** CURI Electrical Safety Program **

1. **Purpose**

This program establishes minimum standards to prevent hazardous electrical exposures to personnel and ensure compliance with regulatory requirements applicable to electrical systems. Working on equipment in a de-energized state (Locked-out) is required unless de-energizing introduces an increased hazard or is infeasible. This program is to help ensure that only trained workers perform work safely.

It is the policy of CURI to have employees lock-out all energy sources prior to installation, repair, or replacement in order to prevent or eliminate hazards. The Electrical Safety Program specifically reinforces the need to fully comply with the Lockout / Energy Control procedure; however, it is recognized there may be situations (e.g., troubleshooting) where energy must remain to complete the task. The information contained in this document describes the procedures necessary to reduce the risk of injury related to working with electrical systems.

Energy is not only electrical but also pneumatic, hydraulic, steam stored, heat, chemical, mechanical etc.

1. **Scope**

This program applies to CURI sites that work on or near energized circuits.

Working on energized circuits means actually touching energized parts. Working near energized circuits means working close enough to energized parts to pose an electrical risk. Common tasks where employees may be working on or near energized components include but are not limited to the following:

* Verifying electrical de-energized state
* Taking voltage measurements
* Opening and closing disconnects and breakers
* Racking breakers
* Removing panel covers and dead fronts
* Opening electric equipment doors for inspection
1. **Principles that this electrical safety program is based upon:**
2. Inspect and evaluate the electrical equipment prior to work, during access and after work completion.
3. Assure the electrical equipment maintains its insulation properties.
4. Plan each job prior to work and document first time procedures.
5. De-energize the system whenever possible. Working on live components only when every control method taken and in place.
6. Anticipate unplanned events.
7. Always identify the electrical hazards associated with the type of action you will take.
8. Always protect other people from the electrical hazards that you create.
9. Make sure to use the right tools for the job.
10. Make sure the unqualified are able to perform the duties in understanding and controlling electrical exposures prior to qualifying them.
11. Annual audit of this program should assure Clemson employees and contractors are following protocol.
12. **References**
13. NFPA 70-E, “Standard for Electrical Safety in the Workplace”, 2015 edition.
14. IEEE Standard 1584-2002, “Guide for Performing Arc Flash Hazard Calculations”.
15. OSHA 29 CFR 1910.331 through 1910.335, “Electrical Safety-Related Work Practices”.
16. OSHA 29 CFR 1910.147, “The Control of Hazardous Energy (Lockout).”
17. CURI Health and Safety, “Lockout/Energy Control Program.”
18. CURI Electrical Safety Training Module
19. **Definitions**
20. Circuit Breaker: - A device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a pre-determined overcurrent without injury to itself when within its rating.
21. Conductor: -

Bare – a conductor having no cover or electrical insulation

Covered – a conductor encased within material of composition or thickness that is not recognized as insulation.

Insulated – a conductor encased within material of composition and thickness that is recognized as electrical insulation.

1. Dead Front: - Without live parts exposed to a person on the operating side of the equipment.
2. Disconnecting (or isolating) Switch: – A device designed to close and / or open an electrical circuit.
3. Energized Electrical Work: - Repair, maintenance, troubleshooting or testing of electrical circuits, components or systems while energized (i.e., live).
4. Flash Protection Boundary: - An approach limit distance from exposed live parts within which a person could receive a second-degree burn if an arc flash were to occur.
5. 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.
6. Ground Fault Circuit Interrupter – A device that interrupts the electrical circuit load when a fault exceeds a predetermined value that is less than that required to operate the overcurrent protective device of the circuit.
7. Hazardous Location: - A location where an airborne flammable dust, vapor or gas may be present and would represent a hazard if a source of ignition were present. (See NFPA Class I and II and Division I and II)
8. Incident Energy: - The amount of energy generated from an arc event that is impressed on a surface a certain distance from the source. A unit of heat usually defined in calories per square centimeter. (cal. / cm2)
9. Isolated: - Not readily accessible to persons unless special means for access are used.
10. Labeled: -Equipment is “Labeled” if there is attached to it a label, symbol, or other identifying mark of a nationally recognized testing laboratory which, a) makes periodic inspections of the production of such equipment, and b) whose labeling indicates compliance with nationally recognized standards to determine safe use in a specified manner.
11. Limited Approach Boundary: - An approach limit is a distance from an exposed live part where a shock hazard exists.
12. Electrically Competent – A person who meets all of the requirements of a qualified person and, in addition, is responsible for all work activities or safety procedures related to custom or special equipment and has knowledge regarding the exposure to electrical hazards, the appropriate control methods to reduce the risk associated with those hazards, and the implementation of those methods.
13. Qualified Person: - A Person who has demonstrated the appropriate skills and knowledge related to the construction and operation of electrical equipment and has received safety training to identify and avoid the hazards involved.
14. Restricted Approach Boundary: - An approach limit distance from an exposed live part within which there is an increased risk of shock, due to due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the live part.
15. Risk Assessment: - An overall process that identifies hazards, estimates the potential severity of injury, estimates the likelihood of occurrence of injury, and determines if protective measures are required.
16. Setting Up: - Any work performed to prepare equipment to perform its normal operation.
17. Voltage Nominal: - A value assigned to a circuit of its approximate voltage class. (plus or minus in a given range)

