Environmental Health & Safety
Electrical Safety Program

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I. Purpose

Ensure the safety of employees who may work on or near electrical equipment, understand and comply with applicable safety standards related to electrical work and follow uniform electrical work practices.

Comply with OSHA Standards according to the following six points:

- Provide and demonstrate a safety program with defined responsibilities.
- Determine the degree of arc flash hazard by qualified personnel.
- Affix warning labels on equipment.
- Provide personal protective equipment (PPE) for workers.
- Provide documented training to workers on Lockout/Tagout procedures and the hazards of arc flash.
- Provide appropriate tools for safe work.

II. Scope

This program applies to all Wright State University properties and work performed by its employees regardless of job site location.

III. Definitions

A. Arc-flash burns - Occur if a conductive object gets too close to a high-amp current source or by equipment failure (for instance, while opening or closing disconnects). The arc can heat the air to temperatures as high as 35,000o F, and vaporize metal in the equipment. The arc flash can cause severe skin burns by direct heat exposure and by igniting clothing.

B. Confined space - 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).

C. Damp location - Partially protected locations subject to moderate degrees of moisture, such as some basements.

D. De-energized electrical work - Electrical work that is performed on equipment that has been previously energized and is now free from any electrical connection to a source of potential difference and from electrical charges.

E. Dry location - Locations not normally subject to dampness or wetness, as in the case of a building under construction.

F. Energized electrical work - Repair, maintenance, troubleshooting, or testing on electrical circuits, components, or systems while energized (i.e., live). Only Qualified

Persons are permitted to work on energized circuitry of 50 volts/25 amps to ground or greater.

G. **Electric shock and burns -** 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.

H. **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.

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

J. **Arc Flash 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.

K. **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.

L. **Ground -** A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

M. **Isolating Switch (or disconnecting switch) -** A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and is intended to operate only after the circuit has been opened by some other means.

N. **Life Safety Equipment -** Equipment that provides critical protection for safety in the event of an emergency or other serious hazard. Life safety equipment, which is electrically energized, should be worked on using Energized Electrical Equipment (EEW) procedures to ensure that the protection provided by the equipment is not lost (e.g., fire alarm and evacuation).

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

P. **Qualified Person–** 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.

- Qualified Persons shall be familiar with the proper use of the special precautionary techniques, personal protective equipment (PPE), 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 is unqualified for others.

- An employee who is undergoing on-the-job training and who, in the course of such training, has performed duties safely at his or her level of training and who is under the direct supervision of a qualified person shall be considered to be qualified.
- Only a Qualified Person is allowed to work on energized circuits.
- Qualified Persons **shall not** be assigned to work alone, except for replacing fuses, operating switches, or other operations that do not require the employee to contact energized high voltage conductors or energized parts of equipment, clearing trouble, or emergencies involving hazard to life or property.

Note One: Whether a person is considered to be a "qualified" person will depend upon various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered "qualified" with regard to certain equipment in the workplace, but "unqualified" as to other equipment.

Note Two: An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

Note Three: A list of duties by trade each employee category is qualified to perform can be found in Appendix II.

Q. 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.

R. Service - The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

S. Service Equipment - The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the entrance of supply conductors to the building and intended to constitute the main control and means of cutoff of the supply.

T. Setting Up - Any work performed to prepare a machine or equipment to perform its normal production operation.

U. Switching Devices - Devices designed to close and/or open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, interrupter switches, and oil (filled) cutouts.

V. Tagout/Lockout - 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.

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

X. **Voltage, low -** Circuits with a nominal voltage less than or equal to 50 volts.

Y. **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.

Z. **Wet location -** Installations subject to saturation with water or other liquids.

IV. Responsibilities

A. Environmental Health and Safety

1. Evaluate work being performed and determine compliance with this program.
2. Provide or assist in the task of specific training for electrical work qualifications.
3. Training record keeping.
4. Periodically review and update this written program.
5. Provide or coordinate general training for work units on the content of this program.
6. Evaluate the overall effectiveness of the electrical safety program on a periodic basis.
7. Assist work units in the implementation of this program.

