

# **Electrical Safety Program—6300-3.1**

**Associated OHS General Industry and  
Process: Construction Safety**

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## **1. Summary**

### **1.1 Objective**

This Electrical Safety Program provides policies and procedures, including training, identification of electrical hazards, proper electrically safe work procedures, and proper system design, to ensure the safety of University of Virginia (UVA) Facilities Management (FM) employees that may work on or near electrical systems. In addition to providing for employee safety, this document will contribute to the protection of UVA equipment and continuity of operations.

### **1.2 Scope**

This Electrical Safety Program applies to all University of Virginia FM employees that perform maintenance, testing or any other task on, or near, electrical systems. This includes work that may be performed on energized conductors or circuit parts.

## **2. Regulations & Other Requirements**

### **2.1 Occupational Safety & Health Administration (OSHA)**

This Electrical Safety Program complies with OSHA Standards 29 C.F.R. 1910 Subpart S–Electrical and 29 C.F.R. 1926 Subpart K–Electrical. Substantial additional guidance is also given by National Fire Protection Association (NFPA) publication NFPA 70E, 2015. Additional general guidance is obtained from Institute of Electrical and Electronics Engineers (IEEE) Std. 1584-2002, *Guidance for Performing Arc-Flash Hazard Calculations*.

### **2.2 University of Virginia**

This Electrical Safety Program complies with UVA-FM requirements.

## **3. Roles and Responsibilities**

### **3.1 Facilities Management Occupational Health & Safety**

It is the responsibility of UVA FM-OHS to:

- a) Develop, administer, and review this Program
- b) Arrange training related to electrical safety
- c) Supervise the selection of personal protective equipment (PPE) and insulated tools associated with electrical safety
- d) Track and review electrical safety metrics for determining the effectiveness of this electrical safety program
- e) Audit this Program annually
- f) Electronically receive and maintain energized electrical work permits

### **3.2 Facilities Management Employees**

It is the responsibility of UVA-FM Employees to:

- a) Perform a job hazard analysis (JHA)
- b) Seek appropriate training
- c) Possess an approved permit for appropriate tasks
- d) Wear properly rated PPE as required
- e) Ensure that PPE has been properly inspected prior to use and is in compliance with PPE guidelines per NFPA 70E, 2015
- f) Perform tasks safely

### 3.3 Facilities Management Supervisors

It is the responsibility of UVA-FM Supervisors to:

- Authorize energized electrical work when an electrically safe work condition is not possible and energized work is justified
- Approve energized electrical work permits
- Make certain all employees are properly trained for the task they are performing
- Ensure that properly rated PPE is provided for the task at hand

## 4. Electrical Safety Program

Electricity in the workplace is a serious potential health and safety hazard. It is the policy of FM-OHS to protect all persons, including employees, students, visitors, contractors, and other personnel from potential electrical hazards. This will be accomplished through compliance with the work practices and risk assessments described in this program, in addition to the effective application of engineering controls, administrative controls, and the use of PPE as a last line of defense.

### 4.1 Effects of Exposure

- Electric current through the body, even at levels as low as 3 milliamps, can cause injuries of an indirect or secondary nature in which involuntary muscular reaction from the electric shock can cause bruises, bone fractures, and severe injury or death as a result from collisions or falls. Typical effects on the human body based on exposure are indicated in Table 1.

#### Effects of Electrical Current Exposure on the Human Body

Current	Reaction
<b>Below 1 milliamperere</b>	Generally not perceptible
<b>1 milliamperere</b>	Faint tingle
<b>5 milliamperes</b>	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries.
<b>6–25 milliamperes (women)</b>	Painful shock, loss of muscular control* * <i>If the extensor muscles are excited by the shock, the person may be thrown away from the power source.</i>
<b>9–30 milliamperes (men)</b>	The freezing current or "let-go" range.* Individual cannot let go, but can be thrown away from the circuit if extensor muscles are stimulated.
<b>50–150 milliamperes</b>	Extreme pain, respiratory arrest, severe muscular contractions. Death is possible.
<b>1,000–4,300 milliamperes</b>	Rhythmic pumping action of the heart ceases. Muscular contraction and nerve damage occur; death likely.
<b>10,000 milliamperes</b>	Cardiac arrest, severe burns; death probable

Table 1; Source: W.B. Kouwenhoven, "Human Safety and Electric Shock," *Electrical Safety Practices, Monograph, 112, Instrument Society of America, p. 93. November 1968.*

- Electric shock occurs when the human body becomes part of the path through which current flows. Shocks occur when a person's body completes the current path with:
  - Both wires of an electric circuit
  - One wire of an energized circuit and the ground
  - A metal part that accidentally becomes energized
  - Another conductor that is carrying a current

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- c) When a person receives a shock, electricity flows between parts of the body, or through the body, to a ground or the earth.

#### 4.2 Employee Training Program

A training program will be provided for each employee who may be exposed to electrical hazards. This training will allow employees to be able to identify hazards and apply safe electrical work procedures when applicable.

- a) Employees exposed to electrical hazards shall receive electrical safety training every 3 years.
- b) Records of this training will be maintained by FM-OHS.

##### 4.2.1 Retraining

An employee shall receive retraining under any of the following conditions:

- a) If a Supervisor or annual FM-OHS audit indicate that an employee is not complying with established safety-related work practices
- b) If new technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those that an employee would normally use
- c) If safety-related work practices must be performed that are not normally used during the employee's regular job duties

##### 4.2.2 Qualified Person

A Qualified Person shall receive training that allows that employee to:

- Recognize and avoid electrical hazards inherent in electrical equipment and systems
- Be familiar with the proper use of special precautionary techniques, PPE, insulating and shielding materials, and insulated tools and test equipment
- Possess the skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment; most often a licensed electrician
- Possess the skills and techniques necessary to determine the nominal voltage of exposed electrical conductors and circuit parts
- Be able to understand and implement the approach distances specified in Table 2 and Table 3 of this document and the corresponding voltages to which the Qualified Person will be exposed
- Be able to understand and implement the decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely

##### 4.2.3 Unqualified Person

An unqualified person who may become exposed to an electrical hazard in the course of performing their duties as an employee shall:

- Become familiar with any of the electrical safety-related practices that are necessary for their safety

##### 4.2.4 Emergency Procedures Training

- a) Employees exposed to shock hazards shall be trained in CPR/AED and First Aid procedures upon initial assignment and every year thereafter. It is the responsibility of FM-OHS to ensure that CPR/AED and First Aid refresher training is current.
- b) Employees will also be trained in methods of release of victims from contact with exposed electrical conductors or circuit parts. Refresher training is to be given annually.

#### **4.2.5 Training Documentation**

FM-OHS shall document that each employee has received training as indicated in this document.

- a) This documentation shall be made when the employee demonstrates proficiency in the work practices involved and shall be maintained for the duration of employment.
- b) The documentation should contain each employee's name and dates of training.

#### **4.3 Risk Assessment Procedure**

(See NFPA 70E Article 110.1(G))

A proper risk assessment of electrical hazards is a vital step to ensure the health and safety of those working with electricity and will reduce the likelihood of injury. Risk assessment is a process of discrete steps intended to ensure that hazards are properly identified and analyzed with regard to their severity and the likelihood of their occurrence. Once hazards have been identified and analyzed, the risk associated with those hazards can be estimated and appropriate protective measures can be implemented with proper follow up to ensure a given control's effectiveness.

- a) Risk assessment includes a comprehensive review of the hazards, the associated foreseeable tasks, and the protective measures that are required in order to maintain an acceptable level of risk, including the following:
  - Identifying and analyzing electrical hazards
  - Identifying tasks to be performed
  - Documenting hazards associated with each task
  - Estimating the risk for each hazard/task pair
  - Determining the appropriate protective measures needed to adequately reduce the level of risk
- b) The diagram in Appendix C.1 indicates a proper risk assessment process. A properly performed job hazard analysis (JHA) conducted prior to the start of a task involving potential exposure to electricity will ensure that all facets of risk assessment have been considered and appropriate controls have been implemented.

#### **4.4 Job Briefing**

(See NFPA 70E Article 110.1(H))

Prior to commencing work, supervisors shall conduct a job briefing with all employees that have a potential for exposure to energized electrical parts. The briefing should cover the following:

- Hazards associated with the task, including identifying shock exposures and arc flash hazards
- Work procedures
- Special precautions such as draining capacitors and gradient potential issues
- Energy source controls (LOTO points)
- PPE
- Emergency response procedures

#### **4.5 Establishing an Electrically Safe Work Condition (LOTO)**

An electrically safe work condition shall be achieved when performed in accordance with university Lockout/Tagout (LOTO) procedures and verified by the process indicated below. Only Qualified Persons can establish an electrically safe condition. The process of establishing an electrically safe work condition is inherently hazardous because it requires Qualified Persons to work around live conductors. Appropriate PPE must be worn and used when performing some of the steps listed below. Electrical conductors and equipment are considered energized until the process of establishing an electrically safe work condition is complete.



