procedures described in this document. See Appendix I: Electrical Work Evaluation Checklist (LOTO & NFPA 70E)
   2. It is recommended that this evaluation be performed in conjunction with the annual Lockout / Tagout evaluation. (See PSU Lockout/Tagout program)
3. **Recordkeeping:**
   1. The most recent training provided by EHS will be maintained (re-training is required every 3 years) for 30 years.
   2. Training provided by the work unit shall be maintained by the work unit for the duration of employment.

* Documentation shall include the content of the training, each employee’s name and dates of training.
  1. Each work unit shall maintain a list of all employees classified as qualified persons.
  2. Documentation of the annual Electrical Work Evaluation Checklist (Appendix I) shall be maintained by the work unit for the period of employment in the work unit.
  3. Documentation containing information pertaining to each electrical task and its corresponding PPE requirements shall be maintained by the work unit using Appendix F or equivalent until superseded/updated + 1 year.
  4. Documentation of the Contractor / Host Employer Meeting (Appendix J) shall be maintained for one year by the work unit who planned/initiated the work until superseded/updated + 1 year.

* 1. Documentation of rubber insulating equipment’s (i.e. gloves) 3rd party inspections shall be maintained by the work unit for the life of the equipment.
  2. Documentation of the Energized Electrical Work Permit (Appendix A) shall be maintained by the work unit until the end of that calendar year + 1 year.

1. **Contract Employees:**
   1. A documented meeting between PSU and contractors engaged in electrical work shall occur. (See Appendix J)

* The meeting shall be conducted by the project manager, project coordinator, electrical engineer, or other PSU employee with knowledge of the electrical system.
  1. Contractors are required to follow all applicable OSHA regulations and NFPA 70 E standards.

**Appendix A: Energized Electrical Work Permit (Page 1 of 2)**

|  |
| --- |
| Part I: To be completed by the requester or supervisor of the job |
| (1) Identify requester: Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Work Unit:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| (2) Job location: |
| (3) Description of work to be done: |
| (4) Explain why the circuit cannot be deenergized or the work delayed until the next scheduled outage: |
| (5) Signature of requester:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Title:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Part II: To be completed by the qualified person(s) completing the work** |
| (6) Description of circuit and equipment: |
| (7) Detailed description of procedure to be used in performing the above work: |
| (8) Safe work practices to be used: (Check all that apply)   |  |  | | --- | --- | | Boundaries | Barriers - Non-conductive covers/blankets | | Voltage rated tools | Attendant | | PPE |  OTHER – (Describe) | | LOTO other circuits/tools | |
| (9) Maximum Voltage that will be exposed: |
| (10) What rating is the upstream protective device? (Amperage): |
| (11) Limited and Restricted Boundaries for shock hazard: Refer to the arc flash label (if present), if not see Appendix B of this program or Table 130.4(E)(a) or (b) in the NFPA 70E 2021 standard.   * Limited boundary =\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * Restricted boundary = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| (12) Determination of flash protection boundaries:   Refer to the arc flash label (if present), if not see Appendix D of this program or if task is not listed in Appendix D see Table 130.7(C)(15)(a) or (b) in the NFPA 70E 2021 standard.   Tasks not listed must be calculated by Electrical Engineer. Calculation Results: \_\_\_\_\_Ft \_\_\_\_\_\_inches |
| (13) Arc flash PPE Category (See Appendix D of this program): |