### Roles and Responsibilities

## Safety Department

* + 1. Responsible for the initial design and communication of the Electrical Safety Program.
		2. Serves as a continuing knowledge resource.

## Director / Employee Manager / Supervisor

* + 1. Assist in implementing the provisions of this program.
		2. Commit adequate site resources to ensure program elements are implemented.
		3. Designate a “Qualified” individual as the site representative.
		4. Has overall responsibility for the electrical safety program of their area.
		5. Provide or assist in task specific training for electrical work qualifications.
		6. Periodically review and update this written program.
		7. Provide or coordinate general training on the content of this program.
		8. Evaluate overall effectiveness of the Electrical Safety Program on a periodic basis.
		9. Periodically review this program with the customer to ensure the program meets electrical safety expectations. These meetings shall be documented.
		10. Ensure that all authorized / qualified persons receive appropriate training.
		11. Ensure appropriate Personal Protective Equipment is provided to authorized / qualified staff who work with electrical equipment.
		12. Conduct periodic Risk Assessments and observations of work and work areas.
		13. Determine the applicability of the Electrical & Arc Flash Safety Program to activities conducted within their respective areas.
		14. Responsible for the implementation of the Electrical & Arc Flash Safety Program within their areas.
		15. Ensure employees comply with all provisions of the Electrical & Arc Flash Safety Program.
		16. Ensure employees receive training appropriate to their assigned electrical tasks and maintain documentation of such training.
		17. Develop and maintain a listing of all qualified employees in their areas.
		18. Ensure employees are provided with and use appropriate protective equipment.
		19. Ensure employees are trained, qualified, and authorized to work on electrical equipment.
		20. Conduct periodic hazard analyses of work areas.
		21. Correct identified safety hazards.

## Employees

1. Follow the work practices described in this document, including the use of appropriate protective equipment and tools.
2. Attend and complete all training required relative to this program.
3. Immediately report any concerns to supervision relating to electrical safety.
4. Recognize the need for electrically safe PPE and when to use Lockout.
5. Adequately inspect and maintain PPE and other safety equipment.
6. **General Requirements for Electrical Safety – Related work practices**

A. Equipment Labeling

Electrical equipment such as switchboards, panel boards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized, are field marked with a label containing all the following information:

* + 1. Available incident energy and the corresponding working distance;
		2. Required level of PPE
		3. Nominal system voltage
		4. Arc flash boundary Labels applied prior to September 30, 2011, are acceptable if they contain the available incident energy or required level of PPE.

*In the absence of an Arc Flash Risk Assessment, “Qualified” CURI employees will use the current NFPA 70 E Table 130.7(c)(15)(a) and Table 130.7 (c)(16) to determine level of protection based upon voltage exposure. These tables can be found in Appendix A at the end of this program.*

## B. Performing a Risk Assessment:

## A Risk Assessment (Arc flash/Shock) will be completed by competent Clemson personnel to assure the severity of hazards are defined and the likelihood that the hazards will occur is considered. The Risk Assessment tool that will be used is the Safety Task Analysis (STA) form. (Appendix E) This form is adequately designed to incorporate the necessary information needed to understand exposures and how to protect against them. This energy determination should be determined and inserted as a component (severity) of the overall Risk Assessment.

## C. Approach Boundaries to Live Parts

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.

## D. Shock Protection Boundaries

The shock protection boundaries identified as Limited and Restricted Boundaries are applicable to the situation in which approaching personnel are exposed to energized parts. See [**Table 1**](#_APPENDIX_B:_Table)for the distances associated with various system voltages. (Appendix B)

## E. Approach to Exposed Energized Parts

No qualified person shall approach or take any conductive object closer to exposed energized parts than the Restricted Approach Boundary set forth in [**Table 1**](#_APPENDIX_B:_Table)unless any of the following apply:

1. The qualified person is insulated or guarded from the energized parts (insulating gloves or insulating gloves and sleeves are considered insulation only with regard to the energized parts upon which work is being performed. No uninsulated part of the qualified person’s body shall cross the Prohibited Approach Boundary setforth in[**Table 1**.](#_APPENDIX_B:_Table)
2. The energized part operating at 50 volts or more is insulated from the qualified person and from any other conductive object.
3. The qualified person is insulated from any other conductive object as during energized work.

## F. 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.

## G. 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 workspace 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.

## H. 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.

## I. Physical or Mechanical Barriers (field fabricated)

Barriers shall be installed no closer than limited approach distance given in [Table 1](#_APPENDIX_B:_Table). While the barrier is being installed, the limited approach distance specified in [Table 1](#_APPENDIX_B:_Table) shall be maintained, or the energized parts shall be placed in an electrically safe work condition

## J. Wet or Damp Locations

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

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

## K. Vehicular and Mechanical Equipment

When work must be performed near overhead lines, the lines shall be de-energized and grounded, or other protective measures shall be provided before work is started.

1. If the lines are to be de-energized, arrangements shall be made with the person or organization that operates or controls the electric circuits involved to de-energize and ground them.
2. If protective measures, such as guarding, isolating or insulating are provided, these precautions shall prevent employees from contacting such energized components directly with any part of their body or indirectly through conductive materials, tools or equipment.

## L. Elevated Equipment

Where any vehicle or mechanical equipment will be elevated near energized components and / or overhead lines, they shall be operated so that the Limited Approach Boundary distance of NFPA table 130.4(a), column 2, is maintained.

## M. Requirements for Temporary Wiring

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:

1. Use of generators >5000 Watts will require use of Ground-fault Circuit Interrupters (GFCI).
2. All equipment and tools connected by cord and plug must be grounded.
3. Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture or by providing a suitable guard or enclosure.
4. 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 when they pass through doorways or other pinch points.

**8. Training**

## Employee training will be conducted through a number of training methods. All CURI electrical training will be used to bring employees performing electrical work to a qualified level where possible. Qualified Persons shall be trained and knowledgeable of the construction and operation of equipment as well as the use of specific work methods and the ability to recognize and avoid electrical hazards that might be present. Only a qualified electrical worker will perform work on energized circuits.

A. Qualified persons;

Qualified persons permitted to work within the Limited and Restricted Approach Boundaries of exposed live parts >50 volts shall, at a minimum, be additionally trained in the following:

* 1. The skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment and the nominal voltage of live parts.
	2. The approach distances specified inTable 130.4(a) of 2015 appendix B).
	3. How to conduct a Pre Job Briefing (Appendix D) to determine actions necessary to determine the degree and extent of the hazard and the personal protective equipment necessary to perform the task safely.
	4. An employee, who is undergoing on-the-job training for the purpose of achieving qualified person status, and who has demonstrates an ability to perform specific duties safely at his or her level of training and who is under the direct supervision of a qualified person, shall be considered a qualified person for the performance of those specific duties.
	5. The selection and use of appropriate voltage detectors.
	6. The proper use of the special precautionary techniques, personal protective equipment, including arc-flash, insulating and shielding materials, and insulated tools and test equipment.
	7. Lockout energy control procedures
	8. Methods for discharging capacitive circuits
	9. Standard operating procedures as they relate to energized work.
	10. First aid and emergency response as well as the methods to release someone who is in contact with energized components. (See Appendix F)

B. Unqualified Persons:

 Unqualified Persons shall be trained in, and be familiar with:

1. Any electrical safety-related practice necessary for their safety.
2. Understanding of electrical hazards and electrical shock
3. Equipment pre-use checks
4. Hazard reporting

C**.** Documentation of Training and Experience

CURI shall document that each employee has received the training required in this section with a roster or electronic log. This documentation shall be made when the employee demonstrates proficiency in the work practices involved and shall be maintained for the duration of the employee’s employment. The documentation shall contain the content of the training, each employee’s name, and dates of training. Written documentation of this training will be kept in the CURI training log system.

D. Observations:

To assure electrical work is being performed properly, qualified employees will conduct periodic observations of employees performing work.

1. Periodic observations / inspections will be conducted at least annually to assure each employee is complying with the safety-related work practices specified by this program and the NFPA 70E Standard. These will be accomplished through the use of an observation checklist while the employee is performing electrical work.
2. An employee will receive additional training (or retraining) under the following conditions:
3. If supervision or inspections indicate that an employee is not following safety-related work practices.
4. If new technology, new types of equipment, or changes in procedures necessitate the use of different safety-related work practices than the employee would normally use.
5. Refresher training shall be performed at intervals not to exceed three years.

**9. Energy Control / Energized Work Permit**

1. Energized work shall be permitted where it can be justified that de-energizing introduces additional hazards or increased risk. Examples of these include, but are not limited to:
2. Interruption of life-support equipment
3. Deactivation of emergency alarm systems
4. Shutdown of ventilation equipment in hazardous areas
5. Energized Work Permit: (Appendix C)
6. If energized parts are not placed in an electrically safe or de-energized state, the work is considered energized electrical work and **shall** be performed by written permit only!
7. Qualified persons are the only people permitted to work in the limited, restricted and prohibited boundaries.
8. The Energized Work permit shall be utilized when working on energized equipment.
9. Persons must utilize all available safety measures to protect themselves from harm.

## Exemptions to Work Permit:

1. Work performed on or near energized parts by qualified persons related to routine tasks such as testing, troubleshooting, voltage measuring, etc. shall be permitted to be performed without an energized electrical work permit, provided appropriate safe work practices and personal protective equipment are used. (An STA – Safety Task Analysis) can also be used for evaluating the hazards.

**10. Personal Protective Equipment: for application with a Risk Assessment**

1. Shock Hazard
2. When an employee is working within the restricted approach boundary, they shall wear personal protective equipment in accordance with NFPA 70E 2012 Table 130.7 (C)(15)(a).
3. Electrical gloves used for electrical shock protection must be inspected prior to use to assure they have been certified within the last six (6) months.
4. Black gloves should be worn the first half of year and red gloves the second half of year for observation purposes and to assure 6 month recertification.
5. Arc Flash Hazard

1. When an employee is working within the arc flash boundary, he or she shall wear protective clothing and other personal protective equipment in accordance with the arc flash Risk Assessment for each job. The arc flash incident energy information can be obtained via the label for the circuit or by using the NFPA 70E 2015 Table 130.7 (C)(15)(a). All parts of the body inside the arc flash boundary shall be protected using the appropriate hazard category.

**11. Analysis Using the Risk Assessment Matrix Method**

1. When performing the risk Assessment, to determine the likelihood of an event occurring, the Risk Assessment Method will be used. This method is a simple matrix where the X axis is the severity of the event, and the Y axis is the likelihood of the event. The below matrix values can be referenced to determine what the likelihood of the event is by reading the STA and understanding the values. 

1. Work should only be performed when the likelyhood of an event occurring is “unlikely” or “seldom” . This is while using all protective and prevention means such as PPE and work practice controls.

**12. Corrective Measures**

Constant awareness of the Electrical Safety program, and compliance with all safety rules are required. Employees that are observed performing work that is not consistent with the above safety procedure, or any safety procedure, which is grossly negligent or of immenent danger to oneself or others, may lead to termination of employment following the protocols of the state of South Carolina and Clemson University.

1. Refer to the disciplinary process outlined in the human resource manual

**APPENDIX A (TASK CHART)**

Table l30.7(C)(l5)(a) *Continued*

|  |  |  |  |
| --- | --- | --- | --- |
| **Tusks Performed on Energized Equipment** | **Hazard/Risk**Category | Rubber **Insulating Gloves** | **Insulated and Insulating Hand Tools** |
| 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 electrical conductors and circuit parts, including voltage testing | 2 | y | y |
| Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed | 0 | y | y |
| Work on control circuits with energized electrical conductors and circuit parts>120 V, exposed | 2 | y | y |
| Application of temporary protective grounding equipment, after voltage test | 2 | y | N |
| Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center | 2 | y | y |
| **600 V class motor control centers (MCCs)**Parameters:Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time; minimum 18 in. working distancePotential arc flash boundary with exposed energized conductors or circuit partsusing above parameters: 165 in. |  |  |  |
| Insertion or removal of individual starter "buckets" fro1n MCC | 4 | y | N |
| Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts) | 4 | N | N |
| Opening hinged covers (to expose bare, energized electrical conductors and circuit parts) | 1 | N | N |
| **600 V class switchgear (with power circuit breakers or fused switches) and**600 V class switchboards Parameters:Maximum of 35 kA short circuit current available; maximum of up to 0.5 sec (30 cycle) fault clearing time; minimum 18 in. working distancePotential arc flash boundary with exposed energized conductors or circuit partsusing above parameters: 233 in. |  |  |  |
| Perform infrared thermography and other non-contact inspections outside the restricted approach boundary | 2 | N | N |
| 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 electrical conductors and circuit parts, including voltage testing | 2 | y | y |
| Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed | 0 | y*'$* | y |
| Work on control circuits with energized electrical conductors and circuit parts>120 V, exposed | 2 | y | y |

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Table 130.7(C)(15)(a) *Continued*

|  |  |  |  |
| --- | --- | --- | --- |
| **Tasks Performed on Energized Equipment** | **Hazard/Risk Category** | Rubber **Insulating Gloves** | **Insulated and Insulating Hand Tools** |
| Insertion or removal (racking) of CBs from cubicles, doors open or closed | 4 | N | N |
| Application of temporary protective grounding equipment after voltage test | 2 | y | N |
| Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts) | 4 | N | N |
| Opening hinged covers (to expose bare, energized electrical conductors and circuit parts) | 2 | N | N |
| Other 600 V class (277 V through 600 V, nominal) equipmentParameters:Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing tine; minimum 18 in. working distance (except as indicated)Potential arc flash bounda1y with exposed energized conductors or circuit partsusing above parameters; 53 in. |  |  |  |
| Lighting or small power transformers (600 V, maximum) | 2 | N | N |
| Removal of bolted covers (to expose bare, energized electrical conductors and |
| circuit parts) |  |  |  |
| Opening hinged covers (to expose bare, energized electrical conductors and | 1 | N | N |
| circuit parts)Work on energized electrical conductors and circuit parts, including voltage | 2 | y | y |
| testingApplication of temporary protective grounding equipment, 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 re1noval or installation | 1 | N | N |
| Work on energized electrical conductors and circuit parts, including voltage testing | 2 | y | y |
| Application of temporary protective grounding equipment, after voltage test | 2 | y | N |
| Insertion or removal of plug-in devices into or from busways | 2 | y | N |
| **NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV**Parameters:Maximum of 35 kA short circuit cu1rent available; maximum of up to 0.2 sec (12 cycle) fault clearing time; minimum 36 in. working distancePotential arc flash boundary with exposed energized conductors or circuit partsusing above parameters: 422 in. |  |  |  |
| Perform infrared thermography and other non-contact inspections outside the restricted approach boundary | 3 | N | N |
| Contactor operation with enclosure doors closed | 0 | N | N |
| Reading a panel meter while operating a meter switch | 0 | N | N |
| Contactor operation with enclosure doors open | 2 | N | ' N |
| Work on energized electrical conductors and circuit parts, including voltage testing | 4 | y | y |
| Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed | 0 | y | y |
| Work on control circuits with energized electrical conductors and circuit parts>120 V, exposed | 3 | y | y |

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APPENDIX B (TABLE 1)