B. Engineering and Construction/Planning and Architecture

1. Complete arc flash analyses and appropriate labeling required by this program during equipment replacement, upgrading, or construction of new facilities.
2. Place an emphasis on controlling electrical hazards through the application of engineering and design controls.
3. Promote consistency in how electrical tasks are completed within the various facilities.

C. Managers, Supervisors, Project Managers

1. Promote electrical safety awareness to all employees and contractors.
2. Evaluate work being performed and determine compliance with this program.
3. Develop a checklist system for working on live circuits and ensure its use.
4. Ensure employees and contractors comply with ALL provisions of the electrical safety program.
5. Ensure employees and contractors receive training appropriate to their assigned electrical tasks and maintain documentation of such training.
6. Develop and maintain a listing of all qualified persons and contractors under their supervision.
7. Ensure employees are provided with and use appropriate protective equipment and contractors use appropriate protective equipment.

D. Employees

1. Follow the work procedures described in this document, including the use of appropriate protective equipment and tools.
2. Attend all training required relative to this program.

3. Immediately report any concerns related to electrical safety to supervision.

E. Contractor Employees

1. Safety programs used by contractors must meet or exceed all applicable guidelines of this Safety Program.
2. Contractors are required to comply with applicable safety and health regulations such as OSHA, NFPA, and EPA.
3. Contractors may be required to submit copies of their safety program to the Project Manager or Environmental Health and Safety upon request.

V. Procedures

A. ELECTRIC SAFETY PRINCIPLES-ENERGIZED CONDITION

1. **De-energize whenever possible.**
2. **Plan every job.** The approach and step-by-step procedures to complete the work at hand must be discussed and agreed upon between all involved employees beginning. Write down first-time procedures. Discuss hazards and procedures in a job briefing with supervisors and other workers before starting any job. Use the checklist system for working on live circuits, if such a scenario arises.
3. **Identify the hazards.** Conduct an electrical hazard risk assessment. Identify steps that could create electric shock or arc-flash hazards.
4. **Minimize the hazards.** De-energize any equipment, and insulate, or isolate exposed live parts so contact cannot be made. If this is impossible, obtain and wear proper personal protective equipment (PPE) and tools.
5. **Anticipate problems.** If it can go wrong, it might. Make sure the proper PPE and tools are immediately available for the worst-case scenario.
6. **Obtain training.** Make sure all involved employees are a qualified electrical worker with appropriate training for the job.

B. PORTABLE ELECTRICAL EQUIPMENT AND EXTENSION CORDS

1. The following requirements apply to the use of cord-and-plug-connected equipment and flexible cord sets (extension cords):

   a) Extension cords may only be used to provide temporary power.
   b) Portable cord-and-plug connected equipment and extension cords must be visually inspected before use on any shift 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 pinched or crushed outer jacket.
   c) Any defective cord or cord-and-plug-connected equipment must be removed from service and no person may use it until it is repaired and tested to ensure it is safe for use.
   d) 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.
   e) Job-made extension cords are forbidden per the electrical code.

f) Personnel performing work on renovation or construction sites using extension cords or where work is performed in damp or wet locations must be provided and must use, a ground-fault circuit interrupter (GFCI).
g) Portable equipment must be handled in a manner that will not cause damage.
h) Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.
i) Extension cords must be protected from damage. Sharp corners and projections must be avoided. Flexible cords may not be run through windows or doors unless protected from damage, and then only on a temporary basis.
j) Flexible cords may not be run above ceilings or inside or through walls, ceilings, or floors, and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.
k) Cords must be covered by a cord protector or tape when they extend into a walkway or other path of travel to avoid creating a trip hazard.
l) 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).
m) 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.
n) Flexible cords may only be plugged into grounded receptacles. The continuity of the ground in a two-prong outlet must be verified before use. It is recommended that the receptacle be replaced with a three-prong outlet.
o) Adapters that interrupt the continuity of the equipment grounding connection may not be used.
p) 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 conductive liquids, must be National Recognized Test Laboratories (NRTL) approved equipment and cords and approved for those locations.
q) Employee's hands must be dry when plugging and unplugging flexible cords and cord-and-plug connected equipment if energized equipment is involved.
r) If the connection could provide a conducting path to employees hands (for example, if a cord connector is wet from being immersed in water), the energized plug and receptacle connections must be handled only with insulating protective equipment.
s) Locking-type connectors must be properly locked into the connector.
t) Lamps for general illumination must be protected from breakage, and metal shell sockets must be grounded.
u) Temporary lights must not be suspended by their cords unless they have been designed for this purpose.
v) Portable lighting used in wet or conductive locations, such as tanks or boilers, must be operated at no more than 12 volts or must be protected by GFCI's.
w) Extension cords are considered to be temporary wiring, and must also comply with the section on "Requirements for Temporary Wiring" in this program.

