INDIANA UNIVERSITY

OFFICE OF THE EXECUTIVE VICE PRESIDENT
FOR UNIVERSITY ACADEMIC AFFAIRS

University Environmental Health and Safety

# Electrical Safety Program

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## 1. INTRODUCTION

### 1.1. Purpose

Indiana University Environmental Health and Safety (IUEHS) has developed the Electrical Safety Program to protect employees from the hazards associated with electricity by establishing the minimum requirements for electrical safety at Indiana University. This Program is also intended to ensure compliance with all applicable requirements specified by the Occupational Safety and Health Administration (OSHA) standards contained within 29 CFR 1910 Subpart S, 137, and 269.

### 1.2. Scope

This Program applies to all Indiana University employees, and covers all electrical equipment (e.g. machinery, tools, equipment, and circuit parts), which due to their nature of operation and/or design, possess inherent hazards from electricity. This Program does not apply when:

1.2.1. Indiana University does not own the electrical equipment (e.g. machinery, tools, and circuit parts) responsible for creating the hazard, and by contract or through actual practice, does not have the authority to correct or mitigate the hazard.

## 2. AUTHORITY AND RESPONSIBILITY

**2.1. University Environmental Health and Safety (IUEHS)** is responsible for:

2.1.1. Developing the Electrical Safety Program and revising the Program as appropriate;
2.1.2. Performing audits of safety-related work practices, procedures, and records as specified in this Program;
2.1.3. Assisting departments with training and the selection of personal and other protective equipment upon request; and
2.1.4. Investigating occupational injuries related to electricity.

**2.2. Departments** are responsible for:

2.2.1. Ensuring that any electrical equipment (e.g. machinery, tools, or circuit parts) that is specified, purchased, and/or installed by the department meets the minimum requirements of this Program (i.e. including the means and methods to permanently label applicable equipment);
2.2.2. Ensuring that electrical equipment that is under the control or responsibility of the department is maintained, labeled, and guarded in accordance with this Program, as well as maintaining all related hazard analysis documentation;
2.2.3. Establishing a hazard/risk assessment procedure as specified in this Program (i.e. if qualified work is performed by the department as defined in this Program), and revising the procedure as necessary to ensure a safe work environment for all employees;

2.2.4. Designating a qualified representative or committee to review and approve energized electrical work permits (i.e. if work is performed on energized electrical equipment operating at 50V or higher);
2.2.5. Providing and maintaining personal and other protective equipment as applicable in accordance with this Program;
2.2.6. Disciplining employees who violate the requirements of this Program;
2.2.7. Ensuring that employees receive training appropriate to their assigned electrical tasks and maintaining documentation of the training in accordance with this Program;
2.2.8. Cooperating with IUEHS audits related to electrical work-practices, procedures, and records;
2.2.9. Providing employees with access to applicable standards and regulations (e.g. NFPA 70E, NFPA 70, etc.) as specified in this Program; and
2.2.10. Maintaining a list of all qualified electrical employees and job titles that are authorized to perform this work.

**2.3. Supervisors** are responsible for**:**

2.3.1. Ensuring that employees comply with all applicable requirements of this Program, and all other applicable federal, state, and local regulations regarding electrical safety;
2.3.2. Ensuring that employees have received training in accordance with this Program;
2.3.3. Removing employees immediately from hazardous work environments if alertness is compromised as specified in this Program.

**2.4. Employees** are responsible for:

2.4.1. Complying with this Program, and all applicable federal, state, and local regulations regarding electrical safety;
2.4.2. Following all appropriate safety-related work practices and procedures, including the use and selection of appropriate protective equipment and tools as specified in this Program.
2.4.3. Attending and completing all training required as specified in this Program.
2.4.4. Reporting safety-related concerns to the Supervisor immediately.
2.4.5. Performing pre-use inspections of personal and other protective equipment as specified in this Program;
2.4.6. Wearing appropriate clothing and attire as specified in this Program; and
2.4.7. Stop and reassess risk if changes in the job, task, or work conditions present new hazards to themselves, other employees, or bystanders.

## 3. PROGRAM ELEMENTS

### 3.1. General Requirements

Safety-related work practices, at a minimum, shall comply with this Program. Through proper planning and training, departments shall ensure that employees are prepared to anticipate, identify, and minimize electrical hazards during their assigned job duties.

### 3.2. Overview of Electrical Hazards

Safety-related work practices outlined in this Program shall be utilized when work is performed near or on equipment or circuits operating at greater than 50 volts when energized. Safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards. Electrical hazards include, but are not limited to:

3.2.1. *Electric Shock and Burns.* An electric shock occurs when electric current passes through the body. This can happen when touching an energized part. If the electric current passes across the chest or head, death can result. At high voltages, severe burns can result.

3.2.2. *Arc Flash Burns.* An electric arc flash can occur if a conductive object gets too close to energized parts (for instance, while opening or closing disconnects). The arc can heat the air to temperatures as high as 35,000° F, and vaporize metal in the equipment. The arc flash can cause severe skin burns by direct heat exposure and by igniting clothing.

3.2.3. *Arc Blast Impacts.* The heating of air and vaporization of metal creates a pressure wave that can damage hearing and cause memory loss (from concussion) and other injuries. Flying metal parts are also a hazard.

3.2.4. *Falls.* Electric shocks and arc blasts can cause falls, especially from ladders or unguarded scaffolding.

**3.3. Basic Program Principles**

Electricity can be dangerous without proper training, knowledge, and planning. This Program was developed based upon the following basic electrical safety principles:

3.3.1. *Prevention through Design.* Design and install equipment with safety in mind.

3.3.2. *Training.* Provide training to employees appropriate for their job.

3.3.3. *Planning.* Plan ahead and conduct pre-work briefings.

3.3.4. *Hazard Identification.* Identify hazards and assess risk.

3.3.5. *Minimize Hazards.* Use appropriate protective equipment and procedures.

3.3.6. *De-Energize.* Avoid work on energized parts and circuits when possible.

**3.4. General Design and Maintenance Requirements**

All electrical systems shall be designed, installed, and maintained in accordance to 29 CFR 1910.302, 29 CFR 1910.308, and NFPA 70E, Edition 2009, Article 205, 210, 215, 220, 225, 230, 235, and 240, and shall meet all other design and installation requirements specified within the applicable electrical code (e.g. Indiana Electrical Code). Departments may decide to adopt requirements specified in more recent editions of NFPA 70E; however, departments shall confirm that the adoption of these requirements or standards will not increase risk to employees (i.e. by introducing unfamiliar hazards or work methods).