TABLE 1- APPROACH BOUNDARIES TO ENERGIZED ELECTRICAL CONDUCTORS
OR CIRCUIT PARTS LIVE PARTS FOR SHOCK PROTECTION
FOR ALTERNATING-CURRENT SYSTEMS - (TABLE 130.4(D)(a) 2015 NFPA 70E)

|  |  |  |  |
| --- | --- | --- | --- |
| (1) | (2) | (3) | (4) |
|  | **Limited Approach Boundary** | **Restricted Approach Boundary** |
| **Nominal System Voltage Range, Phase to Phase** | **Exposed Movable Conductor** | **Exposed Fixed Circuit Part** | **Includes Inadvertent Movement Adder** |
| Less than 5V | Not Specified | Not Specified | Not Specified |
| 50V to 300V | 10ft | 3ft 6in | Avoid Contact |
| 301V to 750V | 10ft | 3ft 6in | 1ft |
| 750V to 15kV | 10ft | 5ft | 2ft 2in |
| 15.1kV to 36kV | 10ft | 6ft | 2ft 7in |
| 36.1 kV to 46 kV | 10ft | 8ft | 2ft 9in |
| 46.1kV to 72.6 kV | 10ft | 8ft | 3ft 3in |
| 72.6kV to 121kV | 10ft 8in | 8ft | 3ft 4in |
| 138kV to 145kV | 11ft | 10ft | 3ft 10in |
| 161kV to 169kV | 11ft 8in | 11ft 8in | 4ft 3in |
| 230kV to 242kV | 13ft | 13ft | 5ft 8in |
| 345kV to 362kV | 15ft 4in | 15ft 4in | 9ft 2in |
| 500kV to 550kV | 19ft | 19ft | 11ft 10in |
| 765kV to 800kV | 23ft 9in | 23ft 9in | 15ft 11 in |

APPENDIX B (TABLE 2)

TABLE 1- APPROACH BOUNDARIES TO ENERGIZED ELECTRICAL CONDUCTORS
OR CIRCUIT PARTS LIVE PARTS FOR SHOCK PROTECTION, DIRECT CURRENT VOLTAGE SYSTEMS
- (TABLE 130.4(D)(b) 2015 NFPA 70E)

|  |  |  |  |
| --- | --- | --- | --- |
| (1) | (2) | (3) | (4) |
|  | **Limited Approach Boundary** | **Restricted Approach Boundary** |
| **Nominal Potential Difference** | **Exposed Movable Conductor** | **Exposed Fixed Circuit Part** | **Includes Inadvertent Movement Adder** |
| Less than 100V | Not Specified | Not Specified | Not Specified |
| 100V - 300V | 10ft | 3ft 6in | Avoid Contact |
| 301 V – 1 kV | 10ft | 3ft 6in | 1ft |
| 1.1 kV - 5kV | 10ft | 5ft | 1ft 5in |
| 5 kV - 15kV | 10ft | 5ft | 2ft 2in |
| 15.1 kV - 45 kV | 10ft | 8ft | 2ft 9in |
| 45.1kV - 75 kV | 10ft | 8ft | 3ft 2in |
| 75.1 kV – 150 kV | 10ft 8in | 10ft | 4ft 0in |
| 150.1 kV – 250 kV | 11ft 8in | 11ft 8in | 5ft 3in |
| 250.1 kV – 500 kV | 20ft 0in | 20ft 0in | 11ft 6in |
| 500.1 kV – 800 kV | 26ft | 26ft | 16ft 5in |

APPENDIX C

ENERGIZED WORK PERMIT

**ENERGIZED ELECTRICAL WORK PERMIT**

 **TO BE COMPLETED BY THE REQUESTER:**

 (1) Description of circuit/equipment/job location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Description of work to be done: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Start Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Expire Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Requester/Title\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

|  |  |  |
| --- | --- | --- |
| 1 | Detailed procedure to be used in performing the above detailed work including hazards, conditions, mechanical, environmental, space obstructions, other voltages:­­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_   |  |
|  | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
|  |  |  |
| 2 | Description of the Safe Work Practices: [ ]  LOTO [ ]  Two Workers [ ] Safety Watch [ ] Notify affected workers [ ] \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Reason not to LOTO \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  |  |
|  |  |  |
|  | Restart Checks Required: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
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| 3 |

