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1. Summary

Working with or around electricity can present hazards to the body that can cause serious injury and death. It is important to understand the basic principles of this energy source and how to recognize and protect against the hazards it can create.

This program establishes the minimum requirements for safe electrical work practices. It shall be used to help ensure the safety of employees who are at risk of electric hazards in the workplace.

2. Scope

The provisions of the program cover electrical safety work practices for both qualified persons (those who have training in avoiding the electrical hazards of working on or near exposed energized parts) and unqualified persons (those with little or no such training). Working on, near, or with exposed energized electrical conductors or circuit parts.

3. Policy and Regulation

University of Iowa Operations Manual, Part III Human Resources, Division II Standards and Ethics, Chapter 16.4d Policy on Ethics and Responsibilities for University of Iowa Staff.


NFPA 70E Standard for Electrical Safety in the Workplace (most current version – updated every 3 years)

4. Definitions

Arc Flash - a phenomenon where a flashover of electric current leaves its intended path and travels through the air from one conductor to another, or to the ground.

Arc Rating - the maximum incident (thermal) energy resistance demonstrated by a material prior to break open or at the onset of a second-degree skin burn, normally expressed in cal/cm².

De-energized - free from any electrical connection to a source of potential difference and from electric charge.
**Electrically Safe Work Condition** - a state in which the conductor or circuit part to be worked on or near 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.

**Energized** - electrically connected to or having a source of voltage.

**Flame-Resistant (FR)** - the property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source.

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

**Flash Hazard Analysis** - a study investigating a worker’s potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and the appropriate levels of Personal Protective Equipment (PPE).

**Flash Protection Boundary** - an approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur.

**Flame-Resistant (FR)** - the property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or non-flaming source of ignition, with or without subsequent removal of the ignition source.

**Limited Approach Boundary** - an approach limit at a distance from an exposed live part within which a shock hazard exists.

**Lockout/Tagout (LOTO)** - the placement of a lockout device and identifying tag on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

**Prohibited Approach Boundary** - an approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part.

**Qualified Person** - one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved.

**Restricted Approach Boundary** - an approach limit at a distance from an exposed live part within which there is an increased risk of shock, due to electrical arc over
combined with inadvertent movement, for personnel working in close proximity to the live part.

**Shock Hazard** - a dangerous condition associated with the possible release of energy caused by contact or approach to live parts.

**Unqualified Person** - any person who is not a qualified person, and has little or no training regarding electrical hazards.


**Working On (live parts)** - coming into contact with live parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment a person is wearing.

### 5. Roles and Responsibilities

Deans, Directors and Department Heads are responsible to:
- Designate and empower the department’s Health and Safety Coordinator (or Program Coordinator or equivalent) and supervisors.
- Actively support these procedures within individual units.
- Ensure an environment where employees are encouraged to follow these procedures.

The Department Health and Safety Coordinator is responsible to:
- Act as an administrative liaison between the department and EHS.
- Provide administrative oversight of health and safety within the department.
- Facilitate the correction of safety problems within the department.

Supervisors are responsible to:
- Implement these procedures.
- Assure that staff is aware of this program and provided with training and the personal protective equipment.
- Maintain documentation and records as required.

Employees are responsible to:
- Comply with these procedures and any further safety requirements set by supervisors.

EHS is responsible to:
- Provide procedural guidelines, educational offerings, administrative consultations and reviews, and select technical and field services.
- Exercise surveillance over health and safety issues at the University.
6. General Requirements for Working on Electrical Equipment

Follow Core Principles of Electric Safety
- Every electrical conductor or circuit part is considered energized until proven otherwise.
- De-energizing an electrical conductor or circuit part and making it safe to work on is in itself a potentially hazardous task, as is the re-energization process. It is mandatory that all PPE identified for this task be worn.
- Anytime electrical work is necessary, a person needs to follow all required LOTO procedures to ensure elimination of all possible hazards and residual energy.
- Identify and use precautions appropriate to the working environment.
- Inspect and evaluate electrical equipment.
- Maintain the electrical equipment’s insulation and enclosure integrity.
- Plan every job and document first-time procedures.
- De-energize (LOTO), if possible.
- Anticipate unexpected events.
- Identify and minimize the hazard.
- Protect the employee from shock, bur, flash, blast, and other hazards due to the working environment.
- Utilize and wear all identified and required PPE.
- Use the right tools for the job.
- Assess people’s abilities.