**3.5. Working Space for Electrical Equipment**

Sufficient access and working space shall be incorporated and maintained around electric equipment to permit safe operation and maintenance of such equipment. Working space for equipment operating at 600 volts, nominal, or less to ground and likely to require examination, adjustment, services or maintenance while energized shall comply with the National Electrical Code (NEC), Article 110.26 and 29 CFR 1910.303. See Appendix B for general guidance regarding work space requirements.

### 3.6. Guarding of Electrical Parts

Energized electrical systems and components must be guarded to prevent damage and inadvertent contact with live conductors. The following requirements apply to the guarding of electrical equipment (See also the Indiana University Machinery and Machine Guarding Program for additional guarding requirements):

3.6.1. Live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact as specified in 29 CFR 1910.303.

3.6.2. In locations where electric equipment is likely to be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

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

3.6.4. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized electrical conductors or circuit parts operating at 50 volts or more (i.e. if movement of the object is likely to create a hazard).

### 3.7. Equipment Labeling and Hazard Analysis

As required by the NEC, Article 110.6, switchboards, panelboards, industrial control panels, motor control centers, and other electrical equipment that are likely to require examination, adjustment, servicing, or maintenance while energized, shall be field marked/labeled to warn qualified employees of potential shock and arc flash hazards (See Appendix C for label examples).

3.7.1. The marking (i.e. label) shall be located so as to be clearly visible to qualified employees before examination, adjustment, servicing, or maintenance of the equipment.

3.7.2. A temporary “DANGER” label shall be used on energized electrical equipment until a hazard analysis has been performed by a qualified person. Non-specific “DANGER” labels may not be used as permanent labeling.

3.7.3. At a minimum, temporary markings shall remind qualified employees that an electrical arc flash hazard exists, to turn off power before opening, and to follow all requirements for safe work practices and electrical protective equipment as specified in this Program.

3.7.4. After a hazard analysis (i.e. including the shock hazard analysis, arc flash analysis, and/or other approved methods) has been completed for electrical equipment by a qualified person in accordance with NFPA 70E (i.e. 2009 Edition or more recent), a permanent equipment label shall be affixed to the equipment which summarizes the shock and flash protection information. The results of an assessment performed by the qualified person shall be maintained on file by the applicable department, and the equipment label shall be updated when any major modification or renovation takes place.

3.7.5. When a hazard analysis has been completed for electrical equipment (as indicated above), labels shall, at a minimum, include the nominal system voltage, the arc flash protection boundary, the required PPE level, the limited approach boundary, the restricted approach boundary, and the prohibited approach boundary. Labels applied prior to the adoption of this Program are acceptable if they contain the nominal system voltage and either the available incident energy/working distance or required level of PPE. Other information such as available incident energy/working distance, minimum arc rating of

clothing, and the highest hazard/risk category (i.e. or arc flash PPE category) for the equipment may be included on labels moving forward; however, the incident energy/working distance and the hazard/risk category (i.e. or arc flash PPE category) may not be displayed on the same label.

## 3.8. Overview of Approach Boundaries

Approach boundaries are applicable where approaching employees may be exposed to uncovered energized electrical conductors or circuit parts operating at greater than 50 volts (See Appendix D for shock protection boundaries for lower voltage, alternating current (AC) electrical conductors or circuit parts). NFPA 70E defines three approach boundaries for shock hazards (i.e. the limited, restricted, and prohibited approach boundaries) and one for arc flash (i.e. the arc flash protection boundary). See the NFPA 70E, 2009 Edition, Table 130.2(C) for a larger range of nominal voltages. In some instances, the arc flash protection boundary might be a greater distance from the energized electrical conductors or circuit parts than the limited approach boundary. The shock protection boundaries and the arc flash boundary are independent of each other. The following provides an overview of these approach distances (See the "Qualified Work Requirements" section for additional requirements.):

3.8.1. *Limited Approach Boundary.* The limited approach boundary is the distance from an exposed live part within which a shock hazard exists. An unqualified employee must be advised of the hazards present and may not cross this boundary unless the person is escorted by a qualified employee. Insulated tools are required within this boundary. Where one or more unqualified persons are working at or close to the limited approach boundary, the persons shall be instructed to remain outside of the limited approach boundary (i.e. through training, verbally, or with signage).

3.8.2. *Restricted Approach Boundary.* The restricted approach boundary is closer than the limited approach boundary. The restricted approach boundary may only be crossed by qualified employees with an approved energized work permit and appropriate protective equipment as specified in this Program. Under no circumstance shall an unqualified person(s) be permitted to cross the restricted approach boundary. Inside this boundary, inadvertent movement can put a part of the body or conductive tools in contact with live parts. The restricted approach boundary may only be crossed by qualified employees with the proper protective equipment as specified in this Program.

3.8.3. *Prohibited Approach Boundary.* The prohibited approach boundary is closer than restricted approach boundary. The prohibited approach boundary is the distance to exposed live parts that by crossing this boundary is considered the same as making direct contact with a live part. The prohibited approach boundary may only be crossed by qualified employees with an approved energized work permit and appropriate protective equipment as specified in this Program.

3.8.4. *Arc Flash Protection Boundary.* The flash protection boundary is the distance from exposed live parts within which a person could be injured if an electrical arc flash were to occur. The arc flash protection boundary may only be crossed by qualified employees with an approved energized work permit and appropriate protective equipment as specified in this Program.

### 3.9. Overview of Qualified and Unqualified Work

Qualified electrical work involves work within the limited approach boundary of exposed, energized electrical conductors and circuit parts operating at 50 volts or higher. Qualified electrical work may only be performed by those trained and authorized (i.e. qualified) by the department to perform that work. Qualified electrical employees shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment (PPE), insulating and shielding materials, insulated tools, and any other applicable concepts applicable to their job function. Departments must maintain a list of all qualified electrical employees and job titles that are authorized to perform this work.

Unqualified electrical work, as it applies to this Program, might include using portable power tools, work on de-energized equipment, and work outside the limited approach boundary. As noted above, unqualified employees may enter the limited approach boundary of energized electrical equipment; however, the unqualified employee must be accompanied by a qualified employee and shall not enter the restricted approach boundary. Qualified and unqualified persons shall be trained in, and be familiar with, any electrical safety-related practices necessary for their safety. See the "Training" section of this Program for specific training requirements for qualified and unqualified persons. The scope and breadth of training for employees may vary widely depending on the tasks required of them during their employment.

### 3.10. Electrically Safe Work Conditions

Before an employee works within the limited approach boundary, energized electrical conductors to which an employee might be exposed shall be put into an electrically safe work condition by a qualified person. Establishing an electrically safe work condition for electrical equipment prior to working on exposed electrical parts is required unless:

3.10.1. De-energizing the equipment creates additional hazards or increased risk, such as the shutdown of life safety systems;
3.10.2. It can be demonstrated that the that the task, such as troubleshooting or testing, can only be performed on an energized system; or
3.10.3. The energized electrical conductors and circuit parts operate at less than 50 volts and it is determined that there will be no increased exposure to electrical burns or to explosion due to electrical arcs.

