

Electrical Safety Program

Electrical hazards are a risk in many industries, but particularly manufacturing. Avoiding electrical shocks in the workplace and on work sites requires awareness of the hazards and a respect for this deadly threat. While people make excellent conductors for electricity, the human body does not respond well when electricity passes through it. Physical results include thermal burns, disruption of normal heart activity, severe muscle contractions and even death.

United Heartland has developed a sample electrical safety program our customers can use to help ensure proper precautions are taken when their employees deal with electrical equipment or electrical sources on the job.

Our safety evaluations, reports and recommendations are made solely to assist your organization in reducing hazards and the potential of hazards and accidents. These recommendations were developed from conditions observed and information provided at the time of our visit. They do not attempt to identify every possible loss potential, hazard or risk, nor do they guarantee that workplace accidents will be prevented.

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Additional Electrical Safety Resources from OSHA

- **Working Safety with Electricity:** https://www.osha.gov/OshDoc/data_Hurricane_Facts/elect_safety.pdf
- **Lockout/Tagout Fact Sheet:** https://www.osha.gov/OshDoc/data_General_Facts/factsheet-lockout-tagout.pdf
- **Control of Hazardous Energy:** <https://www.osha.gov/SLTC/controlhazardousenergy/>
- **Electrical Information:** <https://www.osha.gov/SLTC/electrical/index.html>
- **Best Practices for Arc Exposures:** https://www.osha.gov/SLTC/etools/electric_power/ppe_bestpracticesforarc.html

I. Introduction

As part of your organization's overall safety and health program, an electrical safety program has been established. The program is designed to assist in compliance with Occupational Safety and Health Administration's (OSHA) Electrical Training, Selection and Use of Work Practices, Use of equipment, and Safeguards for personnel protection standards, 29 CFR 1910.332 – 1910.335.

II. Objective

To establish minimum requirements to prevent injury to personnel working on or near exposed energized parts of electrical equipment and to achieve compliance with OSHA final rule 1910 Subpart S. Our intention is to comply with the final rule and raise the awareness level of electrical hazards in the workplace or home, for all organization employees.

- Teaches supervisors and employees how to perform job tasks correctly
- Helps determine cause of an accident after one has occurred
- Improves production efficiency by identifying incorrect procedures
- Increases employee involvement
- Enhances communication between management and employees regarding safety concerns
- Reduces employee injuries and lost work days
- Lowers workers' compensation loss costs

III. Scope

This program applies to employees engaged in maintenance and repair of electric utilization systems, including electric equipment and installations used to provide electric power and light for employee workplaces. It also applies to employees who may be exposed to unguarded electrical installations. It does not apply to OSHA's 29 CFR 1910.269 - Electric Power Generation, Transmission, and Distribution.

IV. Definitions

- **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. Examples of safety training include, but are not limited to, training in the use of special precautionary techniques, personal protective equipment, including arc flash, insulating and shielding materials, and insulated tools and test equipment. A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others.
- **Unqualified Person** – Those with little or no training working on, near, or with electrical wiring or optical fiber cable (where such installations are made along with electrical conductors).

V. General Requirements

This procedure, including the training requirements, applies to both qualified and unqualified persons who work on, near, or with exposed energized parts. This procedure applies only when energized parts are exposed (i.e., not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308) and only to exposed energized parts operating at 50 volts or more.

Work excluded from the provisions of this procedure for qualified persons includes:

- Generation, transmission and distribution installations
- Communications installations
- Installations in vehicles
- Railway installations

Only persons who have the skills, knowledge, and required training (including task specific training) are considered “qualified” and may work on or near any circuit parts or equipment that have not been de-energized. These qualified persons must:

- Be capable of working safely on energized circuits
- Be familiar with the proper use of special precautionary techniques
- Know how to select, use and inspect appropriate personal protective equipment
- Know how to use insulating and shielding materials
- Understand the proper selection and use of insulated tools

VI. Training

Training is required for both qualified and unqualified persons who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308. Training shall be in a classroom setting and/or on the job. The degree of training provided shall be determined by the risk to the employee. Training must be documented.