C. REQUIREMENTS FOR TEMPORARY WIRING

1. Temporary electrical power and lighting installations 600 volts or less, including flexible cords, cables and extension cords, may only be used during and for renovation, maintenance, repair, or experimental work. The duration for temporary wiring used for decorative lighting for special events and similar purposes may not exceed 90 days. The following additional requirements apply:

a) Ground-fault protection (e.g., ground-fault circuit interrupters, or GFCI) must be provided on all temporary-wiring circuits, including extension cords, used on construction sites.
b) In general, all equipment and tools connected by cord and plug must be grounded. Listed or labeled double insulated tools and appliances need not be grounded.
c) Feeders must originate in an approved distribution center, such as a panel board, that is rated for the voltages and currents the system is expected to carry.
d) Branch circuits must originate in an approved power outlet or panel board.
e) Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.
f) Receptacles must be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit must contain separate equipment grounding conductor, and all receptacles must be electrically connected to the grounding conductor.
g) Flexible cords and cables must be NRTL approved type and suitable for the location and intended use. They may only be used for pendants, wiring of fixtures, connection of portable lamps or appliances, elevators, hoists, connection of stationary equipment where frequently interchanged, prevention of transmission of noise or vibration, data processing cables, or where needed to permit maintenance or repair. They may not be used as a substitute for the fixed wiring, where run through holes in walls, ceilings or floors, where run through doorways, windows or similar openings, where attached to building surfaces, or where concealed behind building walls, ceilings or floors.
h) Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.
i) Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture or by providing a suitable guard. Hand lamps supplied by flexible cord must be equipped with a handle of molded composition or other approved material and must be equipped with a substantial bulb guard.
j) Flexible cords and cables must be protected from accidental damage. Sharp corners and projections are to be avoided. Flexible cords and cables must be protected from damage when they pass through doorways or other pinch points.

D. WET OR DAMP LOCATIONS

1. Work in *wet* or *damp* work *locations* (i.e., areas surrounded or near water or other liquids) should not be performed unless it is absolutely critical. Electrical work should be postponed until the liquid can be cleaned up. The following special precautions must be incorporated while performing work in *damp locations:*

a) Only use electrical cords that have Ground Fault Circuit Interrupters (GFCIs);
b) Place a dry barrier over any wet or damp work surface;
c) Remove standing water before beginning work. Work is prohibited in areas where there is standing water;
d) Do not use electrical extension cords in wet or damp locations; and
e) Keep electrical cords away from standing water.

E. WORKING ON DE-ENERGIZED EQUIPMENT

1. Electrically Safe Condition

a) The most important principle of electrical safety is to **assume all electric circuits are energized unless each involved worker ensures they are not.** Every circuit and conductor must be tested every time work is done on them. All proper PPE must be worn until the equipment is proven to be de-energized.

The National Fire Protection Association (NFPA) lists six steps to ensure conditions for electrically safe work.

b) Identify all sources of power to the equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

c) Remove the load current, and then open the disconnecting devices for each power source.

d) Where possible, visually verify that blades of disconnecting devices are fully open or those drawout-type circuit breakers are fully withdrawn.

e) Apply lockout/tagout devices in accordance with the university Lockout Policy.

f) 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.

g) Properly ground all possible sources of induced voltage and stored electric energy (such as, capacitors) before touching. If conductors or circuit parts that are being de-energized could contact other exposed conductors or circuit parts, apply ground-connecting devices rated for the available fault current.