While any employee is exposed to contact with parts of fixed electric equipment or circuits, which have been de-energized, an electrically safe work condition must be established in accordance with this Program prior to the start of work. All electrical circuit conductors and circuit parts shall be considered energized until the source(s) of the energy is (are) removed, at which time they shall be considered de-energized. No bare-hand contact is to be made with exposed energized electrical conductors or circuit parts operating at 50 volts or more, unless the bare-hand method is properly used. All electrical conductors and circuit parts shall not be considered electrically safe until an electrically safe work condition is established by a qualified person as specified in the "Qualified Work Requirements" section of this Program.

Electrical conductors and circuit parts that have been disconnected, but have not been locked/tagged out; tested; and/or grounded (where appropriate), shall not be considered to be in an electrically safe work condition and safe work practices

appropriate for the circuit voltage and energy level shall still be used. Lockout/tagout requirements as specified by the Indiana University Control of Hazardous Energy Program shall apply to all fixed, permanently installed equipment and to temporarily installed equipment. Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work conditions (See the "Qualified Work Requirements" section of this Program for information regarding working within the limited approach boundary of exposed electrical conductors or circuits that may become energized.). Furthermore, only qualified persons shall perform testing of electrical circuits within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more. De-energizing an electrical conductor or circuit part and making it safe to work on is, in itself, a potentially hazardous task.

### 3.11. Securement of Electrical Equipment in Public Areas

All electrical equipment such as electrical panels and disconnects that are located in areas accessible to students and the general public (e.g. classrooms, hallways, etc) shall be closed and locked while not being used to discourage unauthorized access. Note: Locking a cover on electrical equipment to prevent unauthorized access should not be confused with the process of "locking out" a breaker or disconnect.

### 3.12. Underground Electrical Lines and Equipment

Before an excavation starts (e.g. installing fence posts, installing sign posts, planting trees, etc), departments shall take the necessary steps to contact the appropriate owners or authorities to identify and mark the location of the electrical lines or equipment. When it has been determined that a reasonable possibility for contacting electrical lines or equipment exists, a hazard/risk assessment as specified under the "Qualified Electrical Work Requirements" section of this Program shall be performed to identify the appropriate safe work practices to be used during the work.

### 3.13. Overhead Electrical Lines and Equipment

When unqualified persons are working on the ground or in an elevated position near uninsulated, overhead lines, the location shall be such that the employee and the longest conductive object the employee might contact do not come closer to any unguarded, energized overhead power line than the limited approach boundary as determined by a qualified person in accordance with Table 130.2(C), NFPA 70E, 2009 Edition. When work is to be performed within the limited approach boundary, the overhead lines shall be de-energized and visibly grounded or suitably guarded. A hazard/risk assessment as specified under the "Qualified Work Requirements" section of this Program shall be performed to identify the appropriate safe work practices to be used during the work. If the lines are to be de-energized, arrangements shall be made with the person or organization that operates or controls the electric circuits involved to de-energize and ground them.

If protective measures, such as guarding, isolating, or insulating, are provided, these precautions shall prevent employees from contacting such lines directly with any part of their body or indirectly through conductive materials, tools, or equipment. Work (i.e. including the operation and transit of vehicles and mechanical equipment) within the limited approach boundary of energized or de-energized overhead lines shall be performed in accordance with NFPA 70E, Edition 2009, Article 130.5 and 29 CFR 1910.333 as determined by a qualified person.

### 3.14. Wet or Damp Locations

Electrical work or use of electricity in wet or damp locations (i.e. areas surrounded or near water or other liquids) should be avoided. The following special precautions must be incorporated while performing work with electricity in wet or damp locations:

3.14.1. Dry barriers shall be placed over wet or damp work surfaces inside the limited approach boundary to prevent contact between electrical circuits and/or the body with the wet surfaces;

3.14.2. Standing water or liquids shall be removed before beginning work on electrical circuits or systems. Electrical work is strictly prohibited in areas where there is standing water or liquid;

3.14.3. Follow all requirements related to wet or damp locations as specified in the sections entitled "Cord-Connected Electrical Equipment and Extension Cords" and "Temporary Electric Power and Lighting."

3.14.4. Non-conductive boots, gloves, ladders, and a portable GFCI shall be used when working with portable power tools (e.g. a wet vacuum) in wet or damp locations. See the Indiana University Portable Ladder Safety Program, the Indiana University Foot Protection Program, and the Indiana University Personal Protective Equipment Policy for additional requirements.

### 3.15. Alertness around Electricity

Employees shall be alert at all times when working around or with electricity. Employees shall not be permitted to work within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more while their alertness is recognizably impaired due to illness, fatigue, or other reasons. Employees shall also remain alert regarding changes in the job, task, or work conditions that may present new hazards for employees or bystanders, and stop work if these changes could result in a potentially hazardous situation. Employees shall also refrain from reaching blindly into areas that might contain exposed energized electrical conductors or circuit parts where an electrical hazard exists.

### 3.16. Illumination

Employees shall not enter spaces containing electrical hazards unless illumination is provided that enables employees to perform work safely (See also the section entitled "Working Space for Electrical Equipment".). Where lack of illumination or an obstruction precludes observation of the work to be performed, employees shall not perform any task within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more.

### 3.17. Conductive Articles, Materials, Tools, and Equipment

Conductive articles of jewelry and clothing (e.g. watchbands, bracelets, rings, key chains, necklaces, metallic aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed energized electrical conductors or circuit parts operating at 50 volts or more. Other conductive materials, tools, and equipment that are in contact with any part of an employee's body shall be handled in a manner that prevents accidental contact with energized electrical conductors or circuit parts. Such materials and equipment shall include, but are not limited to, long conductive objects such as ducts, pipes, and tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, full floats, chains, etc.

### 3.18. Confined or Enclosed Work Spaces

When an employee works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized electrical conductors or circuit parts operating at 50 volts or more, or where an electrical hazard exists, protective shields, protective barriers, or insulating materials shall be used as necessary to avoid inadvertent contact with these parts and the effects of the electrical hazards. See the Indiana University Permit-Required Confined Space Program for additional information regarding confined space entries.

### 3.19. Housekeeping Duties

Employees shall not perform housekeeping duties inside the limited approach boundary where is a possibility of contact with energized electrical conductors or circuit parts, unless adequate safeguards (such as insulating equipment or barriers) are provided to prevent contact. Electrically conductive cleaning materials (i.e. including conductive solids such as steel wool, metallic cloth, and silicone carbide, as well as conductive liquid solutions) shall not be used inside the limited approach boundary unless procedures to prevent electrical contact are followed.