Training of qualified persons must include at the minimum the following:

- The safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments
- The ability to distinguish live parts from other parts of electrical equipment
- The ability to determine the nominal voltage of live parts
- The knowledge of clearance and/or approach distances when working on or near exposed energized parts, as described in 1910.333 (c)

Training of unqualified persons must include at the minimum the following:

- The safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments
 - The inherent hazards of electricity, such as high voltage, electric current, arcing, grounding and lack of guarding
 - Any electrically related safety practices not specifically addressed by 1910.331 through 1910.335 that pertain to their respective job assignments
 - It is recommended that all employees receive unqualified person training during the new hire orientation process
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VII. Selection and Use of Work Practices

Live electrical parts are to be put into an electrically safe work condition before a potentially exposed employee works on them unless:

- The employer can demonstrate that de-energizing introduces additional or increased hazards. Examples include:
 1. Interruption of life-support equipment
 2. Deactivation of emergency alarms systems
 3. Shutdown of hazardous-location ventilation equipment
 4. Removal of illumination for an area
- The employer can demonstrate that de-energizing is infeasible due to equipment design or operational limitations. Examples of work that may be performed because of infeasibility include:
 1. Testing of electric circuits that can only be performed with the circuit energized (troubleshooting)
 2. Work on circuits that form an integral part of a continual industrial process
- De-energized parts require lockout/tagout accordance with 1910.333 and 1910.147 as well as the lockout/tagout program, unless otherwise exempted.

An electrically safe work condition will be achieved when utilizing the energy control procedure and verified by the following process:

- Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams and identification tags.
 - After properly interrupting the load current, open the disconnecting device(s) for each source.
 - 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.
 - Apply lockout/tagout devices in accordance with local lockout procedure.
 - Use an adequately rated voltage detector to test each phase conductor or circuit part to verify they are de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before the test, determine that the voltage detector is operating properly. When used on 600v and above the voltage detector must be tested before and immediately after each test.
 - Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.
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If live electrical parts are not placed in an electrically safe work condition (i.e., for the reasons of increased or additional hazards or infeasibility), then work being performed shall be considered energized electrical work and shall be performed by written permit only - see Energized Work Permit at end of document.

Work performed on or near live parts by qualified persons related to tasks, such as testing, troubleshooting and voltage measuring, shall be permitted to be performed without an energized work permit, provided appropriate safety work practices and proper personal protective equipment is utilized.

Only qualified persons shall be allowed to work on energized parts or equipment.

If work is to be performed near overhead lines (inside or outside of a building), the lines and ground must be de-energized or other protective measures must be taken, such as guarding, isolation or insulation. Minimum distances for qualified and unqualified persons and vehicles are described in 1910.333 (c) (3). Under no circumstances may an unqualified person come within 10 feet of overhead lines (and greater in some instances).

Appropriate illumination must be provided for employees who work on exposed energized parts. At a minimum 300 lux / 30 footcandles should be maintained in the task work area. However, additional lighting may be required for more detailed tasks. This can be obtained by a combination of general lighting plus specialized supplementary lighting.

Conductive materials and equipment that are in contact with any part of an employee's body shall be handled in a manner that will prevent them from contacting exposed energized parts (conduit, piping, jewelry, cloth with conductive thread, metal headgear, etc.).

Portable ladders (metal) may not have conductive side rails where the employee or the ladder could contact exposed energized parts.

Cleaning and the use of electrically conductive cleaning materials (steel wool, metalized cloth, conductive liquids, etc.), may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.

Only a qualified person may defeat an electrical interlock, and then only temporarily and when following the requirements under 1910.333 (c).

Note: Defeating interlocks is only allowed by a qualified person and only for calibrating or troubleshooting equipment.

VIII. Use of Equipment

Cord and plug-connected equipment, including extension cords:

- Shall be handled in a manner which will not cause damage, such as raising and lowering by the flexible cord, or fastening extension cords with staples
- Shall be visually inspected before each use, and if damaged, removed from service
- Shall be approved for high-conductive (wet, etc.) work locations where required. Employees' hands may not be wet when plugging and unplugging equipment
- A ground fault circuit interrupter must be used when (1) using an electric powered hand tool with an extension cord; (2) in a wet location

Load rated switches, circuit breakers, or the equivalent (load-break type) shall be designed for opening, closing, and reversing circuits under load conditions.

When a circuit is de-energized by a circuit protection device, the circuit may not be manually re-energized until it has been determined it can be done so safely (unless the design allows it to be determined an overload condition rather than a fault condition).

Overcurrent protection of circuits and conductors may not be modified, even on a temporary basis.

Only qualified persons may perform testing work on electrical circuits or equipment. Test instruments shall be visually inspected before use (over 600v the equipment must be checked before and immediately after the test) and shall be rated and designed for their use.

IX. Safeguards for Personal Protection

Electrical protective equipment shall be provided and used when necessary such as non-conductive headgear, eye or face protection where electric arcs or flashes or flying objects may be present, insulated tools and handling equipment, protective barriers and insulating materials, etc.