#### **4.5.1 Process to Establish an Electrically Safe Work Condition**

(See NFPA 70E 120.1)

- a) To establish an Electrically Safe Work Condition:
  - 1) Determine all sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
    - Most electrical equipment has a single source of supply; however, there are instances where there are multiple sources, such as rooftop photovoltaic arrays or emergency generators.
  - 2) After properly interrupting the load current, open the disconnecting device(s) for each source.
    - Fuses aren't considered disconnecting means and a circuit cannot be de-energized by removing one or more fuses. However, a pullout block or safety switch with fuses can be considered a disconnect.
    - Attachment plugs of electric appliances are permitted to be used as disconnects.
  - 3) Wherever 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.
    - Sometimes it's impossible to visually verify the presence of an air gap. In these cases, test for the presence of voltage to verify that the circuit has been fully disconnected.
  - 4) Apply LOTO devices in accordance with University procedures.
  - 5) Use an adequately rated test instrument to test each phase conductor or circuit part to verify it is de-energized. Test each phase conductor or circuit part to both phase-to-phase, neutral-to-ground and phase-to-ground. Before and after each testing, determine that the test instrument is operating properly through verification on a known voltage source.
  - 6) Discharge stored electrical energy and install safety grounds where necessary.
- b) Once these steps have been completed, electrical energy has been removed from all conductors and equipment and cannot reappear unexpectedly. Only under these circumstances is PPE not needed and unqualified persons can perform work on or near electrical equipment.

#### **4.6 Approach Boundaries to Live Parts**

- a) A shock risk assessment shall determine the voltage to which personnel have the potential to be exposed, the boundary requirements, and the PPE necessary to protect employees.
- b) Shock protection boundaries are identified as limited approach boundary and restricted approach boundary. These boundaries are applicable where approaching personnel are exposed to energized electrical conductors or circuit parts.

##### **4.6.1 Limited Approach Boundary**

###### **4.6.1.1 Approach by Unqualified Persons (NFPA 70E 130.4 (C))**

Unless permitted by (11.1.3 this document, a.k.a. NFPA 70E 130.4(C)(3)) no unqualified person shall be permitted to approach nearer than the limited approach boundary of energized electrical conductors or live parts.

###### **4.6.1.2 Unqualified Persons Working at or Close to the Limited Approach Boundary**

It is the responsibility of the designated person in charge of the work space where the electrical hazard exists to advise the unqualified person(s) of the hazard and warn them to stay outside of the limited approach boundary. (See NFPA 70E 130.4 (C)(2))

#### 4.6.1.3 Entering the Limited Approach Boundary (NFPA 70E 130.4(C)(3))

- a) Where there is a need for an unqualified person(s) to cross the limited approach boundary, a Qualified Person shall advise him or her of the possible hazards and continuously escort the unqualified person(s) while inside the limited approach boundary.
- b) Under no circumstance shall the escorted unqualified person(s) be permitted to cross the restricted approach boundary

#### 4.6.2 Restricted Approach Boundary (NFPA 70E 130.4 (D))

- a) No Qualified Person shall approach or take any conductive object closer to exposed energized electrical conductors or circuit parts operating at 50 volts or more than the restricted approach boundary set forth in Table 2 and Table 3 of this document (NFPA 70E Tables 130.4(D)(a) and 130.4(D)(b)), unless one of the following apply:
  - The Qualified Person is guarded or insulated from energized electrical conductors or circuit parts operating at 50 volts or more through adequate PPE
  - The energized electrical conductors or circuit part operating at 50 volts or more are PPE insulated from the Qualified Person and from any other conductive object at a different potential.
  - The Qualified Person is insulated from any other conductive object.

### Approach Boundaries

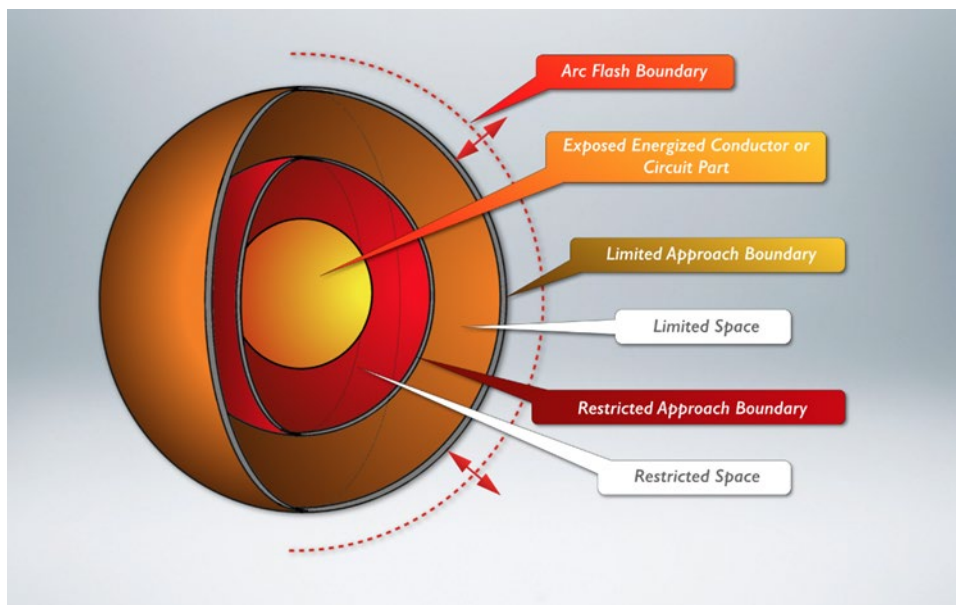


Figure 1: Approach Boundaries  
Source: NFPA 70E (2015)

### Approach Boundaries for Shock Protection for Alternating Currents (AC)

Limited Approach Boundary			
Nominal Potential Difference	Exposed Movable Conductor	Exposed Fixed Circuit Part	Restricted Approach Boundary
<50V	Not specified	Not specified	Not Specified
50V-150V	10 ft 0 in.	3 ft 6 in.	Avoid contact
151V-750V	10 ft 0 in.	3 ft 6 in.	1 ft 0 in.
751V-15kV	10 ft 0 in.	5 ft 0 in.	2 ft 2 in.
15.1 kV- 36kV	10 ft 0 in.	6 ft 0 in.	2 ft 7 in.
36.1kV-46kV	10 ft 0 in.	8 ft 0 in.	2 ft 9 in.
46.1kV-72.5kV	10 ft 0 in.	8 ft 0 in.	3 ft 3 in.
72.6kV-121kV	10 ft 8 in.	8 ft 0 in.	3 ft 4 in.
138kV-145kV	11 ft 0 in.	10 ft 0 in.	3 ft 10 in.
161kV-169kV	11 ft 8 in.	11 ft 8 in.	4 ft 3 in.
230kV-242kV	13 ft 0 in.	13 ft 0 in.	5 ft 8 in.
345kV-362kV	15 ft 4 in.	15 ft 4 in.	9 ft 2 in.
500kV-550kV	19 ft 0 in.	19 ft 0 in.	11 ft 10 in.
765kV-800kV	23 ft 9 in.	23 ft 9 in.	15 ft 11 in.

Table 2: Approach Boundaries for Shock Protection for Alternating Currents (AC)

Source: NFPA 70E, 2015 Table 130.4 D (a)

(All dimensions are distance from energized electrical conductor to employee).

### Approach Boundaries for Shock Protection for Direct Currents (DC)

Limited Approach Boundary			
Nominal Potential Difference	Exposed Movable Conductor	Exposed Fixed Circuit Part	Restricted Approach Boundary
<100V	Not specified	Not specified	Not Specified
100V-300V	10 ft 0 in.	3 ft 6 in.	Avoid contact
301V-1kV	10 ft 0 in.	3 ft 6 in.	1 ft 0 in.
1.1kV-5kV	10 ft 0 in.	5 ft 0 in.	1 ft 5 in.
5kV- 15kV	10 ft 0 in.	5 ft 0 in.	2 ft 2 in.
15.1kV-45kV	10 ft 0 in.	8 ft 0 in.	2 ft 9 in.
45.1kV-75kV	10 ft 0 in.	8 ft 0 in.	3 ft 2 in.

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<b>75.1kV-150kV</b>	10 ft 8 in.	10 ft 0 in.	4 ft 0 in.
<b>150.1kV-250kV</b>	11 ft 8 in.	11 ft 8 in.	5 ft 3 in.
<b>250.1kV-500kV</b>	20 ft 0 in.	20 ft 0 in.	11 ft 6 in.
<b>500.1kV-800kV</b>	26 ft 0 in.	26 ft 0 in.	16 ft 5 in.

*Table 3: Approach Boundaries for Shock Protection for Direct Currents (DC).*

*Source: NFPA 70E, 2015, Table 130.4 D(b).*

*(All dimensions are distance from energized electrical conductor to employee.)*

## 4.7 Arc Flash

Arc flash is a phenomenon that is the result of an electric current leaving its intended path and travelling through the air from one conductor to another, or to the ground. The results of an arc flash are often violent and when workers are in close proximity to the arc flash, serious injury or death will occur.

### 4.7.1 Arc Flash Risk Assessment

- a) An arc flash risk assessment should be done before a person approaches any exposed electrical conductor or circuit part not placed in an electrically safe work condition. This arc flash risk assessment will determine whether an arc flash hazard exists and, if so, the risk assessment shall determine:
  - Appropriate safety-related work practices
  - The arc flash boundary
  - Required PPE to be used within the arc flash boundary
- b) Arc flash risk assessments shall be updated when a major system modification occurs. The interval between document reviews is not to exceed a period of 5 years. The results of an arc flash risk assessment must be documented and maintained.