**Appendix A: Energized Electrical Work Permit (Page 2 of 2)**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| (14) PPE required to safely perform the task: (Either Appendix E of this program OR tables 130.7(C)(15)(c) in the NFPA 70E 2021 standard)  - **Check all that apply.**  - **Circle class of PPE and minimum calorie rating where applicable.**   |  |  | | --- | --- | |  Voltage rated gloves – class 00, 0, 1, 2, 3, 4 |  Long sleeve shirt (non-melting) | |  Voltage rated tools |  Long pants (non-melting) | |  Safety glasses or goggles |  Long sleeve Arc Rated shirt - Calorie rating 4, 8, 25, 40 | |  Hearing protection |  Long Arc Rated pants - Calorie rating 4, 8, 25, 40 | |  Hardhat - (Class C up to 2,200 Volts / Class G up to 20,000 Volts) |  Arc Rated coveralls- Calorie rating 4, 8, 25, 40 | |  Hardhat with flame retardant liner - (Class C up to 2,200 Volts / Class G up to 20,000 Volts) |  Arc Rated jacket or rainwear- Calorie rating 4, 8, 25, 40 | |  Leather boots/shoes |  Flash suit- Calorie rating 4, 8, 25, 40 | |  Leather gloves (heavy duty) |  Flash hood - Calorie rating 4, 8, 25, 40 | |  Dielectric over-boots/shoes |  Arc rated face shield & Balaclava – Arc flash PPE Category 2 | |  |  OTHER: | |
| (15) Method used to restrict access to the work area:   Safety Signs and Tags (tape, barricade)   Attendant |
| (16) Will a job briefing be completed that covers all of the following items?  Yes   |  |  | | --- | --- | | Hazards associated with the job | Energy source controls | | Work procedures involved | PPE | | Special precautions | Tools (Insulated fuse holder handling equipment, insulated hand tools, ETC). | | Other | |   Do you agree the above work can be done safely?  Yes (Forward to EHS) No (Return to requester) Note that additional information may be requested by the PSU Electrical Safety Committee.  Qualified Person performing work: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_  Qualified Person performing work: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_  Attendant:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_  Qualified Person’s Supervisor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Part III: To be completed by members of PSU Electrical Safety Committee** |
| **Approvals:**  Safety Officer (UP): Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Job Title\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Commonwealth Services Representative (Campus): Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Job Title\_\_\_\_\_\_\_\_\_\_\_Date\_\_\_\_\_  Electrical Engineer (OPP): Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Job Title\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date\_\_\_\_\_\_\_\_  EHS: Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Job Title\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |
| **Permit Expiration Date:** |
| ** Approved  NOT Approved** |

**Appendix B**

**Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts**

**(All dimensions are distance from fixed live part to employee)**

**Alternating Current (AC)**

|  |  |  |
| --- | --- | --- |
| **Nominal System Voltage** | **Limited Approach Boundary** | **Restricted Approach Boundary** |
| Less than 50 V | Not Specified | Not Specified |
| 50 V to 150 V | 3 feet, 6 inches | Avoid Contact |
| 151 V to 750 V | 3 feet, 6 inches | 1 foot |
| 751 V to 15 kV | 5 feet | 2 feet, 2 inches |
| *Over 15 kV or a movable conductor (a condition in which the distance between the conductor and a person is not under the control of the person)*  *See NFPA 70 E Table 130.4 (D)(a)* | | |

**Direct Current (DC)**

|  |  |  |
| --- | --- | --- |
| **Nominal Potential Difference** | **Limited Approach Boundary** | **Restricted Approach Boundary** |
| Less than 50 V | Not specified | Not specified |
| 50 V - 300 V | 3 feet, 6 inches | Avoid Contact |
| 301 V - 1 kV | 3 feet, 6 inches | 1 foot |
| *Over 1 kV or a movable conductor (a condition in which the distance between the conductor and a person is not under the control of the person)*  *See NFPA 70 E Table 130.4 (D)(b)* | | |

Definitions

* Limited Approach Boundary - is an approach limit at a distance from an exposed live part within which a shock hazard exists.
* Restricted Approach Boundary - An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.