Employees shall wear flame-resistant (FR) clothing wherever there is possible exposure to an electric arc flash above the threshold incident-energy level for a second-degree burn 5 J/cm² (1.2 cal/cm²).

To determine which level of personal protection is necessary, employees should refer to the electrical equipment on which they will be working. The label on the equipment or the applicable tables in NFPA 70 E will specify the level of PPE required. The requirements follow below:

Arc Flash PPE Category	Required PPE
0 – see red note on next page	Flame-resitant (FR) shirt – Long sleeve FR pants Safety glasses
1	FR shirt – Long-sleeve (see note 1) FR pants (see note 1) Hard hat Safety glasses Leather gloves (see note 2)
2	Non-melting or natural fiber T-shirt Non-melting or natural fiber long pants FR shirt – Long-sleeve FR pants Hard hat with arc-rated face shield or flash suit hood Safety glasses or safety goggles Hearing protection Leather gloves (see note 2) Leather shoes
3	Non-melting or natural fiber T-shirt Non-melting or natural fiber long pants FR shirt – long-sleeve FR pants FR coverall Flash suit hood Hearing protection Hard hat Safety glasses or safety goggles Leather gloves (see note 2) Leather shoes

! WARNING
Arc Flash and Shock Hazard
Appropriate PPE Required

35 inch	Flash Hazard Boundary
3.5 cal/cm ²	Flash Hazard at 18 inches
Category 1	FR Shirt & Pants + Arc-Rated Face Shield & Hearing Protection
480 VAC	Shock Hazard when cover is removed
00	Glove Class
42 inch	Limited Approach
12 inch	Restricted Approach
1 inch	Prohibited Approach

Bus: B CASTER MCC1 Prot: USS12-12

Please note: The new 2015 edition of NFPA70E has determined the labels must now contain all of the following information:

- Nominal system voltage
- Arc flash protection boundary
- At least one of the following:
 1. Incident energy at corresponding distance
 2. Minimum arc rating of clothing
 3. Site specific level of PPE
 4. PPE selected using 70E tables

Arc Flash PPE Category	Required PPE
4	Non-melting or natural fiber T-shirt Non-melting or natural fiber long pants FR shirt - Long-sleeve FR pants Flash suit (multilayer) Flash pants (multilayer) Flash suit hood Hearing protection Hard hat Safety glasses or safety goggles Leather gloves (see note 2) Leather shoes

Note 1 - Alternate is to use FR coveralls (minimum arc rating of 4) over non-melting or untreated natural fiber pants and T-shirt.

Note 2 - If voltage-rated gloves are required, the leather protectors worn external to the rubber gloves satisfy this requirement.

Please note: The new 2015 edition of NFPA70E has removed Hazard Risk Category (HRC) 0 from the above chart. It is believed to be the standard everyday work wear for employees performing electrical related work practices. We have left it in as a reminder for employers to protect employees from explosions and similar hazards when interacting with electrical equipment without direct exposure to energized parts, i.e. switching on/off breakers with equipment doors on. The old Hazard Risk Category (HRC) is being replaced with the words Arc Flash PPE Categories.

It is critical when selecting the appropriate PPE that at a minimum all required elements of the level are worn. In addition, it is necessary to add the arc thermal protective value (ATPV) rating for each layer of clothing to ensure that it exceeds the arc flash rating on the equipment.

Voltage-rated gloves shall be worn when ever the prohibited approach boundary will be crossed. They shall be rated adequately for the task, and be provided with leather over protection.

- Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested as required by 1910.137.
- Safety signs, tags, barricades and attendants shall be used as necessary to warn and protect employees from electrical hazards.

It is recommended that signs reading “WARNING: Arc Flash and Shock Hazard Appropriate PPE Required” be posted on all individual machine panels, power distribution panels, and unit substations, distribution panels, and plant switch gears that are likely to require examination, adjustment, servicing or maintenance while energized to warn qualified persons of the potential electric arc flash hazards.

X. Limits of Approach and Arc Flash Hazard Analysis

Observing a safe approach distance from exposed energized electrical conductors or circuit parts is an effective means of maintaining electrical safety. As the distance between a person and the exposed energized conductors or circuit parts decreases, the potential for electrical accident increases.