### 4.7.2 Arc Flash Boundary

The Arc Flash Boundary is the furthest established boundary from the energy source where, if an arc flash occurred, a worker would be exposed to a curable second-degree burn.

- a) Employees crossing into the arc flash boundary are required to wear the appropriate PPE as determined by the Incident Energy Analysis Method as published in NFPA 70E, 2015 or the Arc Flash PPE Categories Method that utilize Table 130.7 (C)(15)(A)(a) in NFPA 70E, 2015. A copy of this table is located in Appendix 2 of this document
- b) Only a Professional Engineer or other individual specifically qualified through education and experience shall conduct an Incident Energy Analysis that would be used to determine PPE requirements.
- c) The Arc Flash PPE Categories Method may only be used if the specific task to be performed appears in the tables and the maximum possible category for the specified equipment is found to be 2 or less, regardless of listed parameters. The Arc Flash PPE Categories method may be used when the available short-circuit current and fault clearing time are unknown. If those parameters are known the Incident Energy Analysis method shall be used.
- d) If help is needed with arc flash hazard evaluation process, please email [power@virginia.edu](mailto:power@virginia.edu) or [fm-ohs@virginia.edu](mailto:fm-ohs@virginia.edu)

## 4.8 Working on or Near Live Electrical Parts

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- a) When intentionally working within the Restricted Approach Boundary or the Arc Flash Boundary of exposed energized electrical conductors or circuit parts that are not placed in an electrically safe work condition, work to be performed is considered energized electrical work and must be performed by written permit, except for specific exemptions listed in NFPA 70E 130.2. In the rare situation when energized equipment cannot be de-energized (or when working in near proximity to exposed energized electrical conductor or circuit part), the following work practices must be observed to provide protection:
- Obtain Energized Electrical Work Permit, except for specific exemptions listed in NFPA 70E 130.2.
  - Unqualified employees are prohibited from working on, or near, exposed energized circuits, and shall not approach nearer than the limited approach boundary, or the arc flash boundary, whichever is greater.
  - Lockout/tagout all circuits possible.
  - Treat all circuits as energized until proven otherwise, and properly locked/tagged out.
  - Remove all conductive clothing and jewelry.
  - Use proper PPE, shields, and/or barriers to provide effective electrical insulation from energized circuits.
  - Provide adequate lighting and do not enter areas with exposed energized parts unless illumination is provided.
  - Employees entering a confined space with exposed energized electrical parts must use protective barriers, shields, or equipment or insulated materials rated at or above the present voltage to avoid contact with the energized part(s).
  - Doors or other hinged panels shall be constructed and secured to prevent them from swinging into workers and causing contact with exposed energized electrical parts.
  - Maintenance activities in areas of exposed energized electrical parts may not be completed in areas with close contact unless adequate safeguards are present. Conductive cleaning material or liquids may not be used unless procedures are in place and followed.
  - Station a safety observer outside the work area whose sole function is to either quickly de-energize all sources of power or pull worker free from electrical work area with a non-conductive safety rope or other approved devices such as insulated rescue hook if contact is made with an energized electrical circuit.
  - A person qualified in CPR/AED and First Aid must be readily available at the scene.
- b) The Arc Flash Boundary shall be determined for all locations that are greater than 50 volts and that are likely to require examination, adjustment, servicing, or maintenance while energized, (NFPA 70E 130.5(D)).
- c) The preferred risk assessment method to determine the arc flash boundary and incident energy value at a given piece of equipment is described in Institute of Electrical and Electronics Engineers (IEEE) Guide for Performing Arc Flash Calculations (IEEE 1584). Alternate methods for performing these calculations are described in Informative Annex D of the NFPA 70E.
- d) The use of the Arc Flash PPE Categories Method using Table 130.7 (C)(15)(A)(a) or Table 130.7(C)(15)(B) that is contained in NFPA 70E, 2015 is allowed so long as the system parameters and task meet the table requirements and the specific task to be performed appears in the tables and the system meets the listed criteria for short circuit magnitude and speed of response circuit protection. These tables are also indicated in Appendix 2 and Appendix 3 of this document. If the task does not appear in the table, or if the system does not meet the criteria found in the tables, then the tables cannot be used, with the following exceptions:
- Equipment with nominal voltage of 480V or less protected by a 20A or less molded case circuit breaker may be treated as having arc flash incident energy rating of 1.2 cal/cm<sup>2</sup>.

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- The Arc Flash PPE Categories Method may be used for “panelboards or other equipment” with an Arc Flash PPE Category of 2 or less according to NFPA 70E Table 130.7(C)(15)(A)(b) (not including MCCs or switchgear) even if some of the parameters are unknown.

#### 4.8.1 Justification for Work

The only instances where energized work is allowable are those scenarios where it can be demonstrated that additional hazards are created by de-energizing equipment, or the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations. Examples of additional hazards include, but are not limited to, interruption of life-support equipment, deactivation of emergency alarm systems, and shutdown of hazardous ventilation equipment. Examples of a task being infeasible to perform in a de-energized state include equipment design that does not allow for de-energization or performance of diagnostics and testing which requires the equipment to be energized.

#### 4.9 Energized Electrical Work Permit

(See NFPA 70E, 130.2(B))

A sample of the University of Virginia Facilities Management Energized Electrical Work Permit is contained in Appendix C.5 of this document. Specifically, a work permit must be obtained when the following conditions apply, (except when the specific exemptions listed in NFPA 70E 130.2 are applicable):

- When work is performed within the restricted approach boundary
- When the employee interacts with the equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

#### 4.9.1 Elements of Work Permit

(see NFPA 70E, 130.2(B)(2))

- a) In those instances where it is necessary to work on energized conductors or circuit parts, it is necessary for employees to obtain an Energized Electrical Work Permit. Information in this permit includes, but is not limited to the following items (see Appendix C.5 for the permit):
  - Description of the circuit and equipment to be worked on and their location
  - Justification for why the work must be performed in an energized condition
  - Description of the safe work practices to be performed
  - Results of the shock risk assessment
  - Voltage to which personnel will be exposed
  - Limited approach boundary
  - Restricted approach boundary
  - Necessary PPE and other protective equipment to safely perform the task
  - Results of the arc flash risk assessment
  - Available incident energy at the working distance or arc flash PPE category
  - Necessary PPE to protect against the hazard
  - Means employed to restrict access of unqualified personnel from the work area
  - Evidence of completion of a JHA describing the hazards present
  - Evidence of completed pre-job briefing by a supervisor
  - Energized work approval
  - Review by an FM-OHS representative for completeness and clarity before work begins
- b) Completed Energized Electrical Work Permits are to be scanned and emailed to FM-OHS at fm-ohs@virginia.edu. FM-OHS will retain this permit for a period of one year.

#### 4.10 Personal and Other Protective Equipment (NFPA 70E, 130.7)

See 4.6.2 Restricted Approach Boundary (or NFPA 70E, 130.4(D)) for information on PPE for shock protection.

- a) Where it has been determined that work will be performed within the arc flash boundary, one of the following methods should be used for the selection of PPE:
  - 1) Incident energy analysis (NFPA 70E, 130.5(C)(1))
    - The incident energy analysis shall determine and document the incident energy exposure of the employee in calories per square centimeter.
    - The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed.
    - Arc-rated clothing and other PPE shall be used by the employee based on the incident energy exposure associated with the specific task.
  - 2) Hazard/Risk Categories (NFPA 70E, 130.5(C)(2))
    - Where an incident energy analysis study has not been performed, Table 130.7 (C)(15)(A)(a) of NFPA 70E, 2015 shall be used to determine when arc flash PPE is required. When arc flash PPE is required, Table 130.7 (C)(15)(A)(b) of the NFPA 70E, 2015 shall be used to determine the appropriate arc flash PPE category. Copies of these tables are located in Appendix C.2 and Appendix C.3 of this document.
- b) If a task is not listed in Table 130.7 (C)(15)(A)(a) or if a task is being performed with less than the maximum working distance, then an Incident Energy Analysis is to be performed, with the following exceptions:
  - Equipment with nominal voltage of 480V or less protected by a 20A or less molded case circuit breaker may be treated as having arc flash incident energy rating of 1.2 cal/cm<sup>2</sup>
  - The Arc Flash PPE Categories method may be used for panelboards or other equipment with an Arc Flash PPE Category of 2 or less according to NFPA 70E Table 130.7(C)(15)(A)(b) even if some of the parameters are unknown.

#### 4.10.1 PPE Categories

If the Arc Flash PPE Categories Method is being used, then once the appropriate arc flash category has been determined, PPE listed in Table 130.7(C)(16) for the appropriate arc flash PPE category shall be used when working within the arc flash boundary. These categories are provided in NFPA 70E, 2015 Table 130.7 (C)(16) and are also indicated in Appendix C.4 of this document. The results of an incident energy analysis shall not be permitted to specify an arc flash PPE category. For information on selection of arc-rated clothing and other PPE using the incident energy analysis method, see Table H.3(b) in Informative Annex H of the NFPA 70E, 2015 reproduced in this document in Appendix C.4.

