



**Ira A. Fulton College of Engineering & Technology**  
**Electrical Safety Program**

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## 1.0 OVERVIEW

This program outlines measures college members must take in order to protect individuals from electrical hazards. The program considers the work that is performed in the college – this means that there is other electrical work not addressed by this program. The University Lockout Tagout program and this program complement each other, both of which must be satisfied.

## 2.0 APPLICABLE STANDARD(S)

- ▷ OSHA 29 CFR Subpart S Electrical
- ▷ NFPA 70E-2015

## 3.0 PURPOSE

The purpose of this program is to protect members of the Ira A. Fulton College of Engineering & Technology from electrical hazards while performing their work and studies.

*“Electrical Hazard” means a dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn or blast. (NFPA 70E-2015)*

## 4.0 SCOPE

The scope of this program addresses work performed by members of the college who are exposed to electrical hazards 50 volts and higher. College members do work with voltages lower than 50 volts, but this work can be safely addressed by the laboratories performing the work through means other than following this program. With regard to electrical hazards (50 volts and higher), college members are limited to performing the following work:

- Normal use of electric utilization equipment;
- Normal use of flexible cord sets (e.g. extension cord & surge protectors); and
- Testing, troubleshooting, and voltage measuring energized electrical conductors or circuits

*“Utilization Equipment” is equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. (NFPA 70E-2015)*

*“Normal Use” means use of equipment in accord with manufacturer recommendations while satisfying the following conditions (as applicable):*

- *The equipment is properly installed*
- *The equipment is properly maintained*
- *The equipment doors are properly closed and secured*
- *All equipment covers are in place and secured*
- *There is no evidence of impending failure*

## 5.0 NORMAL USE OF ELECTRIC UTILIZATION EQUIPMENT

Utilization equipment that can be or was purchased must be used in accord with the use intended by the manufacturer - consistent with the equipment listing and labeling determined by a National Recognized Testing Laboratory (NRTL). All utilization equipment must be maintained in a condition that does not increase the electrical hazard beyond that inherent with the new product. Any utilization equipment that does not satisfy this requirement shall not be used.

## 6.0 DESIGNING & CONSTRUCTING UTILIZATION EQUIPMENT

When designing and building any utilization equipment it must be designed to satisfy current National Electric Code (NEC) requirements. **If you don't know what the NEC requirements are then don't design or build it!** *All components used to build the utilization equipment must be used in accord with manufacturer recommendations and the listing and labeling of the components. Equipment needs to be designed and constructed so that there are no exposed energized parts when it is put into use.*

## 7.0 FLEXIBLE CORD SETS

Flexible cord sets, such as extension cords and surge protectors, are to be used as intended by the manufacturer. They are not to be used in place of permanent facility wiring.

Flexible cord sets must have a complete ground circuit. Two wire cord sets are not to be used (e.g. flat wire fixture wire).

Flexible cord sets must be GFCI protected if used outdoors or in wet locations.

All flexible cord sets are to be inspected prior to use to make sure they are not damaged. This means that the insulation is intact and not damaged, the ground circuit is complete, and other portions of the flexible cord set are free from damage and in proper working order.

If a flexible cord set must be strewn through a doorway or a footpath then the cord must be adequately protected from damage.

## 8.0 TESTING, TROUBLE SHOOTING, & VOLTAGE MEASURING

The steps outlined below apply when completely de-energizing and locking out all sources of electricity to conductors or circuits isn't feasible because they need to be tested, trouble shot, or voltage measured while energized. If this is not the case then the conductors and circuits must be de-energized, rendered safe to work on, and locked out according to the University Lockout Tagout program before engaging in the work. Do not perform any of this work if you are wearing any conductive materials or if you are impaired (e.g. using over-the-counter or prescription drugs).

## 8.1 Required Steps to Safely Test, Trouble Shoot, or Voltage Measure Energized Conductors or Circuits

***Step 1 – Limited Approach Boundary*** – This step requires that you determine the Limited Approach Boundary for the work you are performing. Due to a shock hazard no “unqualified person” is allowed to approach, or take any conductive object nearer than the Limited Approach Boundary unless they are continuously escorted by a “qualified person” who shall advise them regarding the hazards present and what they need to do to remain protected.