Limits of Approach Definitions (See Illustration 1 and Table 1-1)

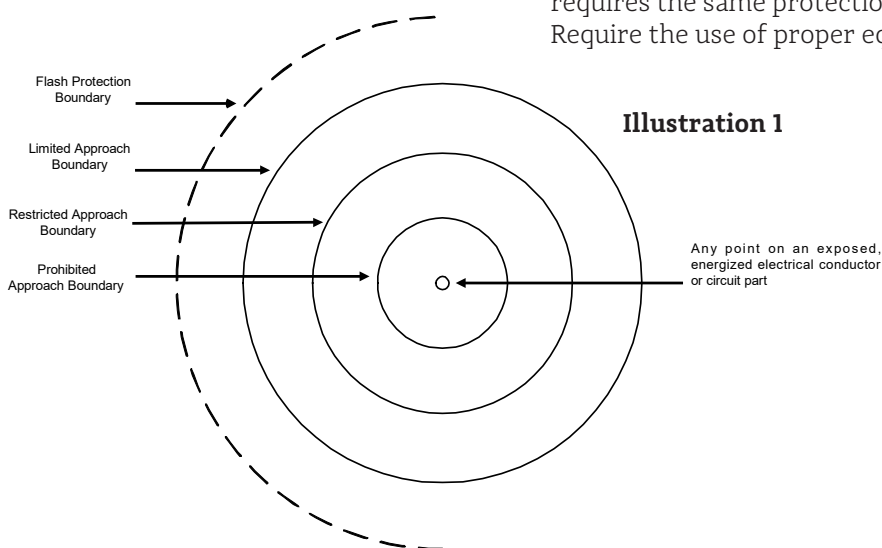
- **Flash Protection Boundary (FPB)** – A boundary to be crossed only with appropriate personal protective equipment to protect against electrical arc flash. The boundary is nominally located at a distance from the energized parts where the incident energy from an anticipated arc is reduced to 1.2 cal / cm². For systems less than 600V, the boundary is 4 feet unless a flash hazard analysis has been performed.

Persons not considered electrically qualified (unqualified), as defined in this document, may enter the FPB but shall not be allowed to perform tasks within the FPB. Unqualified persons must not cross the FPB unless they are wearing appropriate personal protective clothing and are under the close supervision of a qualified person.

- **Limited Approach Boundary (LAB)** – An unqualified person may cross the limited approach boundary only when continuously escorted by a qualified person and wearing proper PPE. Again, an unqualified person may not perform any tasks within the LAB.
- **Restricted Approach Boundary (RAB)** – A shock protection boundary to be crossed by only electrically qualified persons (at a distance from an energized part see table 1-1) which, due to its proximity to a shock hazard, require the use of shock protection techniques and equipment. Qualified employees crossing the restricted approach boundary must have an Energized Work Permit, use appropriate PPE, and keep the body out of the prohibited space and maintain proper body position.

Under no circumstance may an unqualified person cross into the RAB.

- **Prohibited Approach Boundary** – A shock protection boundary to be crossed by only electrically qualified persons (at a distance from an energized part see Table 1-1) which, when crossed by a body part or object, requires the same protection as if direct contact is made with a live part. Require the use of proper equipment, PPE and an Energized Work Permit.



Voltage Phase to Phase	Limited Approach Boundary Exposed Fixed Part	Limited Approach Boundary Exposed Movable Part	Restricted Approach Boundary	Prohibited Approach Boundary
0 to 50	Not specified	Not specified	Not specified	Not specified
51 to 300	3 feet 6 inches	10 feet	Avoid contact	Avoid contact
301 to 750	3 feet 6 inches	10 feet	1 foot	1 inch
751 to 15 kV	5 feet	10 feet	2 feet 2 inches	7 inches
138 kV to 145 kV	10 feet	11 feet	3 feet 7 inches	3 feet 1 inch
230 kV to 242 kV	13 feet	13 feet	5 feet 3 inches	4 feet 9 inches

An arc flash hazard analysis shall be done on order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection Boundary and the personal protective equipment that people within the FPB will use. Arc flash hazard analysis should be done before a person approaches any exposed electrical conductor or circuit part that has not been placed in an electrically safe work condition.

The recommended arc flash analysis method will be IEEE Std. 1584.

XI. High Voltage

High voltage is any voltage greater than 600 volts nominal or greater than 300 volts to ground. Additionally, power supplies with low voltage, high current (greater than 50 amps) shall be considered high voltage.

The minimum clear working space in front of electric equipment such as switchboards, control panels, switches, circuit breakers, motor controllers, relays and similar equipment may not be less than specified in Table 1-2.

Nominal voltage to ground	Conditions ^{2a} (ft)		
	(a)	(b)	(c)
601 to 2,500	3	4	5
2,501 to 9,000	4	5	6
9,001 to 25,000	5	6	9
25,001 to 75kV ^{1a}	6	8	10
Above 75kV ^{1a}	8	10	12

1a. Minimum depth of clear working space in front of electric equipment with a nominal voltage to ground above 25,000 volts may be the same as for 25,000 volts under Conditions (a), (b), and (c) for installations built prior to April 16, 1981.