#### 4.10.2 General PPE Requirements

- a) Protective equipment shall be maintained in a safe and reliable condition and shall be visually inspected before each use. Storage of protective equipment shall be in a manner that prevents damage and that is free from moisture, dust, and any other deteriorating conditions. Clothing should cover potentially exposed areas as completely as possible with shirt sleeves fastened at the wrists, shirts tucked into pants, and shirts and jackets closed at the neck.
- b) PPE shall have an arc rating that is suitable for the arc flash exposure. The level of exposure is determined by reviewing equipment labels or through utilization of the Table Method.
- c) Clothing and other apparel that do not meet requirements as set forth in NFPA 70E-2015 are prohibited when working in the arc flash boundary.

#### 4.10.3 Other Protective Equipment



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- a) Employees are required to use insulated tools and handling equipment when working inside of the Restricted Approach Boundary. Insulated tools are to be rated for the voltages to which they are exposed and the manner in which they are used. All tools are to be inspected prior to use with specific and careful attention paid to insulating material damage on the tool.
- b) In the event a field-fabricated barrier is used, it should be placed no closer than the limited approach boundary as provided in Table 2 and/or Table 3 of this document, or the arc flash boundary, whichever is greater.
- c) In the event a sign or barricade is insufficient to properly provide warning to the electrical hazard present in a work area, an attendant whose primary responsibility is to provide signaling and alerting to unqualified persons near the hazard area shall be provided. This shall be the only duty of this employee.

**4.11 Equipment Labeling (see NFPA 70E, 130.5 (D))**

- a) Each piece of equipment operating at 50 volts or more and not put into a de-energized state must be evaluated for arc flash and shock protection before completing an energized electrical work permit. This evaluation will determine the limited, restricted, and arc flash boundaries and will inform the worker of what PPE is required. Once an evaluation of a piece of equipment is complete, an Arc Flash Hazard warning label must be affixed to any equipment which is likely to require examination, adjustment, servicing, or maintenance while energized and shall be visible to employees who may work on the equipment while energized.
- b) It is the responsibility of the employee to follow the requirements of the arc flash hazard label by wearing the proper PPE and using the proper insulated tools and other safety related equipment. This includes not working on or near the circuit unless that worker is a Qualified Person.
- c) Arc flash labels shall include:
  - Equipment name
  - Nominal system voltage
  - Limited approach boundary
  - Restricted approach boundary
  - Arc flash boundary
  - Incident energy values in cal/cm<sup>2</sup> and the corresponding working distance
- d) If help is needed with arc flash hazard evaluation process, please email [power@virginia.edu](mailto:power@virginia.edu) or [fm-ohs@virginia.edu](mailto:fm-ohs@virginia.edu).

**4.12 Maintenance**

Proper maintenance of electrical equipment is vital to ensure the safety of workers who may be exposed to electrical equipment in an energized or de-energized state. Additionally, proper maintenance can help to ensure continuity of operations of a given system, increase equipment and system reliability, and reduce the risk of fire. General maintenance requirements for UVA employees and equipment are as follows:

- a) Employees who perform maintenance on electrical equipment and installations shall be Qualified Persons and shall be trained in, and familiar with, the specific maintenance procedures and tests required.
- b) A single line diagram, where provided for the electrical system, shall be maintained.
- c) All working space and clearances shall be maintained in accordance with requirements laid out in NFPA 70.
- d) Equipment, raceway, cable tray, and enclosure bonding and grounding shall be maintained to ensure electrical continuity.
- e) Enclosures shall be maintained to guard against accidental contact with energized conductors and circuit parts and other electrical hazards.



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- f) Locks, interlocks, and other safety equipment shall be maintained in proper working condition to accomplish the control purpose.
- g) Identification of components, where required, and safety-related instructions (operating and maintenance), if posted, shall be securely attached and maintained in legible condition.
- h) Warning signs, where required, shall be visible, securely attached, and maintained in legible condition.
- i) Circuit or voltage identification shall be securely affixed and maintained in updated and legible condition.
- j) Electrical cables and single and multiple conductors shall be maintained free of damage, shorts, and ground that would present a hazard to employees.
- k) Flexible cords and cables shall be maintained to avoid strain and damage.
  - Cords and cables shall not have worn, frayed, or damaged areas that present an electrical hazard to employees.
  - Strain relief of cords and cables shall be maintained to prevent pull from being transmitted directly to joints or terminals.

**4.13 Batteries**

Prior to any work on a battery system, a risk assessment is to be performed to identify the following characteristics of batteries and associated systems:

- Chemical properties
- Electrical shock hazards
- Arc flash hazards

**4.14 Single-Line Diagram**

A single-line diagram allows for workers to identify the main components of an electrical system and how they are connected, including redundant equipment. It will show a power distribution path from the incoming power source to each downstream load and will indicate the ratings of each piece of electrical equipment, their circuit conductors, and their protective devices.

A single-line diagram is required in order to perform effective maintenance and to implement effective electrical safety procedures. Please check Geospatial Engineering Services (GES) for single-line diagrams.

**4.15 Blind Reaching**

The practice of blind reaching, or reaching into equipment without a clear line of sight, is prohibited. FM-OHS requires that employees “test before touch” in order to avoid the risk of unintentional electric shock as a result of blind reaching.

**4.16 Confined or Enclosed Work Spaces**

Confined spaces with live, exposed electrical parts are considered permit-required confined spaces. Work inside these spaces must be conducted in accordance with the FM-OHS Confined Space Plan.

**4.17 Overhead Lines**

- a) All equipment should be kept well away from overhead lines. The exact distance depends on the voltage in the overhead lines and can be determined by consulting Table 3 of this document. An employee other than the equipment operator shall watch during equipment movement to ensure the appropriate safe approach distance is maintained.
- b) All work zones near overhead power lines are to be identified through demarcating boundaries (flags, cones, other barriers) or by defining the work zone as the area 360 degrees around equipment, up to the equipment’s maximum working radius.

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- c) If any part of the equipment, load line or load could get closer than 20 feet to a power line when operated at its maximum working radius in the work zone, then one of the following options must be chosen:
  - Confirm from the utility operator/owner that the power line has been de-energized and visibly grounded at the worksite
  - Ensure that no part of the equipment, load line, or load gets closer than 20 feet to the power line
  - Use Table 4 clearance
- d) All employees are required to be aware of the procedures to be followed in the event of electrical contact with a power line. These procedures must include:
  - The importance of the operator to not touch equipment and the ground
  - The importance of the operator to remain inside of the equipment cab unless there is imminent danger of fire or explosion or other emergency that necessitates leaving the cab
  - The safest means of evacuating from equipment that may be energized
  - The danger of the potentially energized zone around the equipment
  - The need for employees in the area to avoid approaching or touching equipment

<b>Voltage (nominal, kV, alternating current)</b>	<b>Minimum clearance distance (feet)</b>
Up to 50	10
Over 50 to 200	15
Over 200 to 350	20
Over 350 to 500	25
Over 500 to 750	35
Over 750 to 1,000	45
Over 1,000	As established by utility owner/operator or registered professional engineer who is qualified with respect to electrical power and distribution.

*Table 4: Minimum Clearance Distances*  
*Source: 29CFR1926.1408(a)(2)(iii)*

#### 4.18 Extension Cords and Power Strips

Employees must be aware of the hazards of misusing extension cords and power strips. These hazards include electrocution and fire.

- a) Extension cords and power strips must be inspected for damage to the outer insulation prior to use. The FM-OHS Electrical Cord Inspection document is indicated in Appendix F of this document. This document can assist employees performing inspections on extension cords and power strips.
- b) Extension cords and power strips must be plugged into a wall outlet and may not be plugged into another extension cord or power strip.
- c) Extension cords and power strips that have a ground pin may only be plugged into grounded outlets.
- d) Devices that have a ground pin may only be plugged into extension cords and power strips that accept ground pins. Do not remove the ground pin from the plug of the device or the extension cord or power strip.
- e) Extension cords may never be used in place of permanent wiring and may only be used for a temporary period of up to 90 days.

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- f) The following work practices shall be followed when using extension cords:
- Never use an extension cord to lift or lower power tools;
  - Avoid running cords over sharp corners and projections;
  - Do not run cords through windows or doors unless they are protected from damage and only used on a temporary basis;
  - Do not run cords above ceilings and inside or through walls, ceilings, or floors;
  - Do not fasten cords with staples or otherwise hang them in such a fashion as to damage the outer jacket or insulation;
  - Cover cords with a cable bridge or tape when they extend into a walkway or other path of travel to avoid tripping hazards.
  - Unless they are specifically designed to do so, extension cords must not be used to suspend portable lighting.
  - Extension cords must be heavy-duty and rated for the power tool with which it is being used.
  - Only extension cords rated for outdoor use may be used outdoors.
- g) Power strips must be UL approved and are to be used within the manufacturer's guidelines. Industrial equipment, power tools, and other high-current devices may not be plugged into power strips unless they are UL-approved for industrial use (the manufacturer's guidelines will specify the rating of the power strip).

**4.19 Use of Equipment****4.19.1 Portable Electric Equipment**

- a) Portable equipment should be handled in a manner that will not cause damage. Flexible electric cords connected to equipment should not be used for raising and lowering the equipment. Flexible cords should not be fastened with staples or otherwise hung in such a fashion as to cause damage to the insulating outer jacket.
- b) If there is a defect or evidence of damage that might expose an employee to injury, the damaged item is to be immediately tagged and removed from service until such time that repairs can be made.
- c) Portable electric equipment that is used in highly conductive locations (such as near water) are to be approved for operation in those locations. Employees should never use inappropriately rated equipment. In addition, employees' hands should never be wet when plugging and unplugging flexible cords.