General Work Procedures
- Only qualified person may work on electrical equipment.
- Every qualified person will start each day with an electrical safety meeting with their supervisor.
  - The meeting shall review the hazards, and controls of the work of that day.
- All work shall be done with circuits de-energized using proper LOTO procedures. Live parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee works on or near them.
- “Electrically safe work condition” means a state in which the conductor or circuit part to be worked on or near has been:
  - Disconnected from energized parts.
  - Locked/Tagged in accordance with University LOTO Program.
  - Tested to ensure the absence of voltage.
  - Grounded if determined necessary.
- No employee shall defeat an electrical interlock/safety interlock without authorization from the area manager.
- Unqualified persons may not perform housekeeping duties in locations where electrical contact hazards exist.
- Electrical conductive cleaning materials and flammable liquids may not be used in proximity to energized parts.

- **Changing Ballasts**
  - Only trained and qualified electrical employees may change ballasts,
  - Power shall be disconnected and controlled prior to changing / maintaining ballasts.
    - Locks should be applied to either the circuit breaker switch or the room light switch.
    - Wear proper PPE as identified by hazard category label on panels.
    - Any live work requires an Energized Work Permit.

- Guidelines for resetting a tripped circuit breaker.
  - Only trained and qualified person wearing the proper PPE may reset circuit breakers.

### 7. Insulated Tools and Equipment

- Only insulated tools and equipment shall be used within the limited approach boundary of exposed energized parts.
- Insulated tools shall be rated for the voltages on which they are used.
- Be rated for the voltage and equipment to which they will be connected, designed for the environment to which they will be exposed, and for the manner in which they will be used.
- Visually inspect for external defects and/or damage before the equipment is used on any shift. Take out of service and repair or replace as needed.
- Ladders shall have non-conductive (fiberglass) side rails if they are used where the employee or the ladder could contact exposed energized parts.

### 8. Guarding Live Energized Parts

- All electrical lines, connectors and load distribution centers shall be covered and/or guarded at all times to prevent accidental contacts with live parts. Any unguarded electrical devices shall be immediately corrected by guarding or disconnecting the power source.
- Barricades shall be used in conjunction with safety signs to prevent or limit access to work areas containing live parts. Conductive barricades shall not be used where they might cause an electrical hazard. Barricades shall be placed no closer than the limited approach boundary.
- If signs and barricades do not provide sufficient protection, an attendant will be assigned to warn and protect pedestrians. The primary duty of the attendant shall be to keep unqualified persons out of the work area where an electrical hazard exists. The attendant shall remain in the area as long as there is a potential exposure to electrical hazards.
9. Working on Live Energized Parts

The only time that work is allowed on live energized parts is when the employer can demonstrate one of the following:

- De-energizing introduces additional or increased hazards.
- De-energizing is not possible due to equipment design or operational limitations.
- Live parts are operating at less than 50 volts to ground and there is no increased exposure to electrical burns or to explosion due to electrical arcs.

Only qualified persons may work on energized electrical equipment. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.

- Energized electrical work shall only be performed after a written energized electrical work permit has been completed. (Appendix D)
  - The Energized Work Permit shall be reviewed and signed by the Department Supervisor / Manager and another Qualified Person before live work is conducted.
  - Exception: An energized electrical work permit is not required for work performed on or near live parts by qualified persons related to tasks such as testing, troubleshooting and voltage measuring when appropriate safe work practices and personal protective equipment are provided and used.

- Testing to ensure the absence of voltage involves a three-step process: Testing the tester, testing the circuit, and then re-test the tester.

- No employee may enter spaces containing exposed energized parts unless authorized, trained, and wearing the required PPE.

- Employees performing electrical work are not permitted to wear clothing that melts as it burns, (e.g. polyester, rayon, or any other synthetic material).

- Conductive articles of jewelry and clothing (e.g. watch bands, bracelets, rings, necklaces) may not be worn.

10. Arc Flash Risk Assessment Methods

Arc flash hazards must be evaluated for the purpose of selecting the appropriate PPE, and for establishing an arc flash boundary. There are two methods for determining the approach distances (arc flash boundary) and arc rated PPE required for energized work: the Incident Energy (IE) Analysis Method and the Arc Flash Categories Method (Table Method). The IE method is preferred.
1. **Incident Energy Analysis Method.** This method is based on detailed calculations under engineering supervision, often with the aid of specialized software, to determine the maximum potential incident energy exposure in calories per square centimeter (cal/cm²). Once the incident energy exposure is calculated, the required arc flash boundary can be determined and the appropriate arc rated protective clothing can be specified.

2. **Arc Flash PPE Category Table Method.** Determine the hazard level of the task by referring to the most current version of NFPA 70E Table 130.7(C)(15)(a) for AC current applications, or 130.7(C)(15)(b) for DC current applications “AF Hazard Categories” (Appendix A & B). Once the hazard level of the task has been determined, the required PPE can be ascertained from the NFPA 70E Table 130.7(C)(15)(c), “Protective Clothing and PPE Matrix” (Appendix C).