2a. Conditions (a), (b), and (c) are as follows: (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 materials. Insulated wire or insulated busbars operating at not over

electrical safety practices and direct you to additional training resources. Contact your United Heartland Loss Control representative to discuss your current needs or explore the United Heartland Toolbox at www.unitedheartland.com/united-heartland-toolbox/ to find more loss control resources.

300 volts are not considered live parts. (b) Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces. (c) Exposed live parts on both sides of the workspace not guarded as provided in Condition (a) with the operator between.

There shall be a written procedure for common tasks involving high voltage. These tasks can include voltage measurements, circuit disconnection by fuse cutouts, inspection of high voltage cable, etc. The procedure should include preparation for work, PPE requirements, steps to perform the task, special tools or instruments required, etc.

A mandatory job meeting must be conducted to plan and review the required work and the procedures to perform the work. This meeting should include a supervisor and those who will be involved in the work.

A minimum of two people (buddy system) will be required when performing any tasks that involve high voltage.

Exceptions would include:

- Routine switching of circuits, if the plant can demonstrate that conditions at the site allow this work to be performed safely.
- Work performed with live-line tools if the employee is positioned so that they are neither within reach of nor otherwise exposed to contact with energized parts.
- Emergency repairs to the extent necessary to safeguard the general public.

A list should be developed and maintained of equipment that operates or have components that operate or have the potential of over 600 volts. Examples of equipment are: switchgears, motor control centers, power factor correction capacitors, unit substations and primary switches.

Training

All employees that can be involved in the maintenance of equipment with high voltage as defined above shall be trained on the hazards and proper work practices. Low voltage safety training is a prerequisite before an employee can receive high voltage training.

Training should include the following areas:

- Dangers associated with high voltage that is not usually a problem with voltages less than 600 volts
- Testing methods
- Performance of voltage checks
- Dangers of induced voltages and currents
- Safety grounds
- Workspace around equipment
- Buddy system
- PPE requirements and how
- to determine proper PPE and available PPE
- Work planning and job meetings
- Levels of high voltage available within the plant
- Review of the plant power distribution one line diagram

High voltage re-training must be provided annually.



Attachment A Energized Work Permit

(To be completed by the Qualified Employee and submitted for approval)

Person(s) Performing the Job: _____

Date: _____

Time: _____ to _____

Description of the circuit and equipment to be worked on and location:

Why is it necessary to perform the work with the equipment energized?

RESULTS OF SHOCK HAZARD ANALYSIS					Voltage: _____
Check appropriate voltage level Nominal System Voltage	Limited Approach Boundary		Restricted Approach Boundary	Prohibited Approach Boundary	
	Exposed Moveable Conductor	Exposed Fixed Circuit Part			
Less than 50V	Not Specified	Not Specified	Not Specified	Not Specified	Not Specified
50 to 300V	10 ft 0 in.	3 ft 6 in.	Avoid Contact	Avoid Contact	
301 to 750V	10 ft 0 in.	3 ft 6 in.	1 ft 0 in.	0 ft 1 in.	
751 to 15kV	10 ft 0 in.	5 ft 0 in.	2 ft 2 in.	0 ft 7 in.	
46.1kV to 72.5kV	10 ft 0 in.	8 ft 0 in.	3 ft 3 in.	2 ft 1 in.	

RESULTS OF FLASH HAZARD ANALYSIS				
Flash Protection Boundary: _____ ft / inches				
Incident Energy Exposure: _____ cal/cm ² @ _____ inches				
PPE Required				
Check required PPE	Min. arc rating (cal/cm ²)		Min. arc rating (cal/cm ²)	
_____ FR Shirt	_____		_____ Multi-Layer Flash Suit	_____
_____ FR Pants	_____		_____ FR Face Shield	_____
_____ FR Coveralls	_____		_____ Multi-Layer Switching Hood	_____
_____ Hearing Protection	NA			

How will non-qualified or affected personnel be kept beyond the Limited Approach Boundary?
 Check those protective measures to be used:
 _____ Barricades _____ Barriers _____ Lookout

List the step-by-step outline of the work and safe work practices employed:

Signatures of attendees at the Job Briefing, which included identification of job specific hazards:

Approvals:	Date:
Crew Manager _____	_____
Maintenance Manager _____	_____
Power Eng. / Eng. Manager _____	_____
Safety Department _____	_____