**4.19.2 Electric Power and Lighting Circuits**

- a) Devices that are specifically designed as a disconnecting means such as load-rated switches and circuit breakers shall be used for the opening, reversing, or closing of circuits under load conditions. Fuses, terminal lugs, and cable splice connections may not be used for such purposes, except in the event of an emergency.
- b) After a circuit is de-energized by a circuit protective device, the circuit may not be manually re-energized until such time that the equipment and circuit can be safely energized.

**4.19.3 Test Instruments and Equipment**

Only Qualified Persons may perform testing on electric circuits or equipment. All test equipment should be inspected prior to each use and, in the event damage or defect is noted, the damaged equipment should be tagged and removed from service. All test equipment should be properly rated for the circuits and equipment to which they will be connected.

**4.20 Ground Fault Circuit Interrupters (GFCI)**

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A GFCI is a protective device that compares the amount of current going into electrical equipment with the amount of current returning from the equipment. If a targeted deviation is exceeded, the circuit is quickly broken.

- a) All 125-volt single-phase, 15-, 20-, and 30-amp receptacle outlets that are not part of the permanent wiring of a building or structure shall have GFCI protection.
- b) In the event that GFCI protection is unavailable, an assured equipment grounding conductor program covering cord sets, receptacles that are not part of the building or structure, and equipment connected by cord and plug shall be implemented.
- c) There are several types of GFCI's available. Although all types will provide ground-fault protection, the specific application may dictate one type over another.
  - 1) **Circuit-Breaker Type:** The circuit-breaker type includes the functions of a standard circuit breaker with the additional functions of a GFCI. It is installed in a panelboard and can protect an entire branch circuit with multiple outlets. It is a direct replacement for a standard circuit breaker of the same rating.
  - 2) **Receptacle Type:** The receptacle style GFCI incorporates within one device one or more receptacle outlets, protected by the GFCI.
  - 3) **Permanently Mounted Type:** Permanently mounted types are mounted in an enclosure and designed to be permanently wired to the supply.
  - 4) **Portable Type:** Portable types are designed to be easily transported from one location to another. They usually contain one or more integral receptacle outlets protected by the GFCI module. Some models are designed to plug into existing non-GFCI protected outlets, or in some cases, are connected with a cord and plug arrangement. The portable type also incorporate a no-voltage release device which will disconnect power to the outlets if any supply conductor is open. Units approved for use outdoors will be in enclosures suitable for the environment. If exposed to rain, they must be listed as rainproof.
  - 5) **Cord Connected Type:** The power supply cord type GFCI consists of an attachment plug which incorporates the GFCI module. It provides protection for the cord and any equipment attached to the cord. The attachment plug has a non-standard appearance and is equipped with test and reset buttons. Like the portable type, it incorporates a no-voltage release device which will disconnect power to the load if any supply conductor is open.

#### 4.20.1 Classes of GFCI

Ground-Fault Circuit-Interrupters are divided into two classes: Class A and Class B.

- a) The Class A device is designed to trip when current flow, in other than the normal path, is 6 milliamperes or greater.
- b) The Class B device will trip when current flow, in other than the normal path, is 20mA or greater.

#### 4.20.2 Testing GFCI

Due to the complexity of a GFCI, it is necessary to test the device on a regular basis. For permanently wired devices, a monthly test is recommended. Portable type GFCIs should be tested each time before use. GFCIs have a built-in test circuit which imposes an artificial ground fault on the load circuit to assure that the ground-fault protection is still functioning. Test and reset buttons are provided for testing.

#### 4.20.3 Overcurrent Protection Devices

The use of overcurrent protection devices such as circuit breakers is an effective way to reduce the damage done by a fault in the electric circuit. In the event of a fault, an overcurrent protection device will isolate the fault and prevent damage to equipment.

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- a) Overcurrent devices are to be used as a line of defense to protect equipment. They are not to be used to protect employees.
- b) All overcurrent devices should be readily accessible and labeled and should clearly indicate their operating position (on or off). If an overcurrent protection device is installed vertically, the up position should indicate "On."
- c) Sufficient working space should be adjacent to protection devices and this space should not be used for storage and must remain clear at all times. Minimum clear working space when working with 600 V or less is indicated in Table 5.

	Minimum Clear Distance for Condition					
	Condition A		Condition B		Condition C	
	M	Ft	M	Ft	M	Ft
0-150	0.9	3.0	0.9	3.0	0.9	3.0
151-600	0.9	3.0	1.0	3.5	1.2	4.0

Table 5: Minimum clear distance when working with 600V or less  
Source: 29CFR1926.403(i)(1)(i)

#### 4.20.4 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.

#### 4.20.5 Condition B

Exposed live parts on one side and grounded parts on the other side.

#### 4.20.6 Condition C

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

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 de-energized parts on the back of enclosed equipment, a minimum working distance of 30 inches horizontally shall be maintained.

#### 4.21 Identification of Disconnecting Means and Circuits

When working with electrical motors, extra caution should be given to the disconnection means.

- a) The disconnecting means for the motor shall be within sight of the motor, or not more than 50 ft. The disconnecting means should be readily accessible and plainly indicate whether it is in the "off" or "on" position. If there is more than one disconnect, only one disconnect means need be readily accessible.
- b) Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, should be legibly marked to indicate its purpose unless it is located and arranged so that the purpose is evident.

#### 4.22 Guarding of Live Parts

Generally, guarding of live parts is intended to protect those employees that are not qualified or trained to be in close proximity to live parts. Except as required, live parts of electric equipment operating at 50 volts or more

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shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to Qualified Persons
- By suitable permanent and substantial partitions that are so arranged to allow only Qualified Persons access to the space within reach of the live parts
- By location on a suitable balcony or platform
- By elevation of 8 feet or more above the floor or other working surface

Entrances to rooms and other guarded locations containing live exposed parts shall be marked with warning signs forbidding unqualified persons to enter.

#### 4.23 Conductors Entering Boxes, Cabinets, or Fittings

Conductors can be damaged if they rub against the sharp edges of cabinets, boxes, or fittings, and therefore must be protected from damage where they enter these structures.

- a) Protective devices, such as a clamp or rubber grommet, must be used to close the hole through which the conductor passes as well as provide protection from abrasion. If the conductor is in a conduit and the conduit fits tightly in the opening, additional sealing is not required. Knockouts in cabinets, boxes, and fittings should be removed only if conductors are to be run through them. However, if a knockout is missing or if there is another hole in the box, the hole or opening must be closed.
- b) All pull boxes, junction boxes, and fittings must be provided with approved covers and, if the covers are metal, they must be grounded. Each outlet box must have a cover, faceplate, or fixture canopy.

#### 4.24 Grounding

Grounding electrical circuits and electrical equipment is required to protect employees against electrical shock, safeguard against fire, and protect against damage to electrical equipment.

There are two kinds of grounding: (1) electrical circuit or system grounding, and (2) electrical equipment grounding.

- a) Electrical system grounding is accomplished when one conductor of the circuit is intentionally connected to earth. This is done to protect the circuit should lightning strike or other high voltage contact occur. Grounding a system also stabilizes the voltage in the system so "expected voltage levels" are not exceeded under normal conditions.
- b) The second kind of ground is equipment grounding. This is accomplished when all metal frames of equipment and enclosures containing electrical equipment or conductors are grounded by means of a permanent and continuous connection or bond. The equipment grounding conductor provides a path for dangerous fault current to return to the system ground at the supply source of the circuit should an insulation failure take place. If installed properly, the equipment grounding conductor is the current path that enables protective devices, such as circuit breakers and fuses, to operate when a fault occurs.
- c) The path to ground from circuits, equipment, and enclosures should be permanent and continuous.

#### 4.25 Wiring Design and Protection

A conductor that is used as a grounding conductor should be identifiable and distinguishable from all other conductors so that employees can easily identify each conductor type. This is typically achieved through markings or color coatings.

The grounding conductor acts as a safeguard against insulation failure or faults in the other circuit conductors. The grounding conductor is not energized under normal conditions and only becomes energized if there is a

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fault in the normal current path. The grounding conductor will direct current back to the source and subsequently enable fuses or circuit breakers.

**5. Review and Recordkeeping****5.1 Program Review**

- a) University of Virginia Facilities Management Occupational Health & Safety will audit this Electrical Safety Program at an interval not to exceed 1 year in order to ensure that the principles and procedures outlined are in compliance with NFPA 70E and any other applicable standard.
- b) Field work shall be audited to verify that the requirements contained in the procedures of this Electrical Safety Program are being followed. Field audits are to be performed at an interval not to exceed 1 year.
- c) Each audit is to be documented and maintained on file in the UVA FM Occupation Health & Safety for a period of a minimum of 5 years.

**5.2 Program Recordkeeping**

Records of this Electrical Safety Program will be considered obsolete when the new version is issued. Obsolete versions will be destroyed after three years.



**Appendix A: Definitions**

**Accessible (as applied to equipment)** means admitting close approach; not guarded by locked doors, elevation, or other effective means.

**Accessible (as applied to wiring methods)** means capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building.

**Accessible, Readily (Readily Accessible)** means capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to actions such as to use tools, to climb over or remove obstacles, or to resort to portable ladders, and so forth.