**Appendix C**

**Arc flash Hazard Identification –**

**Alternating Current Equipment (AC) and Direct Current Equipment (DC) (page 1 of 3)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Task** | **Equipment Condition** | | **Arc Flash PPE Required** | |
| Operation of a circuit breaker, disconnect (lever/knife switch), switch, contactor, or starter | **Note: All of the following requirements must be met to satisfy the “no arc flash PPE required” scenario:**   1. Covers/panels that enclose the circuit breaker (CB), switch, contactor, or starter are in place, and secure. 2. No visual damage to the enclosure of the circuit breaker (CB), switch, contactor, or starter. 3. No visual damage to the circuit breaker (CB) switch, switch, contactor, or starter. 4. No visual damage to the wires/conduits at entry/exit points to the enclosure. 5. No knockouts missing. 6. No evidence of water/liquid damage (puddling, rust, chemicals). 7. No evidence of heat/fire damage (discoloration). 8. No bolts, screws, fasteners missing. 9. No exposed live parts of the enclosure (proper blanks used to cover empty circuit breaker locations)   If conditions in 1-9 are found to be satisfactory, a circuit breaker (CB), disconnect (lever/knife switch), switch, contactor, or starter can be used to turn off/on a circuit without PPE.  **\*\*\*\*\*\*\*\*\*Resetting a tripped breaker\*\*\*\*\*\*\*\*\***  If conditions in 1-9 are found to be satisfactory and circuit breaker operation training has been completed, a tripped circuit breaker can be reset WITHOUT PPE ONLY IF after investigation reveals a probable cause of the trip (overloaded circuit). ADDITIONALLY, the circuit breaker is only permitted to be reset only 1 time.  A person who has been qualified to troubleshoot an electrical circuit (i.e. electrician) must be notified if the breaker trips a 2nd time. | | No | |
| **Task** | | **Arc Flash PPE Required** | |
| 1.) Operation of a CB or switch the first time after installation or completion of maintenance in the equipment. | | Yes | |
| 2.) Reading a panel meter while operating a meter switch | | No | |
| 3.) For ac systems: Work on energized electrical conductors and circuit parts, including voltage/electrical testing | | Yes | |

**Appendix C**

**Arc flash Hazard Identification –**

**Alternating Current Equipment (AC) and Direct Current Equipment (DC) (page 2 of 3)**

|  |  |
| --- | --- |
| **Task** | **Arc Flash PPE Required** |
| 4.) For dc systems: Work on energized electrical conductors and circuit parts of series-connected battery cells, including voltage/electrical testing | Yes |
| 5.) Voltage testing on individual battery cells or individual multi-cell units | No |
| 6.) Removal or installation of circuit breakers or switches | Yes |
| 7.) Examination of insulated cable with no manipulation of cable. | No |
| 8.) Examination of insulated cable with manipulation of cable. | Yes |
| 9.) Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts | No |
| 10.) Insertion or removal of covers for battery intercell connector(s). | Yes |
| 11.) Removal of battery non-conductive intercell connector covers. | No |
| 12.) Opening hinged door(s) or cover(s) or removal of bolted covers (to expose bare, energized electrical conductors and circuit parts). For dc systems, this includes bolted covers, such as battery terminal covers. | Yes |
| 13.) Opening a panelboard hinged door or cover to access dead front overcurrent devices. | No |
| 14.) Perform infrared thermography and other non-contact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers. | No |
| 15.) Application of temporary protective grounding equipment after voltage test. | Yes |
| 16.) Working on control circuits with exposed energized electrical conductors and circuit parts,  nominal 125 volts ac or dc, or below without any other exposed energized equipment over nominal 125 volts ac or dc, including opening of hinged covers to gain access. | No |
| 17.) Work on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V | Yes |
| 18.) Insertion or removal of individual starter buckets from motor control center (MCC) | Yes |
| 19.) Insertion or removal (racking) of circuit breakers or starters from cubicles, doors open or closed | Yes |
| 20.) Insertion or removal of plug-in devices into or from busways | Yes |
| 21.) Work on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center | Yes |
| 22.) Insertion and removal of revenue meters (kW-hour, at primary voltage and current) | Yes |
| 23.) For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack | No |
| 24.) For dc systems, work on exposed energized electrical conductors and circuit parts of utilization equipment directly supplied by a dc source. | Yes |
| 25.) Opening voltage transformer or control power transformer compartments | Yes |