### 3.20. Occasional Use of Flammable or Ignitable Materials

Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be used, unless measures are taken to prevent hazardous conditions from developing. Such materials include, but are not limited to: flammable gases, vapors, or liquids; combustible dust; and ignitable fibers or flyings.

### 3.21. Anticipated Failure

When there is evidence that electrical equipment (i.e. including portable power tools) could fail and injure employees or bystanders, the electric equipment shall be de-energized and locked/tagged out of service, unless de-energizing introduces additional hazards or increased risk or is infeasible because of equipment design or operational limitation as determined by a qualified person. Until the equipment can be repaired or de-energized, employees shall be protected from hazards associated with the impending failure of the equipment by suitable barricades or other approved alerting techniques as specified in this Program.

### 3.22. Cord-Connected Equipment and Extension Cords

The following requirements apply to the use of cord-and-plug-connected equipment (e.g. portable power tools with flexible cords), power strips, and flexible cord sets (i.e. extension cords):

3.22.1. Extension cords may only be used to provide temporary power.

3.22.2. Portable equipment shall be handled in a manner which will not cause damage.

3.22.3. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.

3.22.4. Portable cord-and-plug connected equipment and extension cords must be visually inspected before use for external defects such as loose parts, deformed and missing pins, or damage to outer jacket or insulation, and for possible internal damage such as a pinched or crushed outer jacket.

3.22.5. Any damaged or defective cord or cord-and-plug-connected equipment must be tagged out of service and no person may use it until it is repaired and inspected to ensure it is safe for use.

3.22.6. Extension cords must be of the three-wire type. Extension cords and flexible cords must be designed for hard or extra hard usage (for example, types S, ST, and SO). The rating or approval must be visible.
3.22.7. Job-made extension cords are not permitted for use.
3.22.8. Portable equipment must be handled in a manner that will not cause damage.
3.22.9. Extension cords must be protected from damage. Sharp corners and projections must be avoided.
3.22.10. Flexible cords may not be run through windows or doors unless protected from damage, and then only on a temporary basis.
3.22.11. Flexible cords may not be run above ceilings or inside or through walls and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.
3.22.12. Adapters which interrupt the continuity of the equipment grounding connection may not be used.
3.22.13. Flexible cords must be covered by a cord protector or tape when they pose a tripping hazard in a pathway, aisle, or hallway.
3.22.14. Extension cords used with grounding type equipment must contain an equipment-grounding conductor (i.e., the cord must accept a three-prong or grounded plug).
3.22.15. Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping the grounding prong from an electrical plug is prohibited.
3.22.16. Flexible cords may only be plugged into grounded receptacles. In the event a two-pronged outlet is encountered, it is recommended that the receptacle be replaced with a three-prong outlet. Adapters that interrupt the continuity of the equipment grounding connection may not be used.
3.22.17. Employee's hands must be dry when plugging and unplugging flexible cords and cord-and-plug connected equipment.
3.22.18. Lamps for general illumination must be protected from breakage and metal shell sockets must be grounded.
3.22.19. Temporary lights must not be suspended by their cords unless they have been designed for this purpose.
3.22.20. Energized plug and receptacle connections shall be handled only with insulating protective equipment if the condition of the connection could provide a conductive path to the employee’s hand (e.g. if a cord connector is wet from being immersed in water).
3.22.21. Extension cords are considered to be temporary wiring and must also comply with the section entitled “Temporary Electric Power and Lighting”.
3.22.22. All portable electric equipment and flexible cords used in highly conductive work locations, such as those with water or other conductive liquids, or in places where employees are likely to contact water or other conductive liquids, must be approved for those locations.
3.22.23. Portable lighting used in wet or conductive locations, such as tanks or boilers, must be operated at no more than 120 volts or must be protected by GFCIs.
3.22.24. When an attachment plug is to be connected to a receptacle, the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of mating configuration.
3.22.25. Employees performing work outdoors or in damp or wet locations must be provided, and must use, a ground-fault circuit interrupter (GFCI).

3.22.26. In general, equipment and tools connected by cord-and-plug must be grounded. Listed or labeled as UL double insulated tools and appliances need not be grounded.

3.22.27. Hand lamps supplied by flexible cords must be equipped with a handle of molded composition or other approved material and must be equipped with a substantial bulb guard.

## 3.23. Electric Power and Lighting Circuit Breakers

During routine opening and closing of circuits, only load-rated switches, circuit breakers, or other devices specifically designed as disconnecting means shall be used for the opening, reversing, or closing of circuits under load conditions. Never utilize an electrical disconnect itself as an on/off switch. When opening and closing disconnects or breakers, if applicable, use the left-hand rule when possible (i.e. stand to the right side of the equipment and operate the disconnect switch with the left hand).

After a circuit is de-energized by a circuit protective device (e.g. a circuit breaker is thrown or fuse is blown), the circuit may not be manually re-energized until it has been determined that the equipment and circuit can be safely energized by a qualified person. The repetitive manual reclosing of circuit breakers or the re-energizing of circuits through replaced fuses is prohibited. When it can be determined by a qualified person that the automatic operation of the device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is re-energized. Overcurrent protection of circuits and conductors shall not be modified, even on a temporary basis, beyond that approved by applicable portions of electrical codes and standards related to overcurrent protection.

## 3.24. Temporary Electric Power and Lighting

Temporary electrical power and lighting installations operating at 600 volts or less, including flexible cords, cables and extension cords, must comply with the applicable requirements specified within the section entitled "Cord-Connected Equipment and Extension Cords". The following requirements also apply to the use of temporary electric power and lighting:

3.24.1. Temporary electrical services other than a single extension cord, must originate from an approved distribution panel board that is rated for the voltages and currents the system is expected to carry. These installations must conform with the NEC.

3.24.2. Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.

3.24.3. Receptacles must be of the grounding type, each branch circuit must contain a separate equipment-grounding conductor, and all receptacles must be electrically connected to the grounding conductor.

3.24.4. Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

3.24.5. Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture or by providing a suitable guard.

## 3.25. Qualified Work Requirements

As defined in the "Overview of Qualified and Unqualified Work" section of this Program, qualified electrical work involves work within the limited approach boundary of exposed, energized electrical conductors and circuit parts operating at 50 volts or

higher. The following sections include additional requirements for qualified electrical work:

3.25.1. *Access to Applicable Standards and Regulations.* It is the responsibility of the department to provide qualified electrical employees with access to applicable electrical safety standards and regulations necessary for their work. This may include, but is not limited to, applicable editions of NPFA, ANSI, or ASTM standards.