**Approved** means acceptable to the authority having jurisdiction.

**Arc Flash Hazard** means a dangerous condition associated with the possible release of energy caused by an electric arc.

**Arc Flash Suit** means a complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet.

**Arc Rating** means the value attributed to materials that describe their performance to exposure to an electrical arc discharge. The arc rating is expressed in cal/cm<sup>2</sup> and is derived from the determined value of the arc thermal performance value (ATPV) or energy of breakopen threshold (E<sub>BT</sub>) (should a material system exhibit a breakopen response below the ATPV value). Arc rating is reported as either ATPV or E<sub>BT</sub>, whichever is the lower value.

**Attachment Plug (Plug Cap) (Plug)** means a device that, by insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

**Authority Having Jurisdiction (AHJ)** means an organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

**Automatic** means performing a function without the necessity of human intervention.

**Balaclava (Sock Hood)** means an arc-rated hood that protects the neck and head except for the facial area of the eyes and nose.

**Barricade** means a physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning and to limit access.

**Barrier** means a physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts or to prevent unauthorized access to a work area.

**Bonded (Bonding)** means connected to establish electrical continuity and conductivity.

**Bonding Conductor or Jumper** means a reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected.

**Boundary, Arc Flash** means when an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if an electrical arc flash were to occur.

**Boundary, Limited Approach** means an approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exist.

**Boundary, Restricted Approach** means 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-



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over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.

**Branch Circuit** means the circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

**Building** means a structure that stands alone or that is cut off from adjoining structures by fire walls with all opening therein protected by approved fire doors.

**Cabinet** means an enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.

**Circuit Breaker** means a device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.

**Conductive** means suitable for carrying electric current.

**Conductor, Bare** means a conductor having no covering or electrical insulation whatsoever.

**Conductor, Covered** means a conductor encased within material of composition or thickness that is not recognized by this Code as electrical insulation.

**Conductor, Insulated** means a conductor encased within material of composition and thickness that is recognized by this Code as electrical insulation.

**Controller** means a device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

**Current-Limiting Overcurrent Protective Device** means a device that, when interrupting currents in its current-limiting range, reduces the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.

**Cutout** means an assembly of a fuse support with either a fuse-holder, fuse carrier, or a disconnecting blade. The fuseholder or fuse carrier may include a conducting element (fuse link), or may act as the disconnecting blade by the inclusion of a nonfusible member.

**De-energized** means free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth.

**Device** means a unit of electrical system, other than a conductor, that carries or controls electric energy as its principal function.

**Disconnecting Means** means a device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

**Disconnecting (or Isolating) Switch (Disconnecter, Isolator)** means a mechanical switching device used for isolating a circuit or equipment from a source of power.

**Dwelling Unit** means a single unit providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation.

**Electrical Hazard** means a dangerous condition such that contact equipment failure can result in electric shock, arc flash burn, thermal burn, or blast.

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**Electrical Safety** means recognizing hazards associated with the use of electrical energy and taking precautions so that hazards do not cause injury or death.

**Electrically Safe Work Condition** means 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 ensure the absence of voltage, and grounded if determined necessary.

**Enclosed** means Surrounded by a case, housing, fence, or wall(s) that prevents persons from accidentally contacting energized parts.

**Enclosure** means the case or housing of apparatus – or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized electrical conductors or circuit parts or to protect the equipment from physical damage.

**Energized** means electrically connected to, or is, a source of voltage.

**Equipment** is 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)** means 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.

**Exposed (as applied to wiring methods)** means on or attached to the surface or behind panels designed to allow access.

**Fitting** means an accessory such as a locknut, bushing, or other part of wiring system that is intended primarily to perform a mechanical rather than an electrical function.

**Fuse** means an overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it.

**Ground** means the earth.

**Ground Fault** means an unintentional, electrically conducting connection between an ungrounded conductor of an electrical circuit and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth.

**Grounded (Grounding)** means connected (connecting) to ground or to a conductive body that extends the ground connection.

**Grounded, Solidly** means connected to ground without inserting any resistor or impedance device.

**Grounded Conductor** means a system or circuit conductor that is intentionally grounded.

**Ground-Fault Circuit Interrupter (GFCI)** means a device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a Class A device.

**Grounding Conductor, Equipment (EGC)** means the conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

**Grounding Electrode** means a conducting object through which a direct connection to earth is established.

**Grounding Electrode Conductor** means a conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.

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**Guarded** means 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.

**Hazard** means a source of possible injury or damage to health.

**Hazardous** means exposure to at least one hazard.

**Incident Energy** means 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/cm<sup>2</sup>)

**Incident Energy Analysis** means a component of arc flash risk assessment used to predict the incident energy of an arc flash for a specified set of conditions.

**Insulated** means separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

**Interrupter Switch** means a switch capable of making, carrying, and interrupting specified currents.

**Interrupting Rating** means the highest current at rated voltage that a device is identified to interrupt under standard test conditions.

**Isolated (as applied to location)** means not readily accessible to persons unless special means for access are used.

**Labeled** means equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with produce evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

**Listed** means equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction 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 that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

**Luminaire** means 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 lampholder itself is not a luminaire.

**Motor Control Center** means an assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

**Outlet** means a point on the wiring system at which current is taken to supply utilization equipment.

**Overcurrent** means any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

**Overload** means operation of equipment in excess of normal full-load rating, or of a conductor in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.

**Panelboard** means a single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of

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light, heat, or power circuits; designed to be placed in a cabinet or cutout box places in or against a wall, partition, or other support; and accessible only from the front.

**Premises Wiring (System)** means interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of their associated hardware fittings and wiring devices, both permanently and temporarily installed. This includes: (a) wiring from the service point or power source to the outlets; or (b) wiring from and including the power source to the outlets where there is no service point. Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment.

**Qualified Person** means 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 and avoid the hazards involved.

**Raceway** means an enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard.

**Receptacle** means a receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

**Risk** means 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.

**Risk Assessment** means an overall process that indemnifies 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.

**Service Drop** means the overhead conductors between the utility electric supply system and the service point.

**Service Lateral** means the underground conductors between the utility electric supply system and the service point.

**Service Point** means the point of connection between the facilities of the serving utility and the premises wiring.

**Shock Hazard** means a dangerous condition associated with the possible release of energy caused by contact or approach to energized electrical conductors or circuit parts.

**Short-Circuit Current Rating** means the prospective symmetrical fault current at nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.

**Single-Line Diagram** means a diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices of parts used in the circuit or system.

**Special Permission** means the written consent of the authority having jurisdiction.

**Step Potential** means a ground potential gradient difference that can cause current flow from foot to foot through the body.

**Structure** means that which is built or constructed.

**Switch, Isolating** means a switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

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**Switchboard** means a large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments. These assemblies are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

**Switchgear, Arc-Resistant** means equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee.

**Switchgear, Metal-Clad** means a switchgear assembly completely enclosed on all sides and top with sheet metal, having drawout switching and interrupting device, and all live parts enclosed within grounded metal compartments.

**Switchgear, Metal-Enclosed** means a switchgear assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows), containing primary power circuit switching, interrupting devices, or both, with buses and connections. This assembly may include control and auxiliary devices. Access to interior of the enclosure is provided by doors, removable covers, or both. Metal-enclosed switchgear is available in non-arc resistant or arc-resistant constructions.

**Switching Device** means a device designed to close, open, or both, one or more electric circuits.

**Touch Potential** means a ground potential gradient difference that can cause current flow from hand to hand, hand to foot, or another path, other than foot to foot, through the body.

**Ungrounded** means not connected to ground or to a conductive body that extends the ground connection.

**Unqualified Person** means a person who is not a Qualified Person.

**Utilization Equipment** means Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purpose.

**Voltage (of a Circuit)** means the greatest root-mean-square (rms) Effective) difference of potential between any two conductors of the circuit concerned.