**Appendix C**

**Arc flash Hazard Identification –**

**Alternating Current Equipment (AC) and Direct Current Equipment (DC)**

**(page 3 of 3)**

|  |  |  |
| --- | --- | --- |
| **Task** | | **Arc Flash PPE Required** |
| 26.) Operation of outdoor disconnect switch (hookstick operated) at 1 kV through 15 kV | | Yes |
| 27.) Operation of outdoor disconnect switch (gang-operated, from grade) at 1 kV through 15 kV | | Yes |
| 28.) Maintenance and testing on individual battery cells or individual multi-cell units in an open rack. | Yes, Only if equipment condition considered to be “abnormal”. SEE NOTE AT END OF THIS TABLE | |
| 29.) Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:  -Insertion or removal of individual starter buckets;  -insertion or removal (racking) of circuit breakers from cubicles;  -Insertion or removal (racking) of ground and test device;  -Insertion or removal (racking) of voltage transformers on or off the bus. | Yes,  Only if equipment condition considered to be “abnormal”. SEE NOTE AT END OF THIS TABLE | |
| 30.) Insertion or removal of individual cells or multi-cell units of a battery system in an open rack. | Yes, Only if equipment condition considered to be “abnormal”. SEE NOTE AT END OF THIS TABLE | |

NOTE:

Equipment condition considered to be “normal” if all of the following circumstances apply:

* + 1. The equipment is properly installed in accordance with the manufacturer’s recommendations and applicable industry codes and standards.
    2. The equipment is properly maintained in accordance with the manufacturer’s recommendations and applicable industry codes and standards.
    3. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacture’s instruction.
    4. Equipment doors are closed and secured.
    5. 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.

**Appendix D (Page 1 of 2)**

**Arc flash hazard PPE categories for**

**Alternating Current (AC) Equipment**

|  |  |
| --- | --- |
| **Equipment** | **Arc Flash PPE Category** |
| Panelboards or other equipment rated 240 V and below  *Parameters:*  *Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycle) fault clearing time; minimum working distance 18 in.* | 1 |
| Panelboards or other equipment rated greater than 240 V and up to 600 V  *Parameters:*  *Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycle) fault clearing time; minimum working distance 18 in.* | 2 |
| 600-volt class motor control centers (MCCs)  *Parameters:*  *Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 18 in.* | 2 |
| 600-volt class motor control centers (MCCs)  *Parameters:*  *Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 18 in.* | 4 |
| 600-volt class switchgear (with power circuit fuses or fused switches) and 600-volt class switchboards  *Parameters:*  *Maximum of 35 kA available fault current; maximum of up to 0.5 sec (30 cycles) fault clearing time; minimum working distance 18 in.* | 4 |
| Other 600-volt class equipment (277 volts through 600 volts nominal)  *Parameters:*  *Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycle) fault clearing time; minimum working distance 18 in.* | 2 |
| Arc-resistant equipment up to 600-volt class  *Parameters:*  DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment. | N/A |

**Appendix D (Page 2 of 2)**

**Arc Flash Boundary**

For AC systems that are 600 volts or less, the arc flash boundary shall be a minimum of 20 feet or the entire room if a boundary of 20 feet cannot be obtained (i.e. room is smaller than 20 feet). If the equipment has an NFPA 70E label attached its stated arc flash boundary should be used.