The process of de-energizing is "live" work and can result in an arc flash due to equipment failure. When de-energizing, follow the procedures described in "Working On or Near Live Equipment."

F. WORK WITHIN BOUNDARIES OF OVERHEAD LINES

Work shall conform to NFPA 7OE, Article 130.8

G. UNDERGROUND ELECTRICAL LINES AND EQUIPMENT

Work shall conform to NFPA 7OE, Article 130.9

H. CUTTING AND DRILLING

Work shall conform to NFPA 7OE, Article 130.10

I. WORKING ON OR NEAR ENERGIZED EQUIPMENT

1. Working on live circuits means actually touching energized parts. Working near live circuits means working close enough to energized parts to pose a risk even though work is on de-energized parts. Common tasks where there may be a need to work on or near live circuits include:

a) Taking voltage measurements
b) Opening and closing disconnects and breakers
c) Racking breakers on and off the bus
d) Removing panels and dead fronts
e) Opening electric equipment doors for inspection

2. An energized work permit shall not be required prior to doing any of these common tasks. Also when opening and closing disconnects, when possible (stand to the right side of the equipment and operate the disconnect switch with the left hand).

J. ENERGIZED ELECTRCIAL WORK PERMIT FOR 50 VOLTS AND HIGHER

1. Other than those tasks listed in paragraph I.1. above energized electrical work shall not be permitted unless one of the following conditions exists:

a) It can be demonstrated that de-energizing introduces additional or increased hazards or;
b) De-energizing is infeasible due to equipment design or operational limitations

2. If either of the above two conditions exist, and energized electrical work is necessary, an Energized Electrical Work Permit must be generated that addresses and includes the following:

a) Description of the work to be performed.
b) Justification for the work.
c) List of all safety precautions to be taken prior to, and during, the energized electrical work.
d) Proper personal protective equipment (PPE) to be worn.
e) Results of shock and flash hazard analysis.
f) Evidence of completion of a job safety briefing.
g) Signatures of the qualified electrician(s) who will be performing the work, their supervisor, their departmental director, the university electrical engineer (or his/her representative), and the Director of Environmental Health and Safety (or his/her representative).

3. The completed Energized Electrical Work Permit shall be on-site during the energized electrical work and maintained on file in the department office of the department performing, or overseeing, the work.

K. APPROACH DISTANCES TO EXPOSED LIVE PARTS

The National Fire Protection Association (NFPA) defines 2 approach distances for shock hazards and one for arc flash.

L. ENERGIZED ELECTRICAL EQUIPMENT SAFETY PROGRAM IMPLEMENTATION

1. Equipment Labeling

Article 110.16 of the NEC 2014 code **requires** switchboards, panel boards, industrial control panels, and motor control centers **to be field marked** to warn workers of potential electric arc flash hazards.

a) The term Industrial Control Panel covers every enclosure that may contain exposed energized conductors or components.

b) Marking is intended to reduce the occurrence of serious injury or death due to arcing faults to workers working on or near energized electrical equipment.

c) Markings (labels) shall be located so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment

d) Labels shall be either of the 2 examples (or similar) shown in Figure 1 of the Appendix depending on the available resources of the University.

e) The first DANGER label shall be used when information is not presently available. This is the minimum NEC 110.16 requirement.

f) The DANGER label should remind a qualified worker who intends to open the equipment for analysis or work:

- **i)** Electric arc flash hazard exists
- **ii)** Turn off all power before opening
- **iii)** Follow all requirements of NFPA 70E for safe work practices and wear appropriate personal protective equipment (PPE) for the specific hazard.

g) The second DANGER label shall be used when a qualified electrical worker or electrical engineer determines the values of the shock and flash protection information.

h) When arc flash and shock data are available for industrial control panels, labels shall include information on flash risk boundary, the energy at the flash risk boundary, voltage, glove class, limited approach distances, and restricted approach distance.

i) An unqualified person must not be near open energized equipment.