### 11. Personal Protective Equipment (PPE)

Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment that helps to protect the worker from electrical shock and arc flash hazards. All employees shall wear their assigned PPE when performing electrical work, and additionally in accordance with their departmental guidelines during work hours.

- The PPE shall be designed and constructed for the specific part of the body to be protected and for the work to be performed.
- **Shock protection:** The appropriate nonconductive protective PPE shall be selected and used to protect the electrical worker from injury due to electrical shock from live parts.
  - For example, voltage rated gloves are required to protect the hands from possible electric shock while testing an electrical component for the presence of voltage.
- **Arc flash protection:** The appropriate flame-resistant PPE shall be selected and used to minimize the thermal effects of an electrical arc flash on the electrical worker.
  - Arc flash PPE is based on categories 1 through 4, and shall be selected based on the PPE matrix listed in Appendix C.
  - Arc flash PPE will be inspected per the NFPA 70E guidelines. All PPE will be inspected prior to use by trained personnel. All rubber gloves will be inspected (or replaced) every 6 months by a certified vendor to ensure proper condition.
  - Determine the distance for the Arc Flash, Limited, and Restricted approach boundaries.
    - Any work within Restricted Approach Boundary is limited to a qualified person.
- Any work within the Limited Approach Boundary is limited to a qualified person, or an unqualified person if accompanied by a qualified person.
- Any work within the Flash Protection Boundary must be done with the appropriate arc flash PPE until the conductor or live part has been placed in and Electrically Safe Work Condition.

12. Training

The level of electrical safety training provided is dependent on whether the employee is classified as a “qualified” or “unqualified” person.

Employees who work in environments with electrical equipment will complete computer based training, ICON course Electrical Safety - W517OS. An unqualified person shall be trained in the inherent hazards of electricity and any related work practices that are necessary for their safety. This training is considered an awareness level of training.

Employees who reset electrical breakers will complete the ICON course Electrical Panel Breaker Resetting - W534OS.

All Qualified electrical employees will complete Arc Flash Hazard Training prior to being exposed to electrical hazards and a refresher every 3 years. This training will include the process necessary to determine the degree and extent of electrical hazards along with the PPE and job planning necessary to perform the task safely.

Training records are kept by each department.
## Appendix A - Arch Flash Hazard Identification AC Systems

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Arc Flash PPE Category</th>
<th>Arc-Flash Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panelboards or other equipment rated 240 V and below</td>
<td>1</td>
<td>485 mm (19 in.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kva short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panelboards or other equipment rated &gt;240 V and up to 600V</td>
<td>2</td>
<td>900 mm (3 ft.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 25 kva short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600 –V class motor control centers (MCCs)</td>
<td>2</td>
<td>1.5 m (5 ft.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 65 kva short-circuit current available; maximum of 0.03 sec 2 cycles) fault clearing time; working distance 455 mm 18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600 –V class motor control centers (MCCs)</td>
<td>4</td>
<td>4.3 m (14 ft.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 42 kva short-circuit current available; maximum of 0.33 sec 20 cycles) fault clearing time; working distance 455 mm 18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600 –V switchgear (with circuit breakers or fused switches) and 600 V class switchboards</td>
<td>4</td>
<td>6 m (20 ft.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 35 kva short-circuit current available; maximum of 0.05 sec (30 cycles) fault clearing time; working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other 600 –V class (277 V through 600V, nominal) equipment</td>
<td>2</td>
<td>1.5 m (5 ft.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 65 kva short-circuit current available; maximum of 0.03 sec (2 cycles) fault clearing time; working distance 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV</td>
<td>4</td>
<td>12 m (40 ft.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 35 kva short-circuit current available; maximum of 0.24sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal-clad switchgear, 1kV through 15 kV</td>
<td>4</td>
<td>12 m (40 ft.)</td>
</tr>
<tr>
<td>Parameters: Maximum of 35 kva short-circuit current available; maximum of 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arc-resistant switchgear Type 1 or 2 (for clearing times of &lt;0.5 sec (30 cycles) with a perspective fault current not to exceed the arc-resistant rating of the equipment) and metal enclosed interrupter switch gear, fused or unfused of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, 1kV through 15 kV</td>
<td>N/A (doors closed)</td>
<td>N/A (doors closed)</td>
</tr>
<tr>
<td>Parameters: Maximum of 35 kva short-circuit current available; maximum of 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other equipment 1kV through 15 kV</td>
<td>4 (doors open)</td>
<td>12 m 40 ft.</td>
</tr>
<tr>
<td>Parameters: Maximum of 35 kva short-circuit current available; maximum of 0.24 sec (15 cycles) fault clearing time; working distance 910 mm (36 in.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See Table 130.7(C)(15)(a) in NFPA 70E for complete chart and mandatory notes.
## Appendix B – Arch Flash Hazard Identification DC Systems