3.25.2. *Hazard/Risk Assessment.* A logical and systematic approach is to be used to identify and control the potential hazards associated with exposed energized conductors or circuit parts. Departments performing qualified electrical work shall develop a standard operating procedure (SOP) for performing a hazard/risk assessment. The SOP shall outline the process that qualified employees must take before work is started within the limited approach boundary or within the arc flash boundary of energized electrical conductors and circuit parts operating at 50 volts or more. The SOP is to be used as a tool to identify, assess, and control electrical hazards. This SOP should serve as a concise decision-making model or road map for employees working on exposed, energized parts, and should not be confused with procedures associated with individual circuit parts and equipment (e.g. lockout/tagout procedures). The complexity of the SOP shall depend on the breadth of electrical hazards, voltage, energy level, and circuit conditions that employees for a department encounter during work. If applicable, the SOP shall specify safety-related work procedures that account for variations of equipment labeling due to more recent editions of NFPA 70E, as well as the potential absence of specific equipment labeling (e.g. due to the temporary absence of a hazard analysis). A flow chart may be used within the SOP to simplify the decision-making process for employees.

3.25.3. *Job Planning and Briefing.* When energized electrical work by IU employees is involved, employees shall conduct a job briefing with persons involved with the work. The briefing shall cover subjects such as the hazards associated with the job, work procedures involved, special precautions, energy source controls, personal protective equipment requirements, and any information regarding the energized electrical work permit, if applicable (See Appendix E for an example job briefing/planning checklist). Additional job briefings shall be held if changes occur during the course of the work that might affect the safety of employees or persons. A more extensive discussion shall be conducted if either of the following apply: the work is complicated or particularly hazardous or the employee cannot be expected to recognize and avoid hazards involved in the job.

3.25.4. *Approach to Exposed Energized Conductors or Circuit Parts.* To cross the restricted approach boundary or arc flash boundary, the qualified person must have an approved energized work permit and wear the appropriate PPE as specified below. If an electrically safe condition cannot be established (see requirements below) for energized electrical conductors or circuit parts operating at 50 volts or more prior to the start of work, other safety-related work practices shall be used to protect employees who might be exposed to the electrical hazards. Such work practices shall protect each employee from

arc flash and from contact with energized electrical conductors or circuit parts operating at 50 volts or more directly or indirectly through some other conductive object. Work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the energized electrical conductors or circuit parts. A hazard/risk assessment as specified in this Program shall be performed by a qualified employee to identify the appropriate safe work practices and electrical protective equipment to be used during the work.

Furthermore, only qualified persons following the requirements for working inside the restricted approach boundary shall be permitted to defeat or bypass an electrical safety interlock over which the person has sole control, and then only temporarily while the qualified person is working on the equipment. The safety interlock system shall be returned to its operable condition when work is completed. 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 unless:

3.25.4.1. The qualified person is insulated or guarded from the energized electrical conductors or circuit parts operating at 50 volts or more. Insulating gloves or insulating gloves and sleeves are considered insulation only with regard to the energized parts upon which work is being performed.

3.25.4.2. The energized electrical conductors or circuit part operating at 50 volts or more are insulated from the qualified person and from any other conductive object at a different potential.

3.25.4.3. The qualified person is insulated from any other conductive object as during live-line bare-hand work.

3.25.5. *Establishing an Electrically Safe Work Condition.* All electrical conductors and circuit parts shall be considered to be energized until an electrically safe work condition is established by a qualified person using the following process:

3.25.5.1. Identify all sources of power to the equipment, and review all available up-to-date drawings, lockout/tagout procedures, diagrams, and identification tags.

3.25.5.2. Remove the load current and then open the disconnecting devices for each power source.

3.25.5.3. Where possible, visually verify that blades of disconnecting devices are fully open or that draw-out type circuit breakers are fully withdrawn.

3.25.5.4. Apply lockout/tagout devices in accordance with the Indiana University Control of Hazardous Energy Program.

3.25.5.5. Test each phase conductor or circuit part with an adequately rated voltage detector to verify that the equipment is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Check the voltage detector before and after each test to be sure it is working.

3.25.5.6. 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.

3.25.5.7. Where appropriate, temporary protective grounding equipment shall be utilized as specified in NFPA 70E, 2009 Edition, Article 120.3.

3.25.6. *Energized Electrical Work Permits.* When working within the limited approach boundary or the arc flash boundary of exposed energized electrical conductors or circuit parts (i.e. operating at 50 V or greater) that are not placed in an electrically safe work condition, work to be performed shall be considered energized electrical work and shall be performed by written permit only. An energized electrical work permit must be approved by a designated department representative or committee to ensure the appropriate precautions are taken prior to starting energized electrical work. A copy of the permit must be posted in an appropriate location where the energized work is taking place for the duration of the task. The energized electrical work permit shall include, but not be limited to, the following items (See also example in Appendix F):

3.25.6.1. Description of the circuit and equipment to be worked on and their location.

3.25.6.2. Justification for why the work must be performed in an energized condition.

3.25.6.3. Description of the safe work practices to be employed.

3.25.6.4. Results of the shock hazard analysis that includes the limited approach boundary, restricted approach boundary, prohibited approach boundary, necessary shock-related PPE to safely perform the task.

3.25.6.5. Results of the arc flash hazard analysis that includes the available incident energy or highest hazard/risk category (i.e. or arc flash PPE category), necessary arc flash PPE to perform the assigned task, and the arc flash boundary.

3.25.6.6. Means employed to restrict the access of unqualified persons from the work area.

3.25.6.7. Any other job-specific hazards identified during the initial job briefing.

3.25.6.8. Energized work approval by a designated department representative or committee.

Work performed within the limited approach boundary of energized electrical conductors or circuit parts by qualified persons related to tasks such as testing, troubleshooting, and voltage measuring shall be permitted to be performed without an energized electrical work permit when the Hazard/Risk Category is two or below, if appropriate safe work practices and personal protective equipment are provided and are used according to this Program. If the purpose of crossing the limited approach boundary is only for visual inspection and the restricted approach boundary will not be crossed, then an energized electrical work permit is not required.

3.25.7. *Test Instruments and Equipment.* Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be

visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made. Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used. When test instruments are used for testing the absence of voltage on conductors or circuit parts operating at 50 volts or more, the operation of the test instrument shall be verified before and after an absence of voltage test is performed.

