

TITLE:

**FACILITIES SERVICES  
ELECTRICAL SAFETY PROGRAM**

INSTRUCTION NUMBER:

**33-4016**

# **EAST CAROLINA UNIVERSITY FACILITIES SERVICES ELECTRICAL SAFETY PROGRAM**

FACILITIES SERVICES STANDARD PRACTICE

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## **1. FORWARD**

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The procedures and policies written in this electrical safety program document are a compilation of all the safety policies and programs that every facilities maintenance employee is expected to know and put into practice daily in the performance of their job. Safety covers a very broad spectrum of issues and programs. As such, any effective safety program is the product of collaboration and shared responsibility. This is certainly true here at East Carolina University. At ECU we pride ourselves on the strong relationship that exist between Facilities Services, Environmental Health and Safety and Prospective Health. These three areas form the three legs of our safety program. Each leg having specific roles and responsibilities related to safety as well as unique technical expertise. This document will not attempt to dive into great detail on each and every program or policy but focus rather on the details of those policies and programs as relates to electrical safety for which Facilities Services is responsible in some form or fashion. The scope of this document includes multiple areas beyond electrical safety that an individual could be anticipated to encounter in the course of doing electrical work but is not exhaustive. Programs that are administered by Environmental Health and Safety or Prospective Health will be noted and how their program/policy documentation can be accessed.

The safety of our staff, students and guests holds priority over any other facet of our operation. As such we take very seriously this duty and responsibility. Every member of our team should make themselves intimately familiar with this document and the programs and policies it details. Full compliance is not just a request but a requirement. Continuous improvement is a cornerstone of our operation. As such our safety programs and policies are continually evolving as we integrate lessons learned and new best practices. Safety is not just the responsibility of management but of every member of our team. We expect every employee to be ever vigilant in looking for potential hazards, providing feedback on how to improve our programs, and searching out new and innovative ways to create a safer workplace.

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## **2. ADMINISTRATIVE PROCEDURES**

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### **A. PURPOSE AND SCOPE**

The procedures and policies documented in this safety program are a compilation of all the safety policies and programs that all facilities maintenance staff are expected to know and put into practice daily in the performance of their job. This document details the roles and responsibilities of Facilities Services staff

### **B. RESPONSIBILITIES**

#### **Associate Vice Chancellor for Campus Operations**

The AVC will:

- Charge Campus Operations Director level staff to ensure that all required or recommended safety programs are in place and effective in protecting the health and safety of all Campus Operations staff.
- Request a review the current Safety Programs established herein every three years.
- Provide the required resources necessary to support and sustain the Electrical Safety Program

#### **Facilities Services Directors**

The Directors will:

- Review the current Safety Program established herein every three years.
- Monitor the implementation and enforcement of the policies and procedures established by the safety program as well as the requirements set forth by federal, state and local regulations.
- Review the conditions of the workplace and jobsites.
- Develop an effective plan to address the abatement of hazards.
- Provide on-going safety training to workers, supervisors and management.
- Maintain all records and documents associated with the safety program and generate all required reports.
- Conduct accident and incident investigations and provide corresponding reports.
- Maintain an effective system of communication between workers, supervisors and management relevant to the safety program and abatement of hazards.
- Communicate ECU policies and procedures to contractors and subcontractors and ensure that all work is performed in a safe and compliant manner.

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- Conduct a periodic review of the electrical safety program, as a whole, and make revisions as needed to address changing regulations or conditions.
- Ensure subordinates are auditing activities in the field and enforcing the policies contained herein.

## **Assistant Directors**

Management will:

- Provide the time, resources and authority needed to execute the electrical safety program.
- Monitor the progress of the safety program and take action to ensure its success. This will include the review of incident reports, accident reports, policies, procedures, written communications, and disciplinary actions taken by supervisory staff.
- Lead by example and follow the same policies, procedures and rules established for the staff.

## **Supervisors**

Supervisors will:

- Ensure a "competent person" is available as needed for each jobsite. Competent persons will have the knowledge to recognize hazards and the authority to take appropriate action.
- Inspect and monitor their assigned jobsites. They will ensure that all work is performed safely and in accordance with federal, state, and local regulations as well as the policies, procedures and rules established by this program.
- Enforce the policies, procedures, and rules established in the safety program in accordance with ECU's disciplinary policy.
- Assist in the on-going training of workers by conducting periodic safety talks and activities. They will also bring any problems or concerns of the workers to the attention of management, The Electrical Safety Program Team, Facilities Safety Committee or Environmental Health and Safety.
- Annually review and update Position Profiles and submit to the ESPT for updating the database.
- Ensure all new or transferred employees complete the appropriate electrical safety training before releasing staff to work.

## **Employees**

All employees are:

- Required to work safely in accordance with state, federal and local regulations as well as the rules established by East Carolina University. This will include, but is not limited to, OSH Act 5(b) *"Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct."*

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- Required to notify their supervisor immediately of any unsafe acts, conditions, or job task concerns.
- Encouraged to take an active role in the safety program and make recommendations to improve any and all parts of the program.

## **Electrical Safety Program Team (ESPT)**

ESPT will:

- Report to the AVC for Campus Operations
- Be composed from all levels of Facilities Services
- Have management representatives
- Work to build an effective electrical safety culture at ECU
- Maintain all documentation related to the ESP
- Distribute Position Profiles to supervisors for review

## **Facilities Services Safety Committee (FSSC)**

FSSC is:

- The Facilities Services Safety Committee is a formal forum for the communication, discussion, and resolution of broad-based safety concerns and issues within Facilities Services.

## **C. GENERAL SAFETY RULES**

- In addition to those detailed in the ESP, other applicable procedures and policies can be found at the following locations:
  - Campus Operations: <https://campusoperations.ecu.edu/>
  - Environmental Health and Safety: <https://oehs.ecu.edu/>
  - Prospective Health: <https://prospective-health.ecu.edu/>
- All safety policies and procedures must be followed.
- Horseplay, scuffling and other acts which tend to endanger the safety or well-being of employees are prohibited. Fighting or instigating fights will not be tolerated.
- All injuries shall be reported promptly to the supervisor/assistant director/supervisor so that arrangements can be made for medical and/or first aid treatment.
- Employees should check to see that all guards and other protective devices are in place, and properly adjusted and shall report deficiencies to their immediate supervisor.
- Employees shall not handle or tamper with any electrical equipment, machinery, or *air/water/steam/gas* lines in a manner not within the scope of their duties unless they have received instructions from their supervisor. Only trained and authorized employees shall operate machinery, equipment, tools or vehicles.
- All tools and equipment must be inspected before and after each use. NEVER use damaged

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equipment. Employee shall tag defective tools / equipment as "Out of Service" and shall notify their immediate supervisor.

- Observe all warning signs and tags. Ask your supervisor if you are not sure what they mean.
- All power tools and sources of ignition that may be present shall be turned off or disconnected before working with solvent materials with a low flashpoint. Smoking is only allowed in designated areas.
- EH rated work shoes are required for all staff who may come in contact with energized equipment or conductors. Preferably high top leather with nonskid soles. Inappropriate footwear shall not be worn. Dielectric boots should be worn as needed. Arc Rated clothing may be needed per our Electrical Safety Program. Proper PPE must be worn when necessary. Loose or frayed clothing, dangling ties, finger rings, etc. must NOT be worn around moving machinery or other places where they can get caught.

**In addition to the rules established here, employees are expected to follow all safety policies, procedures and instructions provided in training and jobsite specific safety programs.**

## D. ACCIDENTS / INCIDENTS

### **If an Accident Occurs Follow ECU Protocols for investigation and reporting**

**In cases of a life threatening or severe accident call 911 immediately.**

If an injured worker needs minor medical treatment, either escort or direct the employee to the Office of Prospective Health. If the injured worker cannot be moved due to the nature of the accident or immediate attention is required (i.e., they have stopped breathing or have gone into cardiac arrest) individuals trained as first responders are expected to administer first aid or CPR until EMS arrives.

Supervisory personnel are required to immediately take the appropriate corrective action that will ensure the prevention of future accidents and/or incidents.

Environmental Health and Safety will ensure that a thorough investigation of the incident/accident is made and that additional corrective action, if required, is taken.

The ESPT shall investigate all electrical related incidents to determine the cause and implement any changes needed to the ESP to prevent future occurrences.

In the case of a fatality or hospitalization of three or more employees, Environmental Health and Safety will notify the local OSHA Office to report the accident within 8 hours of being notified.

Supervisors must also ensure that a complete first aid/AED kit is always available to first responders .

Before an injured worker may return to work, they must provide a medical work release form, signed by their physician. Returning to work with any kind of restriction must be approved by the Office of Prospective Health.

### **Accident / Incident Reporting**

**Supervisors are required to document and report all work-related accidents, incidents,**

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**fatalities and job related illnesses to the Assistant Director and EH&S immediately (no later than by the end of the work shift). Incidents include “Near Misses”**

## **Unsafe Acts / Conditions**

Supervisors must also report and/or rectify any unsafe acts or conditions immediately.

Unsafe acts and conditions observed by any employee should immediately be brought to the attention of their immediate supervisor.

## **Auditing ESP**

- This Electrical Safety Program shall be audited to verify the principles and procedures follow NFPA 70E. The frequency of the audit shall not exceed 3 years and shall be documented. The ESPT shall be responsible for this audit, reporting the findings to the AVC for Campus Operations, and implementation of corrective actions or modifications to the ESP.
- Field work shall be audited to verify the requirements contained in the procedures of the Electrical Safety Program are being followed. When the auditing determines that the principles and procedures of the Electrical Safety Program are not being followed, the appropriate revisions to the training program or revisions to the procedures shall be made. See FSSP 33-4016.2.
- The Departments shall conduct a periodic, documented, audit of live electrical work safety procedures. Supervisors/ESPT Members will perform the audit. Departments may use this audit to correct any deviations or inadequacies identified. See FSSP 33-4016.2.
- The audit shall include direct observation of electrical work methods and verification that procedures are appropriate, understood, and implemented. Supervisors must also report or rectify any unsafe acts or conditions immediately.