Selected* Arc Flash Hazard PPE Categories and Boundary Chart

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Arc Flash PPE Category</th>
<th>Arc-Flash Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Storage Batteries, dc switchboards, and other dc supply sources</strong>&lt;br&gt;100V &gt; Voltage &lt; 250 V&lt;br&gt;Parameters:&lt;br&gt;Voltage: 250 V&lt;br&gt;Maximum arc duration and working distance: 2sec @ 455 mm (18 in.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-circuit current &lt;4kA</td>
<td>1</td>
<td>900mm (3 ft.)</td>
</tr>
<tr>
<td>4kA ≤ short-circuit current &lt; 7kA</td>
<td>2</td>
<td>1.2 m (4 ft.)</td>
</tr>
<tr>
<td>7kA ≤ short-circuit current &lt;15 kA</td>
<td>3</td>
<td>1.8 m (6 ft)</td>
</tr>
</tbody>
</table>

| **Storage Batteries, dc switchboards, and other dc supply sources**<br>250V > Voltage < 600 V<br>Parameters:<br>Voltage: 250 V<br>Maximum arc duration and working distance: 2sec @ 455 mm (18 in.) | | |
| Short-circuit current < 1.5 kA | 1 | 900mm (3 ft.) |
| 1.5 kA ≤ short-circuit current < 3kA | 2 | 1.2 m (4 ft.) |
| 3 kA ≤ short-circuit current < 7kA | 3 | 1.8 m (6 ft) |
| 7 kA ≤ short-circuit current < 10kA | 4 | |

* See Table 130.7(C)(15)(b) in NFPA 70E for complete chart and mandatory notes.
Appendix C - Protective Clothing and PPE Matrix

PPE is designated by the PPE category, driven by a minimum Arc rating (1-4).

(AN) = As Needed. (AR) = As Required. (SR) = Selection Required

Category 1  (1.2 cal/cm² up to a minimum of 4 cal/cm².
Minimum PPE’s required for this includes the following:
- Arc-rated long-sleeve shirt and pants or arc-rated coverall.
- Arc-rated face shield or arc flash suit hood.
- Arc-rated jacket, parka, rainwear, or hard hat liner (AN).
- Hard Hat.
- Non-Conductive Safety Glasses or Safety Goggles. (SR)
- Hearing Protection, (ear canal inserts).
- Heavy Duty leather gloves.
- Safety toed Leather footwear. (AN).

Category 2  (4 cal/cm² up to a minimum of 8 cal/cm².
Minimum PPE’s required for this includes the following:
- Arc-rated long-sleeve shirt and pants or arc-rated coverall.
- Arc-rated flash suit hood or arc-rated face shield and arc-rated balaclava.
- Arc-rated jacket, parka, rainwear, or hard hat liner (AN).
- Hard Hat.
- Non-Conductive Safety Glasses or Safety Goggles. (SR).
- Hearing Protection (ear canal inserts).
- Heavy Duty leather gloves.
- Safety toed Leather footwear.

Category 3  (8 cal/cm² up to a minimum of 25 cal/cm²).
Minimum PPE’s required for this includes the following:
- 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.
- Arc-rated jacket, parka, rainwear, or hard hat liner. (AN)
- Hard Hat.
- Non-Conductive safety glasses or safety goggles. (SR).
- Hearing Protection (ear canal inserts).
- Safety toed Leather footwear.
**Category 4** (25 cal/cm² up to a minimum of 40 cal/cm²).

Minimum PPE’s required for this includes the following:

- 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.
- Arc-rated jacket, parka, rainwear, or hard hat liner. (AN)
- Hard Hat.
- Non-Conductive Safety Glasses or Safety Goggles. (SR)
- Hearing protection (ear canal inserts).
- Safety toed Leather footwear.

(AN) = As Needed. (AR) = As Required. (SR) = Selection Required

* See Table 130.7(C)(15)(c) in NFPA 70E for complete chart and mandatory notes.
Appendix D – Energized Electrical Work Permit

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**To be completed by the qualified person(s) completing the work**

- Description of safe work practices to be employed:
- Voltage exposure (shock hazard analysis):
- Determination of shock protection boundaries:
- Results of flash hazard analysis:
- Determination of flash protection boundaries:
- Arc Flash PPE Category (1, 2, 3 or 4) required to safely perform the task:
- Method used to restrict access to the work area:

Do you agree the above work can be done safely? **YES** (proceed to approval) **NO** (return to requestor)

Qualified Person(s) (not the approver below): ___________________________ Date: ________

**Approvals**

- Risk Assessment performed by: ___________________________ Date: ________
- Qualified Person: ___________________________ Date: ________
- Department Supervisor/Manager: ___________________________ Date: ________