*“Unqualified Person” is a person who is not a “qualified person”. (NFPA 70E-2015)*

*“Qualified Person” is a person 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. (NFPA 70E-2015)*

To determine this boundary please reference Appendix A (Table 130.4(D)(a) from NFPA 70E-2015).

***Step 2 – Restricted Approach Boundary*** – This step requires that you determine the Restricted Approach Boundary for the work you are performing. Due to a shock hazard only “qualified persons” are allowed to cross or cause any conductive object to pass beyond the Restricted Approach Boundary.

To determine this boundary please reference Appendix A (Table 130.4(D)(a) from NFPA 70E-2015)

***Step 3 – Arc Flash Boundary*** – This step requires that you determine the Arc Flash Boundary for the work you are performing. This boundary is the distance at which the incident energy (that can be caused by an arc) equals  $5 \text{ J/cm}^2$  ( $1.2 \text{ cal/cm}^2$ ) – enough energy to cause second degree burns.

Determining the Arc Flash Boundary is done one of two ways:

1. Arc Flash Category Method. Look the distance up in tables 130.7(C)(15)(A)(b) or 130.7(C)(15)(B) of NFPA 70E-2015. If you don't have a copy of the standard please visit the college Health & Safety Officer. *Note: the requirements of these tables must apply;* or
2. Incident Energy Analysis Method. Perform an Incident Energy Analysis. Guidelines for performing such an analysis are provided in Appendix D of NFPA 70E. If you don't have a copy of the standard please visit the college Health & Safety Officer.

When determining the arc flash boundary you must consider the design of the overcurrent protective device and its opening time, including its condition of

maintenance. Inadequate or improper maintenance can result in increased opening time which will result in an increased level of incident energy.

*Note: per NFPA 70E-2015 an Arc Flash Risk Assessment is required in order to determine A] The appropriate safety related work practices (determined during Step 4 Below); b] The Arc Flash Boundary (determined during this step); and The PPE to be used within the arc flash boundary (determined during Step 5 below)*

**Step 4 – Safe Work Practices & Protective Measures** – This step requires that safe work practices and protective measures be determined. The safe work practices and protective measures need to be sufficient to fully protect those performing the work and anyone else who will be present in the area. When determining what controls to use please remember to select controls in accord with the following hierarchy of preferred controls (1 being the most preferred):

1. Elimination – getting rid of the hazard
2. Substitution – substituting a lesser hazard in place of a greater hazard
3. Engineering Controls - using controls designed to physically separate individuals from the hazard
4. Awareness – this includes signage
5. Administrative Controls - using actions to separate individuals from a hazard
6. Personal Protective Equipment (PPE) – using gear that you wear to protect against a hazard

A combination of the following work practices must be incorporated into your safe work practices and protective measures. Not even a qualified person is allowed to cross the Restricted Approach Boundary unless they are protected by using a combination of these work practices:

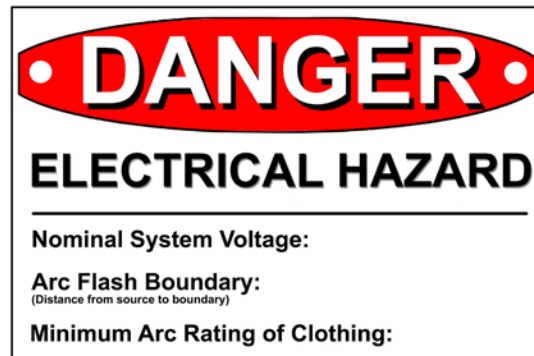
- Each qualified person is insulated or guarded from the energized electrical conductors or circuit parts
- The energized electrical conductors or circuit parts are insulated from the qualified person and from any other conductive object at a different potential
- The qualified person is insulated from any other conductive object

The safe work practices and protective measures you select must be as effective as those considered to be “Best Practice”.