**Voltage, Nominal** means 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).

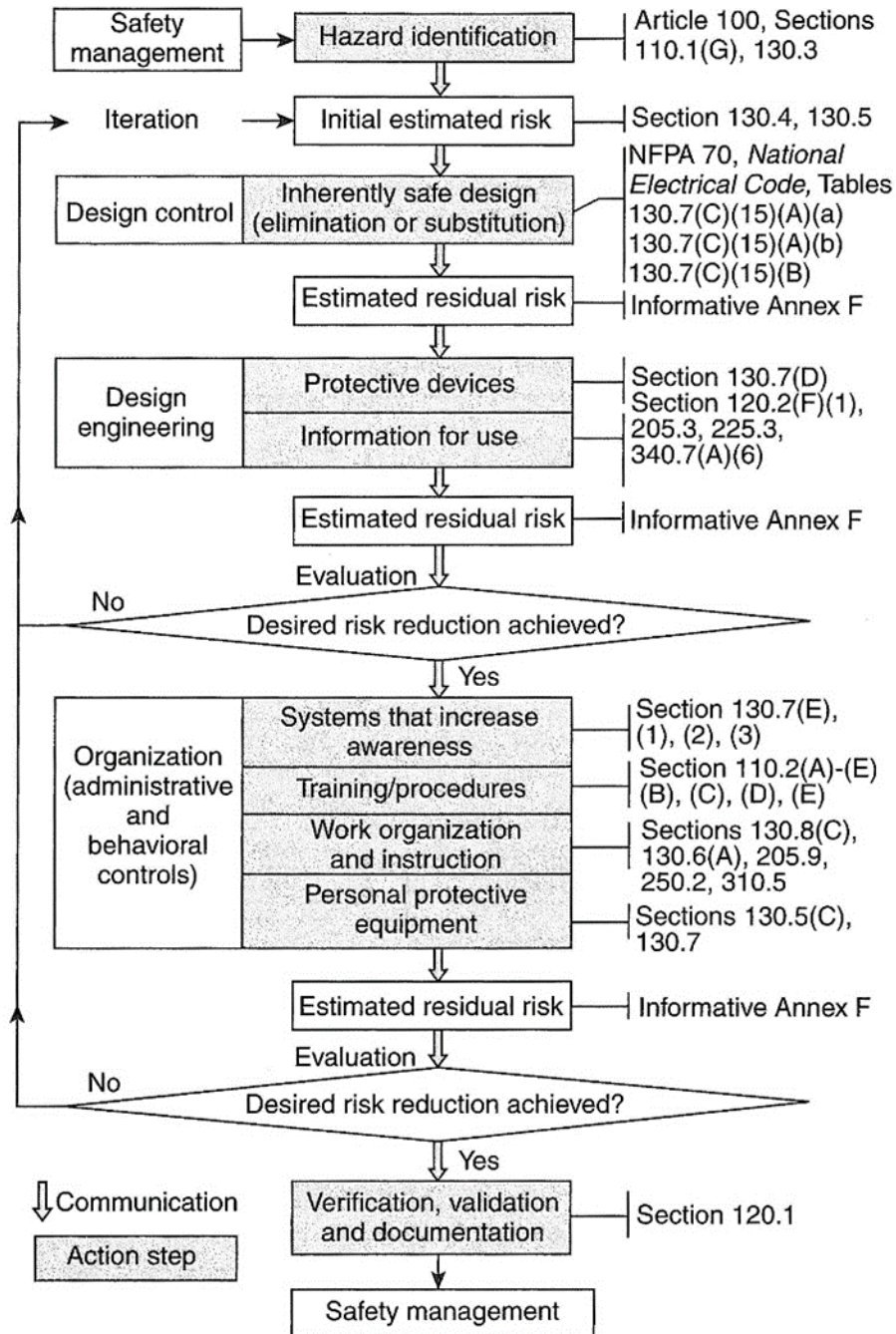
**Working On (energized electrical conductors or circuit parts)** means intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment regardless of the personal protective equipment (PPE) a person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

**Facilities Management**  
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FM:	Facilities Management
GFCI:	Ground Fault Circuit Interrupters
JHA:	Job Hazards Analysis
LOTO:	Lockout/Tagout
OHS:	Occupational Health and Safety
OSHA:	Occupational Safety & Health Administration
PPE:	Personal Protective Equipment
PRCS:	Permit-Required Confined Space
UVA:	University of Virginia



### Appendix C.1: Risk Assessment Process



**Figure F.1(a) Risk Assessment Process.**

## Appendix C.2: Arc Flash Hazard Identification for Alternating Current and Direct Current Systems

2015 NFPA 70E Table 130.7(C)(15)(A)(a)

Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems		
Task	Equipment Condition*	Arc Flash PPE Required
Reading a panel meter while operating a meter switch	Any	No
Normal operation of a circuit breaker (CB), switch, contactor or starter	All of the following: The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
For ac systems: Work on energized electrical conductors and circuit parts, including voltage testing	Any	Yes
For dc systems: Work on energized electrical conductors and circuit parts of series-connected battery cells, including voltage testing	Any	Yes
Voltage testing on individual battery cells or individual multi-cell units	All of the following: The equipment is properly installed The equipment is properly maintained Covers for all other equipment are in place and secured There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
Removal or installation of CBs or switches	Any	Yes
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	All of the following: The equipment is properly installed The equipment is properly maintained There is no evidence of impending failure	No
	Any of the following: The equipment is not properly installed The equipment is not properly maintained There is evidence of impending failure	Yes
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.	Any	Yes



## Appendix C.2 (Continued)

2015 NFPA 70E Table 130.7(C)(15)(A)(a)

Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems		
Task	Equipment Condition*	Arc Flash PPE Required
Removal of battery intercell connector covers	All of the following: The equipment is properly installed The equipment is properly maintained Covers for all other equipment are in place and secure There is no evidence of impending failure	No
	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
Opening hinged door(s) or cover(s) (to expose bare energized electrical conductors and circuit parts)	Any	Yes
Perform infrared thermography and other noncontact inspections outside the restricted approach boundary. This activity does not include opening of doors or covers.	Any	No
Application of temporary protective grounding equipment after voltage test	Any	Yes
Work on control circuits with exposed electrical conductors and circuit parts, 120 volts or below without any other exposed energized equipment over 120 volts including opening of hinged covers to gain access	Any	No
Work on control circuits with exposed energized electrical conductors and circuit parts, greater than 120 V	Any	Yes
Insertion or removal (racking) of CBs or starters from cubicles, doors open or closed	Any	Yes
Insertion or removal of plug-in devices into or from busways	Any	Yes
Insulated cable examination with no manipulation of cable	Any	No
Insulated cable examination with manipulation of cable	Any	Yes
Work on exposed energized electrical conductors and circuit parts of equipment directly supplied by a panelboard or motor control center	Any	Yes
Insertion and removal of revenue meters (kW-hour at primary voltage and current)	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an enclosure	Any	Yes
For dc systems, insertion or removal of individual cells or multi-cell units of a battery system in an open rack	Any	No

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## Appendix C.2 (Continued)

2015 NFPA 70E Table 130.7(C)(15)(A)(a)

Table 130.7(C)(15)(A)(a) Arc Flash Hazard Identification for Alternating Current (ac) and Direct Current (dc) Systems		
Task	Equipment Condition*	Arc Flash PPE Required
For dc systems, maintenance on a single cell of a battery system or multi-cell units in an open rack	Any	No
For dc systems, work on exposed energized electrical conductors and circuit parts or utilization equipment directly supplied by a dc source	Any	Yes
Arc-resistance switchgear Type 1 or 2 (for cleaning times of <0.5 sec with a prospective fault current not to exceed the arc-resistant rating of the equipment) and metal enclosed interrupter switchgear, fused or unfused of arc resistant type construction tested in accordance with IEEE C37.20.7:	All of the following:  The equipment is properly installed The equipment is properly maintained All equipment doors are closed and secured All equipment covers are in place and secured There is no evidence of impending failure	No
<ul style="list-style-type: none"> <li>• Insertion or removal (racking) of CBs from cubicles</li> <li>• Insertion or removal (racking) of ground and test device</li> <li>• Insertion or removal (racking) of voltage transformers on or off the bus</li> </ul>	One or more of the following: The equipment is not properly installed The equipment is not properly maintained Equipment doors are open or not secured Equipment covers are off or not secured There is evidence of impending failure	Yes
Opening voltage transformer or control power transformer compartments	Any	Yes
Outdoor disconnect switch operation (hookstick operated) at 1 kV through 15 kV	Any	Yes
Outdoor disconnect switch operation (gang-operated, from grade) at 1 kV through 15 kV	Any	Yes
<p><b>Note:</b> Hazard identification is one component of risk assessment. Risk assessment involves a determination of the likelihood of occurrence of an incident, resulting from a hazard that could cause injury or damage to health. The assessment of the likelihood of occurrence contained in this table does not cover every possible condition or situation. <b>Where the table indicates that arc flash PPE is not required, an arc flash is not likely to occur.</b></p> <p>*The phrase <b>properly installed</b>, as used in this table, means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase <b>properly maintained</b>, as used in this table, means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase <b>evidence of impending failure</b>, as used in this table, means that there is evidence of arcing, overheating, loose or bound equipment parts, visible damage, deterioration, or other damage.</p>		

### Appendix C.3: Arc-Flash Hazard PPE Categories for Alternating Current Systems

**Table 130.7(C)(15)(A)(b)**

Table 130.7(C)(15)(A)(b) Arc-Flash Hazard PPE Categories for Alternating Current (ac) Systems		
Equipment	Arc Flash PPE Category	Arc Flash Boundary
Panelboards or other equipment rated 240V and below  Parameters: Maximum of 25 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated >240V and up to 600V  Parameters: Maximum of 25 kA short-circuit current available; maximum 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	900 mm (3ft.)
600-V class motor control centers (MCCs)  Parameters: Maximum of 65 kA short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5m (5 ft)
600-V class motor control centers (MCCs)  Parameters: Maximum of 42 kA short-circuit current available; maximum of 0.33 sec (20 cycles) fault clearing time; working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-V class switchgear (with power circuit breakers or fused switches) and 600 V class switchboards  Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.5 sec (30 cycles) fault clearing time; working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-V class (277 V through 600 V, nominal) equipment  Parameters: Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV  Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12m (40 ft)
Metal-clad switchgear, 1 kV through 15 kV  Parameters: Maximum of 35 kA sort-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12m (40 ft)
Arc-resistant switchgear Type 1 or 2 [for clearing times of <0.5 sec (30 cycles) with a perspective fault current not to exceed the arc-resistant rating of the equipment], and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, 1 kV through 15 kV	N/A (doors closed)	N/A (doors closed)
Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4 (doors open)	12 m (40 ft)
Other equipment 1 kV through 15 kV  Parameters: Maximum of 35 kA short-circuit current available; maximum of up to 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)	4	12m (40 ft)
Note: for equipment rated 600 volts and below, and protected by upstream current-limiting fuses or current-limiting circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.		