3.25.8. *Personal and Other Protective Equipment.* At a minimum, electrical protective equipment, including PPE, shall be designed, maintained, selected, and used in accordance with NFPA 70E, 2009 Edition, Article 250 and 130.7. Where it has been determined that work will be performed within the arc flash boundary, a documented incident energy analysis or the Hazard/Risk Category, shall be used when selecting the appropriate protective clothing and PPE. For the purposes of this Program, the Hazard/Risk Category (i.e. used in earlier NFPA 70E editions) and the Arc Flash PPE Category (i.e. used in later NFPA 70E editions) shall be considered equivalent when selecting the appropriate level of PPE. Employees working in areas where there are potential electrical hazards must be provided with and use PPE and other electrical protective equipment that is appropriate for the specific work to be performed in accordance with Article 130.7, NFPA 70E, 2009 Edition. Electrical protective equipment includes, but is not limited to, insulating blankets, matting, covers, line hose, gloves, sleeves, and other insulating garments, tools, and equipment. All electrical tools and protective equipment must be approved, rated, and tested for the levels of voltage of which the equipment and/or employee may be exposed. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made. See the Indiana University PPE Policy for additional requirements related to PPE, and the Indiana University Portable Ladder Safety Program for additional requirements related to portable ladders.

3.25.9. *Alerting Techniques.* Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might cause an electrical hazard. Barricades shall be placed no closer than the limited approach boundary. If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside of a work area where an unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential

for employees to be exposed to the electrical hazards. Where work performed on equipment that is de-energized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction, safety signs and tags, barricades, or a combination shall be employed to prevent employees from inadvertently entering look-alike equipment.

### 3.26. Electrical Safety Auditing and Injury Investigations

IUEHS may perform scheduled or unannounced audits of electrical work practices, equipment, standard operating procedures, lockout/tagout procedures, and other required records (e.g. energized work permits) related to electrical safety as specified in the "Recordkeeping" section of this Program. When auditing or an incident investigation determines that the principles and procedures of this Program are not being followed, the applicable department shall revise their training program and/or procedures to ensure that all applicable requirements of this Program are met.

### 3.27. Electric Power Generation, Transmission, and Distribution

The operation and maintenance of electric power generation, control, transformation, transmission, and distribution lines and equipment shall be performed in accordance with 29 CFR 1910.269.

## 4. TRAINING AND RECORDKEEPING

### 4.1. Training

The training requirements contained in this section shall apply to employees who face a risk of electrical hazard that is not reduced to a safe level by the applicable electrical installation requirements. Such employees shall be trained in safety-related work practices and procedural requirements, as necessary, to provide protection from the electrical hazards associated with their respective job or task assignments.

4.1.1. *Qualified Training.* Qualified training shall be of the classroom or on-the-job type, or a combination of the two. The degree of training provided shall be determined by the risk to the employee and their job duties. A qualified person shall be trained and knowledgeable of the construction and operation of equipment and be trained to recognize and avoid electrical hazards that might be present with respect to that equipment. Such persons shall also be familiar with the proper use of special precautionary techniques; personal protective equipment including arc flash clothing; insulating and shielding materials; and insulated tools and test equipment. A person can be considered qualified with respect to certain equipment and work practices, but still be unqualified for others. Such qualified persons authorized to work within the limited approach boundary of energized electrical conductors or circuit parts operating at 50 volts or more shall, at a minimum, be trained in all of the following:

4.1.1.1. The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment;

4.1.1.2. The skills and techniques necessary to determine the nominal voltage of exposed live parts;

4.1.1.3. The shock approach distances specified in NFPA 70E, 2009 Edition, Table 130.2(C), and the corresponding voltage to which the qualified person will be exposed;

4.1.1.4. The decision-making process necessary to determine the degree and extent of the hazard, and what controls and job planning are necessary to perform the task safely.

4.1.1.5. The skills necessary to select the appropriate PPE and other protective equipment as specified in NFPA 70E, 2009 Edition, Article 130.7.

4.1.1.6. The skills necessary to select the appropriate voltage detector and demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall also include information that enables the employee to understand all limitations of each specific voltage detector that might be used.

An employee who is undergoing on-the-job training for the purpose of obtaining the skills and knowledge necessary to be considered a qualified person and who, in the course of such training, has demonstrated an ability to perform specific duties safely at their level of training, and who is under the direct supervision of a qualified person, shall be considered to be a qualified person for the purposes of this Program.

4.1.2. *Unqualified Training.* Unqualified persons shall be trained in, and be familiar with, any electrical safety-related practices necessary for their safety. For example, if an employee uses a portable electric drill at work, the employee shall be trained in electrical safety-related work practices associated with that tool (e.g. including but not limited to the requirements specified within the section entitled "Cord-Connected Equipment and Extension Cords").

4.1.3. *Emergency Response Training.* Qualified persons shall be trained in methods to release victims from contact with exposed energized electrical conductors or circuit parts. These employees shall be regularly instructed in methods of first aid and emergency procedures, such as approved methods of resuscitation, if their duties warrant such action.

4.1.4. *Retraining.* Retraining shall be performed whenever audits or incident investigations identify that an employee does not have the necessary knowledge or skills to safely work on or around electrical systems. Retraining shall also be performed 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 the employee would normally use, or if the qualified person must employ safety-related work practices that are not normally used during his or her regular job duties. Retraining shall be performed at intervals not to exceed 3 years.

## 4.2. Recordkeeping

4.2.1. *Training Documentation.* The department shall document that each employee has completed the training required as specified in this Program. This documentation shall be created when the employee demonstrates proficiency in the work practices involved and shall be maintained for the duration of the employee's employment. Qualified training documentation

shall contain a summary of the training content, each employee's name and signature, and dates of the training.

4.2.2. *Energized Work Permits.* A copy of all energized work permits must be maintained on file for a minimum of 5 years.

4.2.3. *Hazard Analyses*. Shock and arc flash hazard analyses and supporting documentation shall be maintained for as long as the analysis is valid/current, or for the lifetime of the equipment.

4.2.4. *Personal and Other Protective Equipment Records.*
Records related to performance (e.g. maintenance, repair, testing, and rating) of personal and other electrical protective equipment shall be maintained for the lifetime of the equipment.

## 5. REFERENCES

- NFPA 70, 2002 and 2014 Editions - National Electrical Code (NEC).
- NFPA 70E, 2009, 2012, and 2015 Editions - Electrical Safety in the Workplace.
- 29 CFR 1910 Subpart S - Electrical.
- 29 CFR 1910.269 - Electric Power Generation, Transmission, and Distribution.
- 29 CFR 1910.137 - Electrical Protective Devices.
- Indiana University Control of Hazardous Energy Program
- Indiana University PPE Policy
- Indiana University Portable Ladder Safety Program
- Indiana University Machinery and Machine Guarding Program
- Indiana University Permit-Required Confined Space Program

## 6. REVISIONS

New Document: February 2, 2016

## APPENDIX A – GLOSSARY

1. **Authorized Employee.** A person approved or assigned by the employer to perform a specific type of duty or duties.

2. **Bare-Hand Work.** A technique of performing work on energized electric conductors or circuit parts, after the employee has been raised to the potential of the conductor or circuit part.