When determining what tools and equipment to use make sure to identify and select electrically insulated tools and equipment. Enough detail must be provided in your written procedures to allow someone to identify what they need without consulting you.

Another measure of protection that must be incorporated into your safe work practices is the use of labels, signs, and floor tape (or equivalent) to identify the

hazards and approach boundaries associated with your work. A sign/label or other type of marking, or a constant attendant, must be positioned at the outermost approach boundary, which will be either the Limited Approach Boundary or the Arc Flash boundary, whichever is the greatest distance from the electrical source. Doors and covers that protect against contact with energized parts and that you will remove during your work must be labeled. Labels and signs are to include the following information:



*Note: Appendix B includes this sign*

You can substitute one of the following in place of the Minimum Arc Rating of Clothing (change the wording on the sign if you do):

- The available incident energy and the corresponding working distance;
- The arc flash PPE category; or
- The site-specific level of PPE

The goal for signing/labeling and marking the area is to communicate to anyone who nears the approach boundaries of the hazards present and not to enter the approach boundaries. Access to the approach boundaries is to be prevented or limited, and can be accomplished by using means such as fencing, barricades, and traffic control tape or even an attendant.

***Step 5 – Personal Protective Equipment (PPE), Clothing, & Other Protective Equipment*** – This step requires the proper selection, use, and care of PPE, clothing, and other protective equipment.

*Personal Protective Equipment (PPE)* is selected based upon the results of the method you used to determine the Arc Flash Boundary (Step 3 above). PPE can include head, face, neck, chin, eye, hearing, body, hand, arm, and foot protection. Individuals working in areas where there are electrical hazards must wear all PPE that is necessary to protect them from the hazards. The PPE must be rated, designed, constructed, inspected, and tested per manufacturer recommendations. PPE must be of the proper size and design for the application and part of the body to be protected. Layering PPE may be necessary to adequately protect against shock and arc flash hazards. Note: when layering, the outer layer needs to be the arc flash rated clothing.

PPE must be maintained in a safe reliable condition consistent with the manufacturer recommendations. Damaged PPE must not be used.

If the manufacturer indicates testing of the PPE then this must occur according to what the manufacturer recommends.

Clothing If an arc flash hazard exists then “Clothing consisting of fabrics, zipper tapes, and findings made from flammable synthetic materials that melt at temperatures below 3150C (600oF), such as acetate, acrylic nylon, polyester, polyethylene, polypropylene, and spandex, either alone or in blends, shall not be used.” NFPA 70E-2015 130.7(C)(11) All clothing must be maintained and cared for per manufacturer recommendations.

Other Protective Equipment includes items such as:

- Insulated tools and handling equipment
- Fuse or fuseholder handling equipment
- Ropes and handlines
- Fiberglass reinforced plastic rods
- Portable ladders
- Protective shields
- Rubber insulating equipment (e.g. mats)
- Voltage-rated plastic guard equipment
- Physical or mechanical barriers

Other Protective Equipment must be properly rated and designed for the application. Such equipment must be maintained, inspected, and tested per manufacturer instructions. Damaged equipment must not be used.

**Step 6 – Written Procedures** – This step requires that you create a written procedure that captures how to perform the work in a safe manner and protect other individuals who will or may enter the work area. The procedure will include the Limited Approach Boundary, Restricted Approach Boundary, Arc Flash Boundary, and the Safe Work Practices & Safety Measures you determined when completing the previous steps.

The written procedures must remain up-to-date to reflect any changes or modifications made to the work being performed.

**Step 7 – Training** – complete and document safety training in accord with section 9.0 below.

## 8.2 Test Instruments

Test instruments, equipment, and their accessories must be rated and designed for the application and environment for which they will be used.



A verification of proper operation shall be performed prior to using any instrument that will be used to test the absence of voltage. This verification shall be performed on an energized circuit of known voltage to make sure the instrument is functioning and reading properly.