M. IMPLEMENTATION PROCEDURES

1. Immediately place danger labels on equipment required to be labeled by NEC 110.16.

2. Until an arc flash risk assessment is conducted and labels applied, a qualified electrical worker using NFPA Table 130.7(C)(15)(A)(a), 130.7(C)(15)(B), and/or 130.7(C)(15)(A)(b), shall for each situation:

a) Determine the Arc Flash PPE Category

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3. Engineering & Construction shall ensure an arc flash hazard analysis is completed as required by NFPA 70E.

a) The arc flash risk assessment shall only be completed by a licensed electrical engineer.
b) The arc flash risk assessment shall be completed on all major electrical system upgrades or renovations.
c) The arc flash risk assessment shall be done for all new electrical system installations.
d) The arc flash risk assessment is a responsibility of Engineering & Construction.
e) Supervisors and Managers should evaluate the condition of the electrical equipment and petition Engineering & Construction to conduct the arc flash risk assessment when considered immediately necessary. Reasons for conducting the analysis include the following:

i) Some equipment may be old, possibly in poor condition creating a greater potential for flashover.
ii) Equipment is requiring greater than average maintenance.
iii) Frequent use of high rated Arc Flash PPE during the conduct of maintenance. Qualified persons are frequently wearing high hazard/risk PPE.

f) Engineering & Construction shall develop an arc risk assessment analysis program including an implementation plan for all Wright State University facilities.

N. ARC FLASH RISK ASSESSMENT

1. An arc flash risk assessment includes the following:

a) Collect data on the facility's power distribution system.

i) Arrangement of components on a one-line drawing with nameplate specifications of every device.
ii) Lengths and cross-section area of all cables.

b) Contact the electric utility for information including the minimum and maximum fault currents that can be expected at the entrance to the facility.
c) Conduct a short circuit analysis followed by a coordination study.
d) Feed the resultant data into the equations from the latest editions of NFPA 70E or IEEE Standard 1584.

i) These equations produce the necessary flash protection boundary distances and incident energy to determine the minimum PPE requirement.
ii) The flash protection boundary is the distance at which PPE is needed to prevent incurable burns (2nd degree or worse) if an arc flash occurs. (It is still possible to suffer 1st or 2nd degree burns)

e) For systems of 600 volts and less, the flash protection boundary is 4 feet, based on an available bolted fault current of 50 kA (kiloamps) and a clearing time of 6 cycles (0.1 seconds) for the circuit breaker to act, or any combination of fault currents and clearing times not exceeding 300 kA cycles (5000 ampere seconds)
f) For other fault currents and clearing times, *see* NFPA 70E.

O. PERSONAL PROTECTIVE EQUIPMENT

1. General Requirements

a) Employees working in areas where there are potential electrical hazards must be provided with and use personal protective equipment (PPE) that is appropriate for the specific work to be performed. The electrical tools and protective equipment must be specifically approved, rated, and tested for the levels of voltage of which an employee may be exposed.
b) Wright State University provides the electrical protective equipment (Arc Flash Gear) required by this program. Such equipment includes Arc Flash apparel (until a full arc flash risk assessment is made), eye protection, head protection, hand protection, insulated footwear, and face shields where necessary.

2. Protective Clothing Characteristics

a) Category - Cal/cm2 - Clothing

1	5	Flame retardant (FR) shirt and FR pants
2	8	Cotton underwear, FR shirt and FR pants
3	25	Cotton underwear, FR shirt, FR pants and FR coveralls
4	40	Cotton underwear, FR shirt, FR pants and double layer switching coat and pants

b) Employees shall wear nonconductive head protection whenever there is a danger of head injury from electric shock or burns due to contact with live parts or from flying objects resulting from an electrical explosion.

c) Employees shall wear protective equipment for the eyes whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from an electrical explosion.
d) Employees shall wear rubber insulating gloves where there is a danger of hand or arm contact with live parts or possible exposure to arc flash burn.
e) Where insulated footwear is used as protection against step and touch potential, dielectric overshoes shall be required. Insulated soles shall not be used as primary electrical protection.
f) Face shields without arc rating shall not be used for electrical work. Safety glasses or goggles must always be worn underneath face shields.
g) Additional illumination may be needed when using tinted face shields as protection during electrical work.
h) Electrical Protective Equipment must be selected to meet the criteria established by the American Society of Testing and Materials (ASTM) and by the America National Standards Institute (ANSI).
i) Insulating equipment made of materials other than rubber shall provide electrical and mechanical protection at least equal to that of rubber equipment.
j) PPE must be maintained in a safe, reliable condition and be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage.
k) Employees must use insulated tools and handling equipment that are rated for the voltages to be encountered when working near exposed energized conductors or circuit. Tools and handling equipment should be replaced if the insulating capability is decreased due to damage. Protective gloves must be used when employees are working with exposed electrical parts above fifty (50) volts.
l) Fuse handling equipment (insulated for circuit voltage) must be used to remove or install fuses when the fuse terminals are energized. Ropes and hand lines used near exposed energized parts must be non-conductive.
m) Protective shields, barriers or insulating materials must be used to protect each employee from shock, burns, or other electrical injuries while that person is working near exposed energized parts that might be accidentally contacted or where dangerous electric heating or arcing might occur.

3. Flame-Resistant Apparel & Underlayers

a) FR apparel shall be visually inspected before each use. FR apparel that is contaminated or damaged shall not be used. Protective items that become contaminated with grease, oil flammable liquids, or combustible liquids shall not be used.
b) The garment manufacturer’s instructions for care and maintenance of FR apparel shall be followed.
c) When the apparel is worn to protect an employee, it shall cover all ignitable clothing and allow for movement and visibility.
d) FR apparel must cover potentially exposed areas as completely as possible. FR shirt sleeves must be fastened and FR shirts/jackets must be closed at the neck.
e) Non-melting, flammable garments (i.e. cotton, wool, rayon, silk, or blends of these materials) may be used as underlayers beneath FR apparel.

f) Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers next to skin. (An incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted).
g) FR garments worn as outer layers over FR apparel (i.e. jackets or rainwear) must also be made from FR material.
h) Flash suits must permit easy and rapid removal by the user.

4. Rubber Insulating Equipment

a) Rubber insulating equipment includes protective devices such as gloves, sleeves, blankets, and matting.
b) Insulating equipment must be inspected for damage before each day's use and immediately following any incident that could have caused damage.
c) An air test must be performed on rubber insulating gloves before each use.
d) Insulating equipment found to have defects that might affect its insulating properties must be removed from service until testing indicates that it is acceptable for continued use.
e) Where the insulating capability of protective equipment is subject to damage during use, the insulating material shall be protected by an outer covering of leather or other appropriate materials.
f) Rubber insulating equipment must be tested according to the schedule supplied by the manufacturer.
g) Rubber insulating equipment must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that my cause damage.
h) No repairs to rubber insulating equipment shall be attempted without the approval of the safety manager or coordinator.

5. Insulated Tools and Materials

a) Only insulated tools and equipment shall be used within the Limited Approach Boundary of exposed energized parts.
b) Insulated tools shall be rated for the voltages on which they are used.
c) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
d) Fuse or fuse holder handling equipment, insulated for the circuit voltage, shall be used to removed or install a fuse if the fuse terminals are energized.
e) Ropes and hand-lines used near exposed energized parts shall be nonconductive.
f) Portable ladders used for electrical work shall have nonconductive side rails.

6. Access Limiting Equipment

a) Barricades shall be used in conjunction with safety signs to prevent or limit access to work areas containing live parts. Conductive barricades shall not be used where they might cause an electrical hazard. Barricades shall be placed no closer than the Limited Approach Boundary.
b) If signs and barricades do not provide sufficient protection, an attendant will be assigned to warn and protect pedestrians. The primary duty of the attendant

shall be to keep an unqualified person out of the work area where an electrical hazard exists. The attendant shall remain in the area as long as there is a potential exposure to electrical hazards.

P. WORKING SPACE ABOUT ELECTRIC EQUIPMENT

1. Spaces About Electric Equipment

a) Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operating and maintenance of such equipment. Enclosures that house electric apparatus and are controlled by lock and key shall be considered accessible to qualified persons.

b) Working Space. 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 dimensions of 70E 400.15 (A)(1), 400.15(A)(2), and 400.15(A)(3) or as required or permitted elsewhere in the 70E Standard.

c) Depth of Working Space. The depth of the working space in the direction of live parts shall be not less than that indicated in Table 400.15(A)(1) unless the requirements of 400.15(A)(1)(a), 400.15(A)(1)(b), or 400.15 (A)(1)(c) are met. Distances shall be measured from the exposed live parts if such are exposed or from the enclosure or opening if the live parts are enclosed.

Table 400.15(A)(1) Working Spaces

Nominal Voltage to Ground	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)

Condition 1: 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 300 volts to ground shall not be considered live parts.

Condition 2: Exposed live parts on one side and grounded parts on the other side Concrete, brick, or tile walls shall be considered as grounded surfaces.

Condition 3: Exposed live parts on both sides of the work space (not guarded as provided in condition 1) with the operator between.

d) 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.

e) **Low Voltage**. Smaller working spaces can be permitted where all uninsulated parts operate at not greater than 30 volts rms, 42 volts peak, or 60 volts dc.

f) **Existing Buildings.** In existing buildings were electric equipment is being replaced, Condition 2 working clearance 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 open at the same time. Qualified electrical workers who are authorized will service the installation.

g) **Width of Working Space**. The width of the working space in front of the electrical equipment shall be the width of the equipment or 750 mm (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.

h) **Height of Working Space**. The workspace shall be clear and extend from the grade, floor, or platform to the height required by 70E 400.15(E). 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 150 mm (6 in) beyond the front of the electrical equipment.

i) **Clear Spaces**. Working space required by the 70E standard 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 spaced shall be suitably guarded.

2. Access and Entrance to Working Space

a) **Minimum Required**. At least one entrance of sufficient area shall be provided to give access to the working space about electric equipment.

b) **Large Equipment**. For equipment rated 1200 amperes or more and over 1.8 m (6ft) wide that contains overcurrent devices, switching devices, or control devices, there shall be one entrance to the required working space not less than 610 mm (24in) wide and 2.0 m (6-1/2 ft) high at each end of the working space. Where the entrance has a personnel door(s), the door(s) shall open in the direction of egress and be equipped with panic bars, pressure plates, or other devices that are normally latched but open under simple pressures. A single entrance to the required working space shall be permitted where either of the conditions in 400.14(c)(2)(a) or 400.14(c)(2)(b) is met.

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

d) **Extra Working Space**. Where the depth of the working space is twice that required by 400.15(A)(1), a singled entrance shall be permitted. It shall be located so that the distance from the equipment to the nearest edge of the entrance is not less than the minimum clear distance specified in Table 400.15(A)(1) for equipment operating at that voltage and in that condition.

3. 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.

4. Headroom

The minimum headroom of working spaces about service equipment, switchboards, panel boards, or motor control centers shall be 2.0 m (6-1.2 ft). Where the electrical equipment exceeds 2.0 m (61/2 ft) in height, the minimum headroom shall not be less than the height of the equipment.

5. 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.*

VI. Training and Recordkeeping

A. Requirements

Workers near energized, or potentially energized electrical circuitry of fifty (50) volts to ground or greater, shall be trained in energized electrical safe work practices and procedures and retrained as necessary.

B. Qualified Person

1. Qualified persons must receive training in avoiding the electrical hazards associated with working on or near exposed energized parts prior to performing energized electrical work. Such training will be provided when the employee is initially assigned to the job and refresher training will be provided every three years or when conditions change.

The following items are to be included in the training of Qualified Person:

a) The Lockout/Tagout Training Program including safe work practices required to safely de-energize electrical equipment.
b) Universal electrical safety procedures.
c) Skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.
d) Perform on-the-job training with a qualified person and signed off by their supervisor.
e) Skills and techniques necessary to determine the nominal voltage of exposed live parts.
f) The approach distances specified in Table 130.4 (D)(a) and 130.4(D)(b) and the corresponding voltages to which the qualified person will be exposed.

g) Selection and use of proper work practices, personal protective equipment, tools, insulating and shielding materials and equipment for working on or near energized parts.
h) Be familiar with the updates to NFPA 70E.

2. The following training courses offered by the Ohio Bureau of Workers' Compensation Division of Safety and Hygiene and/or OJT will meet the Qualified Persons training requirements listed above.

a) Electrical Hazard Recognition and Abatement

b) Electrical Safety Audits

3. Qualified Electrical Workers must also be trained in recognizing signs and symptoms of electric shock, heart fibrillation, electric burns, and proper first aid protocols for these conditions. They must have the following training:

a) Basic Cardio Pulmonary Resuscitation (CPR);
b) Automatic External Defibrillator (AED); and
c) Contacting emergency personnel and basic first aid.

C. Documentation of Training and Experience

Documentation of training shall be maintained in the university's EHS training database by Environmental Health and Safety. Experience received by Qualified Persons must be maintained for all personnel covered by this program. Documentation is necessary to demonstrate that individuals have met the training and experience requirements for the types of work being performed.

VII. References

A. NFPA 70-E, "Standard for Electrical Safety in the Workplace", 2015 edition.
B. IEEE Standard 1584-2002, "Guide for Performing Arc Flash Hazard Calculations".
C. OSHA 29 CFR 1910.331 through 1910.335, "Electrical Safety-Related Work Practices"**.**

VIII. Appendices

A. Figure I – Warning Labels
B. Appendix II - List of Qualified Electrical Work by Trade

IX. Approval

Implementation Date: 8-1-14 Last Reviewed: 1-14-16 Last Revision Date: 1-14-16	Approval: Stephen Farrell Director, Environmental Health and Safety Daniel Papay Associate Vice President of Facilities Management and Services	Signature: *(Signature on File)* _____ Stephen Farrell *(Signature on File)* _____ Daniel Papay

Figure 1 – Warning Labels

The following example label shall be affixed to industrial control panels (every enclosure that may contain exposed energized conductors or components) immediately:

The following label is an example of a label to be affixed to industrial control panels after arc flash hazard analysis has been completed:

Appendix I
Wright State University Electrical Safety Program
List of Qualified Electrical Work by Trade
November 2015

Casualty Prevention Worker- Qualified to reset electrical circuit breakers when the source of overload has been identified and eliminated.

Maintenance Worker- Qualified to reset electrical circuit breakers when source of overload has been identified and eliminated.
Qualified to replace light switches and outlets when they can be isolated from power source through breakers or power strips.
Qualified to replace light fixture ballast that are wired with quick disconnects or fuses.

Plumbers- Qualified to reset electrical circuit breakers associated with plumbing systems when source of overload has been identified and eliminated.
Qualified to troubleshoot electrical systems associated with plumbing equipment up to the motor control panel with proper PPE. Connects and disconnects domestic and waste water pump motors and water heaters when they can be isolated from the power source through breakers or disconnects.

HVAC Technician- Qualified to reset electrical circuit breakers associated with HVAC systems when source of overload has been identified and eliminated.
Qualified to troubleshoot electrical systems associated with HVAC equipment up to the motor control panel with proper PPE. Connects and disconnects HVAC equipment motors, motor starters, VFD's, contactors, relays and thermal overloads in a de-energized state.

Electrician- Qualified to reset electrical circuit breakers, fuses and disconnects associated with campus electrical power supply system up to arc flash rating of PPE.
Qualified to replace electrical circuit breakers and perform service to electrical circuit breaker panels with proper PPE.
Qualified to troubleshoot electrical systems associated with campus electrical equipment with proper PPE such as substations, transformers, circuit protection devices.