3. **Circuit Breaker.** A device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a pre-determined overcurrent without damage to itself when properly applied within its rating.

4. **Confined Space (Permit-Required).** An enclosed space which has limited egress and access, and has an atmospheric hazard (e.g., explosive atmosphere or asphyxiating hazard) and/or other serious safety hazards (e.g., electrical hazard).

5. **Disconnecting Means/Switch.** A device designed to close and/or open an electric circuit.

6. **Electrically Safe Work Condition.** A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance to the Indiana University Control of Hazardous Energy Program, tested to ensure the absence of voltage, and grounded if deemed necessary.

7. **Energized Electrical Work.** Repair, maintenance, troubleshooting, or testing on electrical circuits, components, or systems while energized (i.e., live).

8. **Enclosure.** The case or house of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage.

9. **Exposed Electrical Parts.** Energized parts that can be inadvertently touched or approached nearer than a safe distance by a person. Parts not suitably guarded, isolated, or insulated. Examples include terminal contacts or lugs and bare wiring.

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

11. **Ground Fault Circuit Interrupt (GFCI).** A device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds a predetermined value that is less than that required to operate the over-current protective device of the supply circuit.

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

13. **Incident Energy.** The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the common units used to measure incident energy is calories per centimeter squared ($cal/cm^2$).

14. **Interlock.** An electrical, mechanical, or key-locked device intended to prevent an undesired sequence of operation.

15. **Insulated.** Separated from other conducting surfaces by a di-electric (including air space) offering a high resistance to the passage of current.

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

17. **Lockout.** The placement of a lock on an energy-isolating device according to procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

18. **Potential (Electric).** The difference in energy between a point and some other reference point in a circuit.

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

20. **Overcurrent Protection/Protective Device.** 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.

21. **Qualified Person.** One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his/her ability to solve or resolve problems relating to the subject matter, the work, or the project.

22. **Qualified Electrical Employee.** A qualified person trained and knowledgeable of construction and operation of equipment or a specific work method and is trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.

23. **Restricted Approach Boundary.** An approach limit 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.

24. **Tagout.** The placement of a tagout device on an energy-isolating device according to procedure to indicate that the equipment may not be operated until the tagout device is removed.

25. **Voltage (of a circuit).** The greatest root-mean-square (effective) difference of potential between any two conductors of the circuit concerned.

26. **Voltage, Nominal.** An approximate value assigned to a circuit or system for the purpose of conveniently designating its voltage class, e.g., 120/240, 480/277, and 600.

27. **Unqualified Person.** A person who is not a qualified person.

## APPENDIX B – WORKING SPACE AROUND ELECTRICAL EQUIPMENT

The following information is provided as general guidance regarding the required working space around electrical equipment, and does not replace or supersede applicable electrical code requirements**.**

1. *Depth of Working Space.* The depth of the working space, which is measured from the enclosure front, must not be less than the distances contained in Appendix B, Table 1.

Table 1. Working Space

| Voltage (Nominal) | Minimum Clear Distance | | |
|---|---|---|---|
| | Condition 1 | Condition 2 | Condition 3 |
| 0-150 | 900mm(3 ft) | 900 mm(3 ft) | 900mm(3 ft) |
| 151-600 | 900mm(3 ft) | 1m(3-1/2 ft) | 1.2 m (4 ft) |

Reference: National Electrical Code (NEC) Table 110.26(A)(1)).

Condition 1—Exposed live parts on one side of the working space and no live or grounded parts, including concrete, brick, or tile walls are on the other side of the working space.

Condition 2—Exposed live parts on one side of the working space and grounded parts, including concrete, brick, or tile walls are on the other side of the working space (Preferred).

Condition 3—Exposed live parts on both sides of the working space.

2. *Width of Working Space.* The width of the working space in front of the electrical equipment shall be the width of the equipment or 750mm (30 in.), whichever is greater. In all cases, the work space shall permit at least a 90 degree opening of equipment doors or hinged panels.

3. *Height of Working Space.* The workspace shall be clear and extend from the grade, floor, or platform to a height of 2m (6½ ft.) or the height of the equipment whichever is greater. Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150mm (6 in.) beyond the front of the electrical equipment.

4. *Dead-Front Assemblies.* Working space shall not be required in the back or sides of assemblies, such as dead-front switchboards or motor control centers, where all connections and all renewable or adjustable parts, such as fuses or switches, are accessible from locations other than the back or sides. Where rear access is required to work on non-electrical parts on the back of enclosed equipment, a minimum horizontal working space of 762mm (30 in.) shall be provided.

5. *Low Voltage Work Spaces.* Smaller working spaces can be permitted where all un-insulated parts operated are not greater than 30 volts rms, 42 volts peak, or 60 volts dc.

6. *Existing Installations.* In existing buildings where electric equipment is being replaced, the working clearance as specified by Condition 2 in Appendix B, Table 1, shall be permitted between dead-front switch boards, panel boards, or motor control centers located across the aisle from each other where conditions of maintenance and supervision ensure that written procedures have been adopted to prohibit equipment on both sides of the aisle from being opened at the same time. Qualified electrical workers who are authorized shall service the installation.

7. *Clear Working Spaces.* Working space shall not be used for storage. When normally enclosed live parts operating at 50 volts or more are exposed for inspection or service, the working space, if in a passageway or general open space shall be suitably guarded.

8. *Minimum Required Entrances.* At least one entrance of sufficient area shall be provided to give access to the working space around electric equipment.

9. *Large Equipment Entrances.* For equipment rated 1200 amperes or more and over 1.8m (6 ft.) wide that contains over current devices, switching devices, or control devices, there shall be one entrance to an egress from the required working space not less than 610mm (24 in.) wide and 2.0m (6½ ft.) high at each end of the working space.

10. *Personnel Doors***.** If equipment with overcurrent or switching devices rated 1,200A or more is installed, personnel door(s) for entrance to and egress from the working space located less than 7.62m (25 ft) from the nearest edge of the working space must have the door(s) open in the direction of egress and be equipped with panic hardware or other devices that open under simple pressure.

11. *Unobstructed Exits.* Where the location permits a continuous and unobstructed way of exit travel, a single entrance to the working space shall be permitted.

12. *Extra Working Space.* Only one entrance is required where the required working space depth is doubled, and the equipment is located so the edge of the entrance is no closer than the required working space distance.