## 9.0 TRAINING

Supervisors are to ensure that all individuals (qualified & unqualified persons) who will or may be exposed to the electrical hazards associated with the work they supervise receive the requisite training. Qualified persons must receive training sufficient to satisfy the following definition:

*“Qualified Person” is a person 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. NFPA 70E-2015*

Please keep in mind - “A person is not necessarily qualified just because he or she holds an electrical license or has passed an electrical exam. A person who is trained and qualified on Vendor A switchgear, panelboards, and so on, may not be qualified on Vendor B switchgear, panelboards, and so on, because they may operate or disengage differently.” (UGLY’s ELECTRICAL SAFETY AND NFPA 70E)

Unqualified persons must receive the safety training needed to ensure their safety.

All college members need to complete the Basic Electrical Safety training presentation found on YTrain.

*Job Briefings* – Job briefings are to occur before starting work that involves electrical hazards. Supervisors must ensure these briefings occur. Job briefings are to address the:

- Hazards associated with the work
- How to perform the work
- What safe work practices and protective measures will be used to perform the work safely
- How to properly maintain and store any equipment, including personal protective equipment that was used during the work

All safety training is to be recorded. A record of the training is to be provided to your department office. *Note: YTraining is recorded automatically.*

## 10.0 SPACE ABOUT ELECTRIC EQUIPMENT

Sufficient access and working space shall be provided and maintained about all electric equipment. Working space may not be used for storage. Electric equipment includes things like breaker panels & cut-off switches. Sufficient access and working space varies depending upon the voltage of the conductors. If you don’t know how much access and working space is required please consult with the college Health & Safety Officer. *Note: at minimum 36” in front and 30 inches from side to side will be required.*

## **11.0 RESPONSIBILITIES**

### 11.1 College & Departments

- Provide online Basic Electrical Safety training
- Institute programs and help faculty members maintain a safe working environment for themselves and their students
- Provide a college Health & Safety Officer (801-422-6589) to serve as a resource
- Departments collect and maintain specific training records for their students and employees
- Address issues identified by Risk Management
- Perform walkthroughs of labs and shops to help supervisors identify hazards

### 11.2 Supervisors

- Maintain a safe working environment for students and employees
- Ensure that the Electrical Safety Program is implemented
- Make sure equipment is properly maintained in safe working order
- Ensure their students and employees complete the appropriate electrical safety training
- Perform an annual audit to make sure this program has been fully implemented
- Investigate any near misses
- Correct any electrical issues reported to you
- Make sure electrical equipment is safe for use and maintained properly

### 11.3 Employees & Students

- Complete Basic Electrical Safety training
- Complete Specific Safety Training, which includes all training necessary for you to be considered a Qualified Person if you will test, trouble shoot, or perform voltage testing on conductors or circuits
- Perform your work in a safe manner, in accordance with your training and this program
- Report any “near misses” to your supervisor
- Report any unsafe conditions, including damaged or improperly functioning electrical equipment to your supervisor
- Do not use any damaged utilization equipment or flexible cord sets

## APPENDIX A

Table 130.4(D)(a) from NFPA 70E-2015

Use the following table for Shock protection for alternating current **(AC) systems**. All dimensions are distance from energized electrical conductor or circuit part to employee.