**Appendix C.4: PPE**
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**Table 130.7(C)(16) Personal Protective Equipment (PPE)**

PPE Category	PPE
<b>1</b>	<b>Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm<sup>2</sup> (see Note 1)</b> Arc-rated long-sleeve shirt and pants of arc-rated coverall Arc-rated face shield (see Note 2) or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN) <b>Protective Equipment</b> Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear (AN)
<b>2</b>	<b>Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm<sup>2</sup> (see Note 1)</b> Arc-rated long-sleeve shirt and pants of arc-rated coverall Arc-rated flash suit hood or arc-rated face shield (see Note 2) and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN) <b>Protective Equipment</b> Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (see Note 3) Leather footwear (AN)
<b>3</b>	<b>Arc-Rated Clothing, Minimum Arc Rating of 25 cal/cm<sup>2</sup> (see Note 1)</b> 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 (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) <b>Protective Equipment</b> Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear
<b>4</b>	<b>Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm<sup>2</sup> (see Note 1)</b> 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 (see Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN) <b>Protective Equipment</b> Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear

**Notes:**

(1) Arc rating is defined in Article 100.

(2) 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.

(3) 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.

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### Appendix C.4 (Continued)

**Table H.3(b) Guidance on Selection of Arc-Rated Clothing and Other PPE for Use When Incident Energy Exposure Is Determined**

Incident Energy Exposure	Protective Clothing and PPE
$\leq 1.2 \text{ cal/cm}^2$	
Protective clothing, nonmelting (in accordance with ASTM F 1506) or untreated natural fiber	Shirt (long sleeve) and pants (long) or coverall
Other PPE	Face shield for projectile protection (AN) Safety glasses or safety goggles (SR) Hearing protection Heavy-duty leather gloves or rubber insulating gloves with leather protectors (AN)
$\geq 1.2 \text{ to } 12 \text{ cal/cm}^2$ Arc-rated clothing and equipment with an arc rating equal to or greater than the <u>determined incident energy</u> (See Note 3.)	Arc-rated long-sleeve shirt and arc-rated pants or arc-rated coverall or arc flash suit (SR) (See Note 3.) Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR) (See Note 1.) Arc-rated jacket, parka, or rainwear (AN)
Other PPE	Hard hat Arc-rated hard hat liner (AN) Safety glasses or safety goggles (SR) Hearing protection Heavy-duty leather gloves or rubber insulating gloves with leather protectors (SR) (See Note 4.) Leather footwear
$\geq 12 \text{ cal/cm}^2$ Arc-rated clothing and equipment with an arc rating equal to or greater than the <u>determined incident energy</u> (See Note 3.)	Arc-rated long-sleeve shirt and arc-rated pants or arc-rated coverall and/or arc flash suit (SR) Arc-rated arc flash suit hood Arc-rated gloves Arc-rated jacket, parka, or rainwear (AN)
Other PPE	Hard hat Arc-rated hard hat liner (AN) Safety glasses or safety goggles (SR) Hearing protection Arc-rated gloves or rubber insulating gloves with leather protectors (SR) (See Note 4.) Leather footwear

AN: As needed [in addition to the protective clothing and PPE required by 130.5(C)(1)].

SR: Selection of one in group is required by 130.5(C)(1).

Notes:

- (1) Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). For full head and neck protection, use a balaclava or an arc flash hood.
- (2) All items not designated "AN" are required by 130.7(C).
- (3) Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system consisting of a combination of arc-rated shirt and pants, coverall, and arc flash suit.
- (4) Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.



## Appendix C.5: Energized Electrical Work Permit

All References to 2015 NFPA 70E

Part I: To be completed by the requester	
1. Date Start: Expiration:	2. Job/WO Number:
3. Equipment ID/Circuit/Panel:	
4. Address of work location (address/building name/floor/room):	
5. Description of work to be done:	
6. Justification why circuit/equipment cannot be de-energized:	
Part II: To be Completed by the Electrically qualified person(s) performing the work	
Check when complete	
1. Voltage Rating of the Equipment: 120V/208V 277V/480V 12.5kV Other (specify): _____	<input type="checkbox"/>
2. Detailed job description procedures to be used in performing the above work: _____ _____ _____	<input type="checkbox"/>
3. Description of the Safe Work Practices to be employed: _____ _____	<input type="checkbox"/>
4. Results of the Shock Hazard Analysis:	
a. Limited approach boundary: 130.4(D)(a) _____	<input type="checkbox"/>
b. Restricted approach boundary: 130.4(D)(b) _____	<input type="checkbox"/>
c. Necessary shock, personal and other protective equipment to safely perform assigned task: _____ _____	<input type="checkbox"/>
5. Results of the arc flash assessment	
a. Available incident energy at the working distance or arc flash PPE category: _____	<input type="checkbox"/>
b. Necessary arc flash, personal and other protective equipment to safely perform assigned task: _____ _____	<input type="checkbox"/>
c. Arc flash boundary: 130.5(B) _____	<input type="checkbox"/>
6. Means employed to restrict the access of unqualified persons from the work area: _____ _____	<input type="checkbox"/>
7. Completed Job Hazard Analysis? <i>(Attach to this form)</i>	<input type="checkbox"/>
8. Completed pre-job briefing by supervisor? Yes No	<input type="checkbox"/>
9. Do you (Qualified Person) agree the above-detailed work can be done safely? Yes No <i>(If no, provide explanation and return to the Requester.)</i>	<input type="checkbox"/>
10. Electrically Qualified Person's Name/Phone:	Signature:
11. Electrically Qualified Person's Name/Phone:	Signature:
12. FMOHS Representative Reviewed:	Signature:
Part III: Final approvals required to perform the work while electrically energized	
1. Supervisor Name/Phone:	Signature:
2. Superintendent Name/Phone:	Signature:

**Appendix C.6: Electrical Cord Inspection**

## Electrical Cord Inspection

Project Name:		Date:	
Name of Inspector:		Time:	
Employee ID:		Shop #:	

Cord Inspection	Cord 1	2	3	4	5
Cord Length					
American Wire Gauge size of cord (example - 14 - 12 - 10)					
Do extension cords have a grounding conductor/third prong?	Y / N	Y / N	Y / N	Y / N	Y / N
Are cords with frayed, nicked or deteriorated insulation replaced promptly?	Y / N	Y / N	Y / N	Y / N	Y / N
Are cords rated for extra hard use? Example: type SO, SJO, SJTW insulation rating.	Y / N	Y / N	Y / N	Y / N	Y / N
Are male/female caps securely fastened to cords to afford proper strain relief?	Y / N	Y / N	Y / N	Y / N	Y / N
Multi-outlet power cords are rated for their use?	Y / N	Y / N	Y / N	Y / N	Y / N
Are cords exposed to pinching hazards such as doors, windows or heavy materials?	Y / N	Y / N	Y / N	Y / N	Y / N
Are cords exposed to cutting hazards such as metal studs/track or sharp unprotected edges?	Y / N	Y / N	Y / N	Y / N	Y / N
Are cords exposed to water, moisture or chemicals rated for this use?	Y / N	Y / N	Y / N	Y / N	Y / N
Are any cords smaller than 14 AWG being used?	Y / N	Y / N	Y / N	Y / N	Y / N
Are cords exposed to heat, sparks or flame?	Y / N	Y / N	Y / N	Y / N	Y / N
Are cords used for more than 90 days in one location, as a substitute for permanent wiring?	Y / N	Y / N	Y / N	Y / N	Y / N
Have cords been used in place of rope to tie down equipment or lift up equipment such as buckets?	Y / N	Y / N	Y / N	Y / N	Y / N
Are tools being hoisted or carried by their cords?	Y / N	Y / N	Y / N	Y / N	Y / N
Site Specific Question:	Y / N	Y / N	Y / N	Y / N	Y / N

Equipment and Tool Inspection					
Is the equipment/tool grounded with a three prong cord?	Y / N	Y / N	Y / N	Y / N	Y / N
If NOT: Is equipment/tool marked as double insulated?	Y / N	Y / N	Y / N	Y / N	Y / N
Is cord frayed, damaged or pulled out from connector?	Y / N	Y / N	Y / N	Y / N	Y / N
Is equipment/tool inspected on a regular schedule?	Y / N	Y / N	Y / N	Y / N	Y / N
Have any problems been reported with this equipment/tool?	Y / N	Y / N	Y / N	Y / N	Y / N
Site Specific Question:	Y / N	Y / N	Y / N	Y / N	Y / N

Ground Fault Circuit Interrupter					
Does pushing the "Test" button on GFCI trip the device?	Y / N	Y / N	Y / N	Y / N	Y / N
Does pushing the "Reset" button on the GFCI rest the device?	Y / N	Y / N	Y / N	Y / N	Y / N
Is the device chipped, cracked, or damaged?	Y / N	Y / N	Y / N	Y / N	Y / N
Is the device labeled as GFCI protected?	Y / N	Y / N	Y / N	Y / N	Y / N
Site Specific Question:	Y / N	Y / N	Y / N	Y / N	Y / N

Please retain this form for one year for review by FM-Occupational Health and Safety

\* Forms may be downloaded from the FM-OHS website