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| --- | --- | --- | --- | --- | --- |
| Flash Hazard (0 to 4) |  | Shock Hazard (max V) |  | Working Distance |  |
| Flash Boundary |  | Limited Approach |  | Glove Class, minimum |  |
| Incident Energy (cal/cm2) |  | Restricted Approach |  | Voltage Hazard(Volts) |  |
| Prohibited Approach |  |

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|  |

 |  |
| 4 |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Protective Equipment

|  |  |  |  |
| --- | --- | --- | --- |
| [ ]  Natural Fiber Clothing | [ ]  Safety Glasses/Goggles | [ ]  Ear Plugs | [ ]  Leather Shoes |
| [ ]  FR Clothing | [ ]  Face Shield | [ ]  Leather Gloves | [ ]  Voltage-rated Shoes |
| [ ]  Voltage-rated Tools | [ ]  Balaclava Hood  | [ ]  Voltage-rated Gloves  | [ ]  Hard Hat  |
| [ ]  Category III Meter | [ ]  2 Layer Switching Hood | [ ]  Flash suit  | [ ]  Other |

 |
| Other: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

 |  |
| 5  | Means employed to restrict the access of unqualified persons from the work area: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |

 6 **Qualified Workers**  **Date Initials**

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:**

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Department Manager/Designee Date Electrically Knowledgeable Person/ Engineer Date

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Independent Reviewer Date

**PART IV: WORK**

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| --- | --- | --- |
|  | Evidence of completion of Job Briefing including discussion of any job-related hazards: |  |
|  | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |  |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Manager/Representative Close-out Date

APPENDIX D

Pre-Job Briefing

**CURI JOB BRIEIFING AND PLANNING CHECKLIST**

**Identify:**

 The hazards

 The voltage levels involved

 Skills required

 Any “foreign” (secondary source)

 Any unusual work conditions

 Number of people needed to do the job

 The shock protection boundaries

 The available incident energy

 Potential for arc flash (Conduct a flash-hazard analysis)

 Flash protection boundary

**Ask:**

 Can the equipment be de-energized?

 Are back-feeds possible?

 Is a “standby person” required?

**Check:**

 Job plans

 Single-line diagrams and prints

 Status board

 Information on plant and vendor resources is up to date

 Safety Procedures

 Vendor Information

 Individuals are familiar with the facility

**Know:**

 What the job is

 Who else needs to know-Communicate!

 Who is in charge?

**Think:**

 About the unexpected event (what if).

 Lock-Tag-Test-Try

 Test for voltage-FIRST

 Use the right tools and equipment including PPE

 Install barriers and barricades

**Prepare for and emergency:**

 Is the standby person CPR trained?

 Is the required emergency equipment available? Where is it?

 Where is the nearest telephone?

 Where is the fire alarm?

 Is confined space rescue available?

 What is the exact location?

 How is the equipment shut off in an emergency?

 Are the emergency telephone numbers known?

 Where is the fire extinguisher? Are radio communications available?

APPENDIX E

SAFETY TASK ANALYSIS (STA)

RISK ASSESSMENT



**APPENDIX F**

**Electrical Emergency Response and Proper Release Methods**

Clemson Qualified personnel will receive training on how to respond to an electrical emergency. Every work task should include a plan to include response if an event were to occur. Where there is potential for electrical shock, the emergency plan should assure that the appropriate assistance is provided to the person in need without endangering the safety of would be responders.

The following 5 steps should be followed:

1. Approach: Call 911 immediately or have someone else do it as you respond. The approach to where the coworker has succumbed to shock must be made cautiously. Make sure the electrical current does not harm you by taking appropriate actions.
2. Examine: A quick look at the incident scene will reveal whether the coworker remains in contact with the electrical source. Avoid any nearby conductors and don’t touch the victim until all power to the area has been de-energized.
3. De-Energize: Flip the electrical interrupt for the area or simply unplug any cord-powered equipment. (The energy source must be identified in the planning stage.)
4. Insulate: If de-energization is impossible, you may have to remove the victim from an energized source. CURI has “electrical sticks” that are insulated and used for this purpose. This equipment should be staged nearby the work area prior to work start.
5. Rescue: Make sure the power is off and render assistance to the victim. Provide proper 1st aid / CPR / AED assistance if you are properly trained to do so.