(1) Nominal System Voltage Range, Phase to Phase <sup>a</sup>	(2) <b>Limited Approach Boundary<sup>b</sup></b> Exposed Movable Conductor <sup>c</sup>	(3) Exposed Fixed Circuit Part	(4) <b>Restricted Approach Boundary<sup>b</sup>; Includes Inadvertent Movement Adder</b>
<50 V	Not Specified	Not Specified	Not Specified
50 V – 150 V <sup>d</sup>	3 M (10 ft 0 in.)	1 M (3 ft 6 in.)	Avoid Contact
151 V – 170 V	3 M (10 ft 0 in.)	1 M (3 ft 6 in.)	0.3 M (1 ft 0 in.)
171 V – 15 kV	3 M (10 ft 0 in.)	1.5 M (5 ft 0 in.)	0.7 M (2 ft 2 in.)
15.1 kV – 36 kV	3 M (10 ft 0 in.)	1.8 M (6 ft 0 in.)	0.8 M (2 ft 7 in.)
36.1 kV – 46 kV	3 M (10 ft 0 in.)	2.5 M (8 ft 0 in.)	0.8 M (2 ft 9 in.)
46.1 kV – 72.5 kV	3 M (10 ft 0 in.)	2.5 M (8 ft 0 in.)	1.0 M (3 ft 3 in.)
72.6 kV – 121 kV	3.3 M (10 ft 8 in.)	2.5 M (8 ft 0 in.)	1.0 M (3 ft 4 in.)
138 kV – 145 kV	3.4 M (11 ft 0 in.)	3 M (10 ft 0 in.)	1.2 M (3 ft 10 in.)
161 kV – 169 kV	3.6 M (11 ft 8 in.)	3.6 M (11 ft 8 in.)	1.3 M (4 ft 3 in.)
230 kV – 242 kV	4.0 M (13 ft 0 in.)	4.0 M (13 ft 0 in.)	1.7 M (5 ft 8 in.)
345 kV – 362 kV	4.7 M (15 ft 4 in.)	4.7 M (15 ft 4 in.)	2.8 M (9 ft 2 in.)
500 kV – 550 kV	5.8 M (19 ft 0 in.)	5.8 M (19 ft 0 in.)	3.6 M (11 ft 10 in.)
765 kV – 800 kV	7.2 M (23 ft 9 in.)	7.2 M (23 ft 9 in.)	4.9 M (15 ft 11 in.)

*Note 1: for arc flash boundary, see 30.5(A)*

*Note 2: All dimensions are distance from exposed energized electrical conductors or circuit part to employee*

<sup>a</sup> For single-phase systems above 250 V, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732

<sup>b</sup> See definition in Article 100 and text in 130.4(D)(2) and informative Annex C for elaboration.

<sup>c</sup> Exposed movable conductor describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

<sup>d</sup> This includes circuits where the exposure does not exceed 120V.

Use the following table for shock protection for direct current **(DC) systems**.

(1) Nominal Potential Difference	(2) <b>Limited Approach Boundary</b> Exposed Movable Conductor	(3) Exposed Fixed Circuit Part	(4) <b>Restricted Approach Boundary; Includes Inadvertent Movement Adder</b>
<100 V	Not Specified	Not Specified	Not Specified
100 V – 300 V	3.0 M (10 ft 0 in.)	1.0 M (3 ft 6 in.)	Avoid Contact
301 V – 1 kV	3.0 M (10 ft 0 in.)	1.0 M (3 ft 6 in.)	0.3 M (1 ft 0 in.)
1.1 kV – 5 kV	3.0 M (10 ft 0 in.)	1.5 M (5 ft 0 in.)	0.5 M (1 ft 5 in.)
5 kV – 15 kV	3.0 M (10 ft 0 in.)	1.5 M (5 ft 0 in.)	0.7 M (2 ft 2 in.)
15.1 kV – 45 kV	3.0 M (10 ft 0 in.)	2.5 M (8 ft 0 in.)	0.8 M (2 ft 9 in.)
45.1 kV – 75 kV	3.0 M (10 ft 0 in.)	2.5 M (8 ft 0 in.)	1.0 M (3 ft 2 in.)
75.1 kV – 150 kV	3.3 M (10 ft 8 in.)	3.0 M (10 ft 0 in.)	1.2 M (4 ft 0 in.)
150.1 kV – 250 kV	3.6 M (11 ft 8 in.)	3.6 M (11 ft 8 in.)	1.6 M (5 ft 3 in.)
250.1 kV – 500 kV	6.0 M (20 ft 0 in.)	6.0 M (20 ft 0 in.)	3.5 M (11 ft 6 in.)
500.1 kV – 800 kV	8.0 M (26 ft 0 in.)	8.0 M (26 ft 0 in.)	5.0 M (16 ft 5 in.)

*Note: all dimensions are distance from exposed energized electrical conductors or circuit parts to worker. Exposed movable conductor describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.*

## APPENDIX B