**Arc flash hazard PPE categories for**

**Direct Current (DC) Equipment**

|  |  |  |
| --- | --- | --- |
| **Equipment** | **Arc Flash PPE Category** | **Arc-Flash Boundary** |
| Storage batteries, dc switchboards, and other dc supply sources 100 volt or greater but less than or equal to 250 volts.  *Parameters:*  *Maximum arc duration and minimum working distance: 2 sec @ 18 in.* | | |
| Available fault current less than 4 kA | 2 | 3 feet |
| Available fault current greater than or equal to 4 kA and less than 7 kA | 2 | 4 feet |
| Available fault current greater than or equal to 7 kA and less than 15 kA | 3 | 6 feet |
| Storage batteries, dc switchboards, and other dc supply sources greater than 250 volts and less than or equal to 600 volts.  Parameters:  Maximum arc duration and minimum working distance: 2 sec @ 18 in. | | |
| Available fault current less than 1.5 kA | 2 | 3 feet |
| Available fault current greater than or equal to 1.5 kA and less than 3 kA | 2 | 4 feet |
| Available fault current greater than or equal to 3 kA and less than 7 kA | 3 | 6 feet |
| Available fault current greater than or equal to 7 kA and less than 10 kA | 4 | 8 feet |

The methods for estimating the dc arc flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems are in open areas or rooms. If the specific task is within an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table. Research with ac arc flash has shown a multiplier of as much as 3x for arc-in-a-box versus open air.

**Appendix E: Personal Protective Equipment**

|  |  |
| --- | --- |
| **PPE Category** | **PPE** |
| 1 | **Arc Rated Clothing, Minimum Arc Rating of 4 cal/cm2**  Arc-rated long-sleeve shirt and pants or Arc- rated coveralls  Arc-rated face shield (see Note 2) or arc flash suit hood  Arc-rated jacket, parka, high visibility apparel, rainwear or hard hat liner (AN)  **Protective Equipment**  Hard hat  Safety glasses or safety goggles  Hearing protection (ear canal inserts)  Heavy duty leather gloves with rubber insulating gloves (see note 1)  Leather footwear (AN) |
| 2 | **Arc Rated Clothing, Minimum Arc Rating of 8 cal/cm2**  Arc-rated long-sleeve shirt and pants or arc-rated coveralls  Arc-rated flash suit hood or arc-rated face shield (note 2) AND arc-rated balaclava  Arc-rated jacket, parka, high visibility apparel, rainwear, or hard hat liner (AN)  **Protective Equipment**  Hard hat  Safety glasses or safety goggles  Hearing protection (ear canal inserts)  Heavy duty leather gloves with rubber insulating gloves (see note 1)  Leather footwear |
| 3 | **Arc Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm2**  Arc-rated long-sleeve shirt (AR)  Arc-rated pants (AR)  Arc-rated coverall (AR)  Arc-rated arc flash suit jacket (AR)  Arc-rated arc flash suit pants (AR)  Arc-rated arc flash suit hood  Arc-rated gloves 1  Arc-rated jacket, parka, high visibility apparel, rainwear or hard hat liner (AN)  **Protective Equipment**  Hard hat  Safety glasses or safety goggles  Hearing protection (ear canal inserts)  Rubber insulating gloves  Leather footwear |
| 4 | **Arc Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm2**  Arc-rated long-sleeve shirt (AR)  Arc-rated pants (AR)  Arc-rated coverall (AR)  Arc-rated arc flash suit jacket (AR)  Arc-rated arc flash suit pants (AR)  Arc-rated arc flash suit hood  Arc-rated gloves 1  Arc-rated jacket, parka, high visibility apparel, rainwear or hard hat liner (AN)  **Protective Equipment**  Hard hat  Safety glasses or safety goggles  Hearing protection (ear canal inserts)  Rubber insulating gloves  Leather footwear |

AN: As Needed AR: As Required

Notes:

1. Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, **alternatively**, an arc-rated arc flash suit hood is required to be worn.
2. 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.

**Appendix F: Work Unit Electrical Tasks and PPE Requirements**

This appendix, or equivalent, is mandatory and must be completed for each electrical task that is conducted within the work unit/group/department. Job safety planning and risk assessments are important components to ensuring safety of workers and personnel in the area where the work is being performed.

This document must be reviewed with all qualified workers (those conducting the task) and made available to them.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description of Task** | **Equipment** | **Voltage** | **PPE Category** | **Specific PPE To Be Worn** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Use additional pages if necessary……..