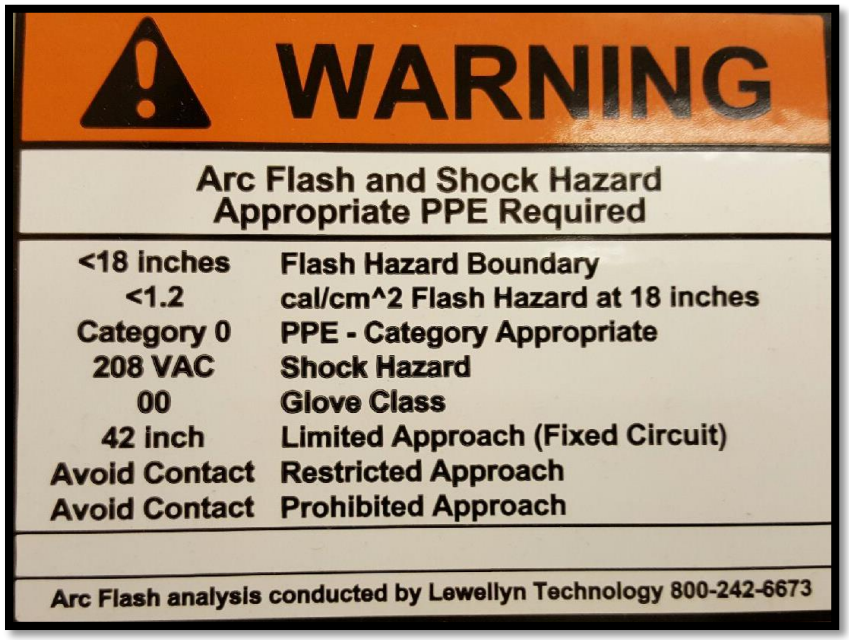
13. *Illumination.* Illumination shall be provided for all working spaces about service equipment, switchboards, panel boards, or motor control centers installed indoors. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source. In electrical equipment rooms, the illumination shall not be controlled by automatic means only.

14. *Dedicated Equipment Space.* All switchboards, panel boards, distribution boards, and motor control centers shall be located in dedicated spaces and protected from damage. Exception: control equipment that by its very nature or because of other rules of the standard must be adjacent to or within sight of the operating machinery shall be permitted in those locations. The space equal to the width and depth and extending from the floor to height of 1.8m (6 ft.) above the equipment or to the structural ceiling whichever is lower, shall be dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in the dedicated footprint space.

**APPENDIX C – SHOCK AND ARC FLASH EQUIPMENT LABELS (EXAMPLES)**

Figure 1. Temporary Arc Flash and Shock Hazard Label


Figure 2. Permanent Arc Flash and Shock Hazard Label (2009 Edition)




Note: See the "Equipment Labeling and Hazard Analysis" section of this Program for minimum labeling requirements.

## APPENDIX D - APPROACH BOUNDARIES (FOR LOWER AC VOLTAGES)

Table 1. Approach Boundaries for Alternating Current (AC) Shock Protection.

| | Limited approach boundary | | | |
|---|---|---|---|---|
| **Nominal system voltage range, phase to phase** | **Exposed movable conductor** | **Exposed fixed-circuit part** | **Restricted approach boundary (allowing for accidental movement)** | **Prohibited approach boundary** |
| 0 to 50 volts | Not specified | Not specified | Not specified | Not specified |
| 51 to 300 volts | 10 ft. 0 in. | 3 ft. 6 in. | Avoid contact | Avoid contact |
| 301 to 750 volts | 10 ft. 0 in. | 3 ft. 6 in. | 1 ft. 0 in. | 0 ft. 1 in. |
| 751 to 15 KV | 10 ft. 0 in. | 5 ft. 0 in. | 2 ft. 2 in. | 0 ft. 7 in. |

Note: Distance is measured from the energized electrical conductor or circuit part to the employee.
Reference: NPFA 70E, 2009 Edition, Table 130.2(C)

## APPENDIX E – JOB BRIEFING AND PLANNING CHECKLIST (EXAMPLE)

| **Identify** | |
|---|---|
| ○ Conduct hazard/risk assessment<br>○ Voltage levels involved?<br>○ Skills required?<br>○ Any "foreign" (secondary source) voltage or energy source?<br>○ Any unusual work conditions? | ○ Number of people needed to do the job?<br>○ Shock protection boundaries?<br>○ Available incident energy?<br>○ Potential for arc flash?<br>○ Arc flash boundary?<br>○ Appropriate PPE? |
| **Ask** | |
| ○ Can the equipment be de-energized?<br>○ Are backfeeds of the circuits to be worked on possible? | ○ Is a standby person needed in the event of an emergency?<br>○ Do we have adequate training? |
| **Check** | |
| ○ Job plans?<br>○ Single-line diagrams and prints? | ○ Safety procedures?<br>○ Qualified persons are familiar with equipment? |
| **Know** | |
| ○ What the job is?<br>○ Who else needs to know? | ○ Who is in charge? |
| **Think** | |
| ○ What if an unexpected event happens?<br>○ What are the right tools and equipment for the job?<br>○ What is the sequence of work? | ○ How long will the work take?<br>○ Are barriers and barricades needed?<br>○ Is a confined space permit needed?<br>○ What else? |
| **Prepare for the Unexpected** | |
| ○ Is the standby person trained appropriately (if applicable)?<br>○ Is the required emergency equipment available?<br>○ Where is the nearest telephone?<br>○ Where is the fire alarm?<br>○ What is the exact work location? | ○ Where are the exits?<br>○ How is the equipment shut off in an emergency?<br>○ Are the emergency numbers known by everyone?<br>○ Where is the fire extinguisher? |

Note: This checklist is not comprehensive, and should be adapted for the specific work being done.

## APPENDIX F –ENERGIZED ELECTRICAL WORK PERMIT (EXAMPLE)

**PART I. TO BE COMPLETED BY THE REQUESTER**

1) Description of circuit/equipment/job location:

2) Description of work to be done:

3) Justification of why the circuit/equipment cannot be de-energized or the work deferred to the next scheduled outage:

Requester: Date:

**PART II: TO BE COMPLETED BY THE QUALIFIED PERSON PERFORMING THE WORK**

1) Detailed job description procedure to be used in performing the above detailed work:

2) Description of the safe work practices to be employed:

3) Summary of the shock hazard analysis:
   a) Limited approach boundary:
   b) Restricted approach boundary:
   c) Prohibited approach boundary:
   d) Necessary personal and other protective equipment:

4) Summary of arc flash hazard analysis:
   a) Available incident energy or hazard/risk category (i.e. or arc flash PPE category):
   b) Necessary personal and other protective equipment:
   c) Arc flash boundary:

5) Means employed to restrict access of unqualified persons from the work area:

6) Any other job-specific hazards identified during the initial job briefing:

7) Do you agree the above work can be done safely? If yes, sign below. If no, return to requestor.
Qualified Person(s): Date:

**PART III. TO BE COMPLETED BY DEPARTMENT REPRESENTATIVE/COMMITTEE**

Approver(s): Date: