

Electrical Safety Program

**Facilities Management
West Virginia University**

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Introduction

Electricity is a serious workplace hazard, capable of causing both employee injury and property damage. It is the policy of West Virginia University, Facilities Management to protect all employees, students, and other personnel from potential electrical hazards. This will be accomplished through compliance with the work practices described in this policy along with effective application of engineering controls, administrative controls, and the use of personal protective equipment.

This Electrical Safety Program is founded on the principle of avoiding energized work unless it is absolutely necessary. Live parts will be de-energized before an employee works on or near them unless one of the conditions applies:

- De-energizing introduces additional or increased hazards. Examples of additional or increased hazards would include deactivation of emergency alarm systems or shutdown of hazardous location ventilation systems.
- De-energizing is not possible due to equipment design or operational limitations. Examples of this situation would include testing and troubleshooting of electrical circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.
- Live parts are operating at less than 50 volts to ground and there is no increased exposure to electrical burns or to explosion due to electrical arcs.

Purpose

This program has been established in order to:

- Ensure the safety of employees who may work on or near electrical systems.
- Ensure that employees understand and comply with safety standards related to electrical safety.
- Ensure that employees follow uniform practices during the completion of electrical work.

Responsibilities

Facilities Management Department

- Assist shops in implementing the provisions of this program.
- Provide or assist in task specific training for electrical work qualifications.
- Periodically review and update this written program.
- Provide or coordinate general training for shops on the content of this program.
- Evaluate overall effectiveness of the Electrical Safety Program on a periodic basis.

Supervisors, Operations Managers, and Managers

- Determine the applicability of the Electrical Safety Program to activities conducted within their respective areas.
- Responsible for the implementation of the Electrical Safety Program within their areas.
- Ensure employees comply with all provisions of the Electrical Safety Program.
- Ensure employees receive training appropriate to their assigned electrical tasks and maintain documentation of such training.
- Develop and maintain a listing of all qualified employees in their areas.
- Ensure employees are provided with and use appropriate protective equipment.

Employees

- Follow the work practices described in this document, including the use of appropriate protective equipment and tools.
- Attend all training required relative to this program.
- Immediately report any concerns related to electrical safety to supervision and generate a work order for corrective action.

Definitions

The following terms are defined in order to allow a better understanding of this program.

- **Arc rating:** The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to “breaking open” or at the onset of a second-degree skin burn. This rating is assigned to electrical protective clothing and is normally expressed in calories per square centimeter (cal/cm²).
- **Electrically safe work condition:** A state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, locked/tagged in accordance with Facilities management policy, tested to ensure the absence of voltage, and grounded if determined necessary.
- **Energized:** Electrically connected to or having a source of voltage.
- **Exposed (as applied to live parts):** Capable of being inadvertently touched or not suitably guarded, isolated, or insulated.
- **Flash hazard analysis:** A study to investigate a worker’s potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices along with appropriate levels of PPE.
- **Flash protection boundary:** An approach limit at a distance from exposed live parts within which a person could receive a second-degree burn if an electrical arc flash were to occur.
- **Flash suit:** A complete FR clothing and equipment system that covers the entire body, except for the hands and feet. (Such a suit typically includes pants, jacket, and a “bee-keeper” style hood or properly rated face shield).
- **FR apparel:** Flame-resistant apparel; describes a broad category of clothing designed to protect employees from electrical arc events during completion of energized tasks.
- **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 units used to measure incident energy is calories per square centimeter (cal/cm²).
- **Limited approach boundary:** An approach limit at a distance from an exposed live part within which a shock hazard exists.

- **Live parts:** Energized conductive components.
- **Prohibited approach boundary:** An approach limit at a distance from an exposed live part within which work is considered the same as making contact with the live part.
- **PPE:** An acronym for “Personal Protective Equipment”.
- **Qualified person:** One who has skills and knowledge related to the construction and operation of the electrical equipment and installation and has received training on the hazards involved.
- **Restricted approach boundary:** An approach limit at a distance from an exposed live part within which there is an increased risk of shock (due to electrical arc-over combined with inadvertent movement) for personnel working in close proximity to the live part.
- **Unqualified person:** Any person who does not meet the definition of a qualified person.
- **Working near (live parts):** Any activity within a Limited Approach Boundary.
- **Working on (live parts):** Coming in contact with live parts via tools, probes, test equipment, hands, feet, or other body parts regardless of the level of PPE worn.

Training

- Employees who are exposed to an electrical hazard that is not reduced to a safe level by the installation must be trained.
- The level of electrical safety training provided is dependent on whether the employee is classified as a “qualified person” or “unqualified person”.
- A “qualified person” shall be trained and knowledgeable in all of the following topics:
 - Construction and operation of equipment on which work is assigned.
 - Skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.

- o Skills and techniques necessary to determine the nominal voltage of exposed live parts.
- o The approach distances specified in this document and the corresponding voltages to which the qualified employee will be exposed.
- o The process necessary to determine the degree and extent of electrical hazards along with the PPE and job planning necessary to perform the task safely.
- A person can be considered qualified with respect to certain equipment and methods but unqualified for others.
- An “unqualified person” shall be trained in the inherent hazards of electricity and any related work practices that are necessary for their safety.
- Training must be provided before the employee is assigned duties that involve work near or on electrical systems.
- Environmental Health Safety (EHS) shall maintain a record of all electrical training provided to their employees for immediate access along with a listing of all qualified employees.

Working On or Near Electrical Conductors or Circuit Parts

ARTICLE 110.8

- A. General: Safety-related work practices shall be used to safeguard employees from injury while they are working on or near exposed electric conductors or circuit parts that are or can become energized. The specific safety-related work practice shall be consistent with the nature and extent of the associated electric hazards.
- 1) Live Parts—Safe Work Condition: Live parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee works on or near them, unless work on energized components can be justified according to 130.1.
 - 2) Live Parts—Unsafe Work Condition: Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.

B. Working On or Near Exposed Electrical Conductors or Circuit Parts that Are or Might Become Energized: Prior to working on or near exposed electrical conductors and circuit parts operating at 50 volts or more, lockout/tagout devices shall be applied. If, for reasons indicated in 130.1, lockout/tagout devices cannot be applied, 130.2(A) through 130.2(D)(2) shall apply to the work.

1) Electrical Hazard Analysis: If the live parts operating at 50 volts or more are not placed in an electrically safe work condition, other safety-related work practices shall be used to protect employees who might be exposed to the electrical hazards involved. Such work practices shall protect each employee from arc flash and from contact with live parts operating at 50 volts or more directly with any part of the body 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 live parts. Appropriate safety-related work practices shall be determined before any person approaches exposed live parts within the Limited Approach Boundary by using both shock hazard analysis and flash hazard analysis.

a) Shock Hazard Analysis: A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electrical shock to personnel.

FPN: See 130.2 for the requirements of conducting a shock hazard analysis.

b) Flash Hazard Analysis: A flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection Boundary and the personal protective equipment that people within the Flash Protection Boundary shall use.

FPN: See 130.3 for the requirements of conducting a flash hazard analysis.

2) Energized Electrical Work Permit: If live parts are not placed in an electrically safe work condition (i.e., for the reasons of increased or additional hazards or infeasibility per 130.1), work to be performed shall be considered energized electrical work and shall be performed by written permit only.

FPN: See 130.1(A) for the requirements of an energized electrical work permit.

- 3) Unqualified Persons: Unqualified persons shall not be permitted to enter spaces that are required to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.
- 4) Safety Interlocks: Only qualified persons following the requirements for working inside the Restricted Approach Boundary as covered by 130.2(C) 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 the work is completed.

Working On Or Near Live Parts

ARTICLE 130

Working On or Near Live Parts

130.1 Justification for Work:

Live parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Energized parts that operate at less than 50 volts to ground shall not be required to be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

- o FPN No. 1: Examples of increased or additional hazards include, but are not limited to, interruption of life support equipment, deactivation of emergency alarm systems, and shutdown of hazardous location ventilation equipment.
- o FPN No. 2: Examples of work that might be performed on or near exposed energized electrical conductors or circuit parts because of infeasibility due to equipment design or operational limitations include performing diagnostics and testing (e.g., start-up or troubleshooting) of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.
- o FPN No. 3: For voltages of less than 50 volts, the decision to de-energize should include consideration of the capacity of the source and any over current protection between the energy source and the worker.

(A) Energized Electrical Work Permit:

- 1) Where Required: If live parts 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.
- 2) Elements of Work Permit: The energized electrical work permit shall include, but not be limited to, the following items:
 - o A description of the circuit and equipment to be worked on and their location
 - o Justification for why the work must be performed in an energized condition (130.1)
 - o A description of the safe work practices to be employed [110.8(B)]
 - o Results of the shock hazard analysis [110.8(B)(1)(a)] Determination of shock protection boundaries [130.2(B) and Appendix B]
 - o Results of the flash hazard analysis (130.3)
 - o The Flash Protection Boundary [130.3(A)]
 - o The necessary personal protective equipment to safely perform the assigned task [130.3(B), Appendix C]
 - o Means employed to restrict the access of unqualified persons from the work area [110.8(A)(2)]
 - o Evidence of completion of a job briefing, including a discussion of any job-specific hazards Energized work approval (authorizing or responsible management, safety officer, or owner, etc.) signature(s)
- 3) Exemptions to Work Permit: Work performed on or near live parts by qualified persons related to tasks such as testing. Troubleshooting, voltage measuring, etc., shall be permitted to be performed without an energized electrical work permit by providing appropriate safe work practices and personal protective equipment.

130.2 Approach Boundaries to Live Parts:

- A. Shock Hazard Analysis: A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electric shock to personnel.
- B. Shock Protection Boundaries: The shock protection boundaries identified as Limited, Restricted, and Prohibited Approach Boundaries are applicable to the situation in which approaching personnel are exposed to live parts. See Appendix B for the distances associated with various system voltages.

FPN: In certain instances, the Flash Protection Boundary might be a greater distance from the exposed live parts than the Limited Approach Boundary.

- C. Approach to Exposed Live Parts Operating at 50 Volts or More: No qualified person shall approach or take any conductive object closer to exposed live parts operating at 50 volts or more than the Restricted Approach Boundary set forth in Appendix B, unless any of the following apply:
- 1) The qualified person is insulated or guarded from the live 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), and no un-insulated part of the qualified person's body crosses the Prohibited Approach Boundary set forth in Appendix B.
 - 2) The live part operating at 50 volts or more is insulated from the qualified person and from any other conductive object at a different potential.
 - 3) The qualified person is insulated from any other conductive object as during live-line bare-hand work.
- D. Approach by Unqualified Persons: Unqualified persons shall not be permitted to enter spaces that are required to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.
- 1) Working At or Close to the Limited Approach Boundary: Where one or more unqualified persons are working at or close to the Limited Approach Boundary, the designated person in charge of the work space where the electrical hazard exists shall cooperate with the designated person in charge of the unqualified person(s) to ensure that all work can be done safely. This shall include advising the unqualified person(s) of the electrical hazard and warning him or her to stay outside of the Limited Approach Boundary.
 - 2) Entering the Limited Approach Boundary: Where there is a need for an unqualified person(s) to cross the Limited Approach Boundary, a qualified person shall advise him or her of the possible hazards and continuously escort the unqualified person(s) while inside the Limited Approach Boundary. Under no circumstance shall the escorted unqualified person(s) be permitted to cross the Restricted Approach Boundary.

130.3 Flash Hazard Analysis:

A flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection

Boundary and the personal protective equipment that people within the Flash Protection Boundary shall use.

- A. **Flash Protection Boundary.** For systems that are 600 volts or less, the Flash Protection Boundary shall be 4.0 ft, based on the product of clearing times of 6 cycles (0.1 second) and the available bolted fault current of 50 kA or any combination not exceeding 300 kA cycles (5000 ampere seconds). For clearing times and bolted fault currents other than 300 kA cycles, or under engineering supervision.

- B. **Protective Clothing and Personal Protective Equipment for Application with a Flash Hazard Analysis:** Where it has been determined that work will be performed within the Flash Protection Boundary by 130.3(A), the flash hazard analysis shall determine, and the employer shall document, the incident energy exposure of the worker (in calories per square centimeter). The incident energy exposure level shall be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Flame-resistant (FR) clothing and personal protective equipment (PPE) shall be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE shall be used for any parts of the body that are closer than the distance at which the incident energy was determined as an alternative. The PPE requirements for flash hazard analysis described in Appendix G.

Approach Boundaries to Live Parts

- Observing a safe approach distance from exposed energized parts is an effective means of maintaining electrical safety. As the distance between an individual and live parts increases, the potential for an electrical injury decreases.

- Safe approach distances will be determined for all tasks in which approaching personnel are exposed to live parts.

- Safe approach distances to fixed live parts can be determined by referring to Appendix B, "Approach Boundaries to Live Parts for Shock Protection". This appendix can be used to identify the Limited, Restricted, and Prohibited Approach Boundaries associated with various system voltages.

- Unqualified persons may only cross the Limited Approach Boundary when they are under the direct supervision of a qualified person.

- Qualified persons may not cross or take any conductive object closer than the Restricted Approach Boundary unless one of the following conditions apply:

- o The qualified person is insulated or guarded from the live parts and no un-insulated part of the qualified person's body crosses the Prohibited Approach Boundary.
 - o The live parts are insulated from the qualified person and from any other conductive object at a different potential.
- Crossing the Prohibited Approach Boundary is considered the same as making contact with energized parts. Qualified persons may only cross this boundary when all of the following precautions have been taken:
 - o The qualified person has specific training to work on energized parts.
 - o The qualified person uses PPE appropriate for working on energized parts, which are rated for the voltage and energy level involved.

Other Precautions for Personnel Activities

- Employees shall not reach blindly into areas that might contain exposed live parts.
- Employees shall not enter spaces containing live parts unless illumination is provided that allows the work to be performed safely.
- Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed live parts.
- 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 live parts. Such materials and equipment include, but are not limited to, long conductive objects such as ducts, pipes, tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, and chains.
- When an employee works in a confined space or enclosed space (such as a manhole or vault) that contains exposed live parts, the employee shall obtain a Confined Space Work Permit and use protective shields, barriers, or insulating materials as necessary to avoid contact with these parts. Doors, hinged panels, and the like shall be secured to prevent them from swinging into employees.

Personal Protective Equipment

General Requirements

- Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment (Arc Flash Gear) that is designed and constructed for the specific body part to be protected and for the work to be performed.
- WVU Facilities Management will provide electrical protective equipment (Arc Flash Gear) required by this program at no cost to employees. Such equipment shall include an Arc Flash rated apparel, eye protection, head protection, hand protection, insulated footwear, and face shields where necessary. WVU Facilities Management is not responsible for providing under layers of clothing.
- All protective equipment shall be maintained in a safe, reliable condition by the employee to whom it is issued.
- Employees shall wear nonconductive head protection whenever there is a danger of a head injury from electric shock or burns due to contact with live parts or from flying objects resulting from an electrical explosion.
- Employees shall wear nonconductive protection for the face, neck, and chin whenever there is danger of injury from exposure to electric arcs or flashes or from flying objects resulting from an electrical explosion.
- Employees shall wear protective equipment for the eyes and face whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from an electrical explosion.
- Employees shall wear rubber-insulating gloves where there is a danger of hand and arm injury due to contact with live parts or possible exposure to arc flash burn.
- If an employee is wearing shoes other than hard-soled type (tennis shoes are not considered hard soled), he/she must wear dielectric overshoes or boots designed specifically for electrical work, which will be provided by the Facilities Management.
- Face shields without an arc rating will not be used for electrical work. Safety glasses or goggles must always be worn underneath face shields.
- Additional illumination may be needed when using tinted face shields as

protection during electrical work.

- For Personal Protective Clothing see Appendix E and Figure 1.

Flash Protection Boundary

- Personal protective equipment shall be provided to and used by all employees working within the “Flash Protection Boundary”.
- For systems that are 600 volts or less the Flash Protection Boundary shall be a minimum of four feet. The formula in Appendix C can be used to determine the exact Flash Protection Boundary for systems over 600 volts.
- For systems that are above 600 volts, the Flash Protection Boundary shall be determined through engineering analysis.
- The specific protective equipment to be worn within the Flash Protection Boundary can be determined by either of the following two methods:
 - Complete a flash hazard analysis that determines the incident exposure energy of each employee. Appropriate protective clothing can then be selected based on the calculated exposure level.
 - Determine the hazard level of the task by referring to NFPA 70E Appendix C, “Hazard/Risk Category Classifications” (Appendix C of this document). This table also indicates whether voltage-rated gloves and/or tools need to be used. Once the hazard level of the task has been determined, the required PPE can then be ascertained from NFPA 70E, “Protective Clothing and PPE Matrix”. (Appendix D of this document).

Flame-Resistant Apparel & Under Layers

- 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.
- The garment manufacturer’s instructions for care and maintenance of FR apparel shall be followed.
- When FR apparel is worn to protect an employee, it shall cover all ignitable clothing and allow for movement and visibility.

- FR apparel must cover potentially exposed areas as completely as possible. FR shirtsleeves must be fastened and FR shirts/jackets must be closed at the neck.
- Non-melting, flammable garments (i.e. cotton, wool, rayon, silk, or blends of these materials) may be used as under layers beneath FR apparel.
- Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric under layers next to the skin. (An incidental amount of elastic used on non-melting fabric underwear or sock shall be permitted).
- FR garments worn as outer layers over FR apparel (i.e. jackets or rainwear) must also be made from FR material.
- Flash suits must permit easy and rapid removal by the user.

Rubber Insulating Equipment

- Rubber insulating equipment includes protective devices such as gloves, sleeves, blankets, and matting.
- Insulating equipment must be inspected for damage before each day's use and immediately following any incident that could have caused damage.
- An air test must be performed on rubber insulating gloves before each use.
- 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.
- Where the insulating capability of protective equipment is subject to damage during the use, the insulating material shall be protected by an outer covering of leather or other appropriate material.
- Rubber insulating equipment must be tested according to the schedule contained in Appendix E.
- Rubber insulating equipment must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that may cause damage.

Insulated Tools and Materials

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

Alerting Techniques

- 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.
- Barricades, such as plastic fencing, must be in place if workers have to leave energized parts exposed.
- If signs and barricades do not provide sufficient protection, and attendant will be assigned to warn and protect pedestrians. The primary duty of the attendant shall be to keep unqualified persons out of the work area where an electrical hazard exists. The attendant shall remain in the area as long as there is a potential exposure to electrical hazards.

Contract Employees

- Contractors will be required to comply with applicable Safety and Health regulations such as OSHA, NFPA, EPA, etc in regards to electrical safe work practices.

Electric Arc Flash Protection

Standard Operating Procedure

It is the goal of the WVU Facilities Management to control the arc flash hazard, which occurs during the maintenance of electrical building components throughout campus. Standard operating procedures will eliminate or control arc flash events to reduce the hazard to employees.

To reduce the potential for arc flash occurrences, the following standard operating procedures will be applied:

1. De-energize all circuits before performing any maintenance on them.
2. Ensure that all possible sources of supply are found and open disconnecting devices for each source.
3. Apply Lockout/Tagout devices in accordance with the Facilities Management Lockout/Tagout procedures.
4. Test voltage on each conductor to verify that it is de-energized while wearing the appropriate PPE.
5. Apply grounding devices where stored energy or induced voltage could exist or where de-energized conductors could contact live parts.

If it is necessary to work on energized equipment; the following procedures will be applied:

1. Establish boundaries keeping those not involved with the work ten feet away.
2. Use insulated tools.
3. Consider using insulated floor mats, fire rated blankets, and other engineered solutions.
4. Wear safety glasses.
5. Wear voltage rated gloves.
6. Wear hard-soled leather work shoes or dielectric overshoes.
7. Wear appropriate arc flash protection per NFPA 70E

References:

- 1) Signals power and grounding specialists inc. "Codes and standards that require an arc fault analysis. National Electrical Code (NEC) NFPA 70" Accessed on 15 May 2010 Available from <http://www.spgs-ground.com/information/arc-flash-codes>
- 2) Electrical Construction & Maintenance "Keys to Understanding NFPA Standard A 70E" Accessed on 15 May 2010 Available from http://ecmweb.com/mag/electric_keys_understanding_nfpa/
- 3) West Virginia University "West Virginia University Environmental Health and Safety" Accessed on 14 May 2010 Available from <http://ehs.wvu.edu/r/download/28861>

Appendix A: Energized Electrical Work Permit

(Required for work over 600 volts only)

Part 1: To be completed by the requestor or supervisor of the job																	
Description of Circuit & Equipment:	Job Location:																
Description of work to be done:																	
Justification of why the circuit cannot be de-energized or the work delayed until the next scheduled outage:																	
Part 2: To be completed by the qualified person(s) completing the work																	
(1) Detailed description of procedure to be used in performing the above work:																	
(2) Description of safe work practice to be employed:																	
(3) Voltage exposure (shock hazard analysis):																	
(4) Determination of shock protection boundaries:																	
(5) Results of flash hazard analysis:																	
(6) Determination of flash protection boundaries:																	
(7) PPE required to safely perform the task:																	
(8) Method used to restrict access to the work area:																	
Do you agree the above work can be done safely? YES (proceed to Part 3) NO (return to requestor)																	
Qualified Person: _____	Date: _____																
Qualified Person: _____	Date: _____																
Qualified Person: _____	Date: _____																
Part 3: To be completed by Supervisor																	
Approvals: <table style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 20%;"></th> <th style="width: 40%;">Name</th> <th style="width: 20%;">Job Title</th> <th style="width: 20%;">Date</th> </tr> </thead> <tbody> <tr> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> <td>_____</td> <td>_____</td> </tr> </tbody> </table>			Name	Job Title	Date	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____
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Note: A supervisor must approve all energized work before starting.																	

Appendix B: Approach Boundaries to Live Parts for Shock Protection

(All dimensions are distance from live part to employee)

Nominal System Voltage (phase to phase)	Limited Approach Boundary (fixed circuit parts)	Restricted Approach Boundary (includes inadvertent movement adder)	Prohibited Approach Boundary
Less than 50V	Not specified	Not specified	Not specified
50V to 300V	3 feet, 6 inches	Avoid contact	Avoid Contact
301V to 750V	3 feet, 6 inches	1 foot	1 inch
751V to 15kV	5 feet	2 feet, 2 inches	7 inches
Over 15kV or movable conductor	See NFPA 70 E Table 130.2 (C)		

- Limited Approach Boundary:** Distance from an exposed live part within which a shock hazard exists. An unqualified person may not cross this boundary unless they are continuously escorted by a qualified person and properly suited with PPE.

- Restricted Approach Boundary:** 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. This boundary may only be crossed by a qualified person who is safely insulated or guarded from the live parts.

- Prohibited Approach Boundary:** Distance from an exposed live part within which work is considered the same as making contact with the live part. This boundary may only be crossed by a qualified person who has specific training to work on energized parts; has obtained an approved Energized Electrical Work Permit; and uses PPE appropriate for working on energized parts which are rated for the voltage and energy level involved.

- Flash Protection Boundary (not listed in table):** Distance from exposed live parts within which a person could receive a second-degree burn if an electrical arc flash were to occur. This boundary may only be crossed by a qualified person wearing the appropriate PPE. For systems that are 600 volts or less, the Flash Protection Boundary shall be a minimum of four feet. An analysis must be performed to determine the Flash Protection Boundary for systems that are above 600 volts.

Appendix C: Hazard/Risk Category Classifications

Table 130.7(C)(9)(a) Hazard/Risk Category Classifications

Task (Assumes Equipment Is Energized, and Work is Done Within the Flash Protection Boundary)	Hazard/ Risk	V-rated	V-rated
	Category	Gloves	Tools
Panel boards Rated 240 V and Below — Notes 1 and 3			
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches		Y	Y
Removal of bolted covers (to expose bare, energized parts)	1	N	N
Opening hinged covers (to expose bare, energized parts)	0	N	N
Panel boards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) — Notes 1 and 3			
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
600 V Class Motor Control Centers (MCCs) —Notes 2 (except as indicated) and 3			
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC — Note 4	3	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)		N	N
600 V Class Switchgear (with power circuit breakers or fused switches) — Notes 5 and 6			
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	2*	Y	Y
Insertion or removal (racking)) of CBs from cubicles, doors open	3	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	2*	Y	N

Removal of bolted covers (to expose bare, energized parts)	3	N	N
Opening hinged covers (to expose bare, energized parts)	2	N	N
Task (Assumes Equipment Is Energized, and Work is Done Within the Flash Protection Boundary)	Hazard/ Risk	V-rated	V-rated
	Category	Gloves	Tools
Other 600 V Class (277 V through 600 V, nominal) Equipment — Note 3			
Lighting or small power transformers (600 V, maximum)			—
Removal of bolted covers (to expose bare, energized parts)	2*	N	N
Opening hinged covers (to expose bare, energized parts)	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Revenue meters (kW-hour, at primary voltage and current)	—	—	—
Insertion or removal	2*	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
NEMA E2 (fused contactor) Motor Starters, 2.3 kV through 7.2 kV			
Contactors operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactors operation with enclosure doors open	2*	N	N
Work on energized parts, including voltage testing	3	Y	Y
Work on control circuits with energized parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized parts >120 V, exposed	3	Y	Y
Insertion or removal (racking)) of starters from cubicles, doors open	3	N	N
Insertion or removal (racking) of starters from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	3	Y	N
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Metal Clad Switchgear, 1 kV and Above			
CB or fused switch operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	4	N	N
Work on energized parts, including voltage testing	4		Y
Work on control circuits with energized parts 120 V or below, exposed	2		Y
Work on control circuits with energized parts >120 V, exposed	4	Y	
Insertion or removal (racking)) of CBs from cubicles, doors open	4	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	2	N	N
Application of safety grounds, after voltage test	4		N
Removal of bolted covers (to expose bare, energized parts)	4		N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4		N

Task (Assumes Equipment Is Energized, and Work is Done Within the Flash Protection Boundary)	Hazard/ Risk	V-rated	V-rated
	Category	Gloves	Tools
Other Equipment 1 kV and Above			
Metal clad load interrupter switches, fused or unfused	—	—	—
Switch operation, doors closed	2	N	N
Work on energized parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized parts)	4	N	N
Opening hinged covers (to expose bare, energized parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	N	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

PPE Requirements can be found in Appendix D

Additional Information:

- V-rated Gloves are gloves rated and tested for the maximum line-to-line voltage upon which work will be done.
- V-rated Tools are tools that are rated and tested for the maximum line-to-line voltage upon which work will be done.
- 2(*) means that a double-layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category requirements of Appendix D.
- Y = Yes (required)
- N = No (not required)

Notes:

1. 25 kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
2. 65 kA short circuit current available, 0.03 second (2 cycle) fault clearing time.
3. For < 10 kA short circuit current available, the hazard/risk category required may be reduced by one number.
4. 65 kA short circuit current available, 0.33 second (20 cycle) fault clearing time.
5. 65 kA short circuit current available, up to 1.0 second (60 cycle) fault clearing time.
6. For < 25 kA short circuit current available, the hazard/risk category required may be reduced by one number.

Appendix D: Personal Protective Equipment Matrix

Protective Clothing and Equipment	Protective Systems for Hazard/Risk Category						
	Hazard/Risk Category Number	-1 (Note 3)	0	1	2	3	4
Non-melting (according to ASTM F 1506-00) or Untreated Natural Fiber							
a. T-shirt (short-sleeve)	X				X	X	X
b. Shirt (long-sleeve)			X				
c. Pants (long)	X	X	X (Note 4)	X (Note 6)	X (Note 6)	X	X
FR Clothing (Note 1)							
a. Long-sleeve shirt			X	X	X (Note 9)		X
b. Pants			X (Note 4)	X (Note 6)	X (Note 9)		X
c. Coverall			(Note 5)	(Note 7)	X (Note 9)		(Note 5)
d. Jacket, parka, or rainwear			AN	AN	AN		AN
FR Protective Equipment							
a. Flash suit jacket (multilayer)							X
b. Flash suit pants (multilayer)							X
c. Head protection							
1. Hard hat			X	X	X		X
2. FR hard hat liner						AR	AR
d. Eye protection							
1. Safety glasses	X	X	X	AL	AL	AL	AL
2. Safety goggles				AL	AL	AL	AL
e. Face and head area protection							
1. Arc-rated face shield or hood				X (Note 8)			
2. Flash suit hood					X		X
3. Hearing protection (ear canal inserts)				X (Note 8)	X		X
f. Hand protection							
Leather gloves			AN	X	X		X
g. Foot protection							
Leather work shoes			AN	X	X		X
PPE Arc Flash Gear Required	N/R	N/R	4cal	8cal	25cal	40cal	40cal

Hazard categories up to 2 will require 11 calorie protection.
Hazard categories over 2 will require 40 calorie protection.

AN = As needed **AR** = As required **AL** = Select one in group **X** = Minimum required

Notes:

1. Arc rating for a garment is expressed in cal/cm².

2. If voltage-rated gloves are required, the leather protectors worn external to the rubber gloves satisfy this requirement.
3. Hazard/Risk Category Number “-1” is only defined if determined by Notes 3 or 6.
4. Regular weight (minimum 12oz/yd² fabric weight), untreated, denim cotton blue jeans are acceptable in lieu of FR pants. The FR pants used for Hazard/Risk Category 1 shall have a minimum arc rating of 11 cal.
5. Alternate is to use FR coveralls (minimum arc rating of 11 cal) instead of FR shirt and FR pants.
6. If the FR pants have a minimum arc rating of 11 cal, long pants of non-melting or untreated fiber are not required beneath the FR pants.
7. Alternate is to use FR coveralls (minimum arc rating of 11 cal) over non-melting or untreated natural fiber pants and T-shirt.
8. A face shield with a minimum arc rating of 11 cal, with wrap around guarding to protect not only the face, but also the forehead, ears and neck is required.
9. Alternate is to use two sets of FR coveralls (the inner with a minimum arc rating of 4 cal and outer coverall with a minimum arc rating of 5) over non-melting or untreated natural fiber clothing, instead of FR coveralls over the FR shirt and FR pants over non-melting or untreated natural fiber clothing.

Appendix E: Inspection Schedule for Rubber Insulating Equipment

Type of Equipment	When to Test
Rubber insulating line hose	Upon indication that insulating value is suspect
Rubber insulating covers	Upon indication that insulating value is suspect
Rubber insulating blankets	Before first issue and every 12 months thereafter (*)
Rubber insulating sleeves	Before first issue and every 12 months thereafter (*)
Rubber insulating gloves	Before first issue and every 6 months thereafter (*)

(*) – If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.

Figure 1: PPE Clothing Based on Hazard Risk Levels



Appendix F: Personal Protective Equipment and Clothing

For Most Service and Maintenance Work

Voltage	Clothing	Gloves	Other PPE
Up to 240 Volts	100% long-sleeve cotton shirt and pants	Leather Gloves	Safety Glasses Hard Hat
240 - 600 Volts	100% long-sleeve cotton shirt and pants	Class 00 or 0 Insulated Rubber Gloves w/ Leather Protectors	Safety Glasses Class E Hard Hat with 8 Cal. ATPV Face Shield
2300-4160 Volts	FR Coveralls - 9.4 ounce Indura Ultra Soft	Class 1 Insulated Rubber Gloves w/ Leather Protectors	Safety Glasses
	100% long-sleeve cotton shirt and pants		Class E Hard Hat with 8 Cal. ATPV Face Shield

Limited work on 2300V and 4160V

Synthetic fibers, such as polyester, nylon, acetate, rayon, either alone or in blends are not permitted – they melt at low temperatures, adhere to the skin and increase the extent of injury.

Appendix G: Flash Hazard Analysis

Risk Category	Min. Arc Rating of PPE	PPE Requirements - NFPA-70E 2004
0	0-2 cal/cm ²	Untreated Cotton; leather gloves; safety glasses
1	2-4 cal/cm ²	FR shirt and pants (or jeans); rubber gloves; safety glasses; hard hat
2	4-8 cal/cm ²	FR shirt and pants (or jeans); rubber gloves; safety glasses; hard hat; arc face shield
3	8-25 cal/cm ²	FR shirt and pants; rubber gloves; safety glasses; hard hat; arc hood; arc jacket
4	25-40 cal/cm ²	FR shirt and pants; rubber gloves; safety glasses; hard hat; arc hood; multi-layer flash suit