**Appendix G: Inspection Schedule for Rubber Insulating Equipment**

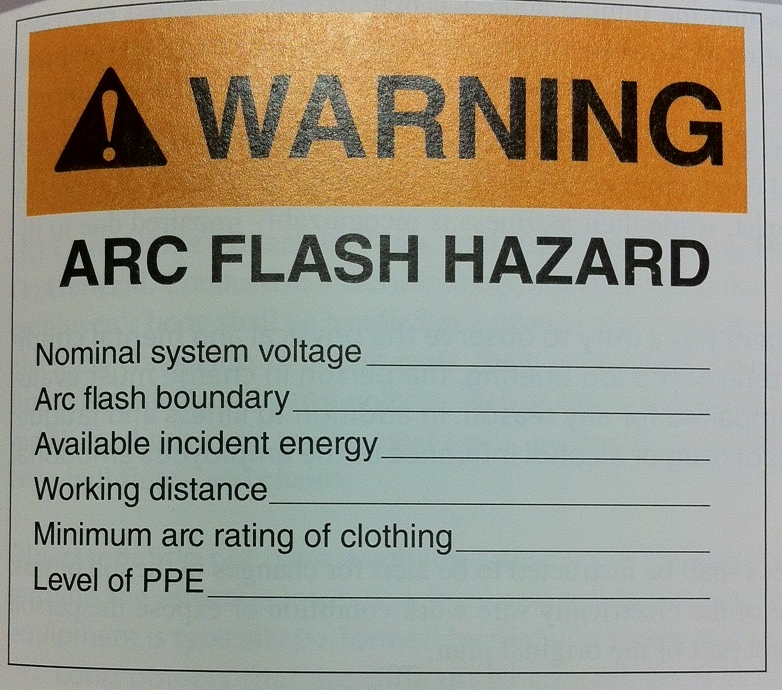
|  |  |
| --- | --- |
| **Rubber Insulating Equipment** | **When to Test** |
| line hose | If insulating value is suspect |
| covers | If insulating value is suspect |
| blankets | Before first issue; and every 12 months thereafter (\*) |
| gloves | Before first issue; and every 6 months thereafter (\*) |
| sleeves | Before first issue; and every 12 months thereafter (\*) |

(\*) – New insulating equipment is not permitted to be placed into service unless it has been electrically tested within the previous 12 months.

Insulating equipment that has been issued for service is not new and is required to be retested in accordance with the intervals in this table.

**Appendix H: Label (Example)**

**NFPA 70E**



**Appendix I: Electrical Work Evaluation Checklist (LOTO & NFPA 70E) (Page 1 of 2)**

|  |  |
| --- | --- |
| **SECTION I: GENERAL INFORMATION** | |
| Date: | Inspector(s): |
| Employee(s) being evaluated: | |
| Affected or Other Employee(s): | |
| Specify equipment & location where the LOTO procedure is being used: | |
| Is the evaluator an “authorized employee” (trained in LOTO)? Yes No  (Employees may not inspect their own procedures) | |

|  |  |  |
| --- | --- | --- |
| **SECTION II: NFPA 70E PROCEDURE** | | |
| 1. Does the task require an Energized Electrical Work Permit? | Yes | No |
| * + 1. Was the permit approved before work began? | Yes | No |
| 1. If the work does not require an Energized Electrical Work Permit were the following observed: |  |  |
| 1. Were approach distances and arc flash boundaries determined? | Yes | No |
| 1. Was Arc flash PPE required? | Yes | No |
| 1. What PPE category does the task fall under? (circle one) | 1 2 3 4 | |
| 1. Are Voltage rated tools required? | Yes | No |
| 1. How did the employee(s) determine the answers to questions “a-d” above? | | |

|  |  |  |
| --- | --- | --- |
| ***(If LOTO was applied complete this section)***  **SECTION III: LOCKOUT/TAGOUT PROCEDURE** | | |
| 1. Were all “affected” and “other” employees verbally notified of the lockout? | Yes | No |
| 1. Were operational controls turned to the “Off” position prior to lockout? | Yes | No |
| 1. Were all energy sources turned to the “Off” or “Safe” position? | Yes | No |
| 1. Were lockout devices and locks properly attached to each energy isolation device? | Yes | No |
| 1. Were warning tags indicating the authorized employee’s name and the date attached to each energy isolation device? | Yes | No |
| 1. Was all stored energy properly controlled?   (Pneumatic & hydraulic energy bled, suspended parts lowered, etc) | Yes | No |
| 1. Was an attempt made to restart the equipment or otherwise ensure the effectiveness of the lockout prior to beginning the service work? | Yes | No |
| 8) If a group lockout was required, did all authorized employees attach their own locks and tags to each energy isolation device? | Yes | No |
| 9) Were all locks and devices properly removed after servicing? | Yes | No |
| 10) Were all “affected” and “other” employees verbally notified when the lockout was complete? | Yes | No |

**Appendix I: Electrical Work Evaluation Checklist (LOTO & NFPA 70E) (Page 2 of 2)**

|  |
| --- |
| **SECTION IV: EVALUATION RESULTS AND SIGNATURES** |
| Please fully explain all “No” responses and note any other deficiencies that are not specifically covered by a checklist item: |
| Employee(s) Name:  Signature: Date: |
| Evaluator Name:  Signature: Date: |

**Appendix J: Contractor / Host Employer Meeting (Page 1 of 2)**

The PSU Energized Electrical Safety Program requires that each work unit contracting (i.e. a 3rd party/non-PSU employee/s) electrical work (50 volts or higher) on PSU owned equipment share information related to the electrical equipment with the contract employer.

The exchange of information must occur before electrical work begins.

|  |  |
| --- | --- |
| **Identification of Contractor & Host Employer:** | |
| Contractor Company Name: | Contractor Employer Representative (must have knowledge of the electrical system that is being worked on): |
| PSU Representative: *(The meeting shall be conducted by the project manager, project coordinator, electrical engineer, or other PSU employee with knowledge of the electrical system)* | Project Name/Equipment/Building: |

|  |  |
| --- | --- |
| **PSU Responsibilities:** | |
| Identify any known electrical hazards that are related to the contract employer’s work that might not be recognized by the contractor or its employees. Including, but not limited to, sharing information pertaining to the voltage of the system, the information provided via the arc flash label (if present), and reviewing any alternate/backup power sources to the system being worked on. | Comments:  🞏 (Check) |
| Note that PSU will report any observed contract employer related violations concerning electrical work to the contract employer | Comment:  🞏 (Check) |

|  |  |
| --- | --- |
| **Contractor Responsibilities:** | |
| Communicate hazards to their employees as communicated to the contractor by PSU. | Comments:  🞏 (Check) |
| Follow the safe work practices required by OSHA & NFPA 70E and any required by PSU. | Comments:  🞏 (Check) |

………continued on next page !!!!

**Appendix J: Contractor / Host Employer Meeting (Page 2 of 2)**

|  |  |
| --- | --- |
| Inform PSU of any unique hazards presented by the contractors work and any unanticipated hazards found during the contractor’s work that were not communicated by PSU. | Comment:  🞏 (Check) |
| Communicate to PSU the measures taken to correct any violations reported by PSU and to prevent such violation from recurring in the future. | Comment:  🞏 (Check) |

|  |
| --- |
| **Lockout / Tagout (LOTO) Exchange of Program:** |
| 🞏 Check here to confirm that LOTO programs have been exchanged. (i.e. types of locks, tags, and circuit control devices to be utilized, shift change LOTO methods, procedures to ensure safe conditions remain during tasks that will not be completed in one shift/day.  Comments: |
| After comparing the two LOTO programs, note any additional restrictions or prohibitions that either party needs to comply with: |

|  |  |
| --- | --- |
| **Acknowledgements:** | |
| Signature of Contract Employer Representative: | Date: |
| Signature of PSU Representative: | Date: |