Unsafe acts and conditions observed by any employee should immediately be brought to the attention of their immediate supervisor.

## **E. RECORDS**

Facilities Services shall maintain copies of all electrical safety training records for the duration of any staff members employment

Environmental Health and Safety will ensure that all records and documents related to the safety program are properly maintained. This will include material safety data sheets, accident/incident reports, and the OSHA Log and Summary.

Environmental Health and Safety will ensure accidents are entered in the OSHA log within 6 days of knowledge of the accident.

Requests for safety related documents should be submitted to Environmental Health and Safety.

## **F. COMMUNICATION AND TRAINING**

No employee shall be allowed to perform a job or task unless they have received training on the hazards present and the precautions necessary to perform the job safely. Facilities Services in partnership with Environmental Health and Safety will ensure the following training is provided:

### **Qualified Electrical Workers (QEW):**



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## 1. Initial LV and HV Training

Each newly hired worker will complete the appropriate electrical safety training prior to being released to work unsupervised. Participants will be instructed in all elements of ECU's Electrical Safety Program and will complete all safety training required by federal, local agencies and ECU

## 2. Refresher Training

On-going safety training will be a primary component of ECU's safety program. This training may take the form of classroom or on-the-job instruction. Facilities Services in collaboration with EH&S and Prospective Health will establish a training agenda. This agenda will include all refresher training required by federal, state and local agencies. The training agenda will also be based on a recent hazard analysis and review of accident/incident reports.

## 3. Hazard Specific Training

Before beginning any job, a review of the hazards will be conducted by the qualified individual. Training will be provided for any new hazards introduced to the workers. This may include the introduction of new substances, equipment, tools, processes or procedures.

### **Non-Qualified Electrical Worker (Non-QEW) Specific Training**

1. Certain positions based on the position's roles and responsibilities will receive electrical safety awareness training but will not be considered Qualified Electrical Workers (QEW).
2. Non-QEW can only perform electrical work on hard-wired equipment that has been placed in an Electrically Safe Work Condition (ESWC) provided that:
  - A Qualified Electrical Worker (QEW) places the equipment in an ESWC.
  - All persons join the LOTO in accordance with ECU policy
  - A QEW provides direct field supervision of any electrical work performed while in an ESWC
  - A QEW performs Test Before Touch every time that job continuity is interrupted
  - A Non-QEW may not perform any operation that does not meet the requirements for "Normal Operation":
    - a) The equipment was properly installed in accordance with applicable industry codes and standards and the manufacturer's directions
    - b) The equipment has been properly maintained by qualified persons
    - c) The equipment is used in accordance with the instructions included in the listing and labeling in accordance with manufacturer's instructions
    - d) The equipment doors are closed and secured
    - e) All equipment covers are in place and secured
    - f) There is no evidence of impending failure
    - g) There is no history of failures
3. Where the conditions for normal operation are not satisfied, it is assumed that a shock or arc flash hazard may exist when operating the equipment. Operation by a Non-QEW is not permitted.
4. A Non-QEW may not perform any task within the Restricted Approach Boundary of exposed live parts that have not been placed in an ESWC by a QEW.
5. A Non-QEW may perform the following types of tasks:
  - a) Normal operation of approved electrical equipment

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- b) Non-hazardous switching, where there is no shock or arc flash hazard, and the equipment meets all requirements for normal operation
- c) Enter the Limited Approach Boundary (LAB) of exposed live parts that have not been placed in an ESWC, if escorted by a QEWS provided they are wearing all the required PPE
- d) Any work that does not involve the modification, repair, build or assembly of electrical circuit parts or wiring designed to operate above 50 VAC, within the Limited Approach Boundary of exposed parts that have been placed in an ESWC. Zero Voltage Verification (ZVV) must be performed by a QEWS and the Non-QEWS must apply a personal LOTO lock in accordance with the ECU Electrical Safety Program (ESP).
- e) Perform voltage and current measurements on circuits or equipment operating below 50 VAC, provided that they are outside the Limited Approach Boundary or Arc Flash Boundary of other exposed energized parts operating above 50 VAC.

## **Training Curriculum**

The training curriculum that is used for the electrical safety classes delivered by ECU staff on site at ECU are based on the nationally recognized program developed by e-Hazard

## **Job Planning and Job Briefings**

Job safety planning should occur before any work (See FSSP 33-4016.3). In the course of typical daily maintenance and repair tasks staff should make a risk assessment upon arriving at the work site. Identify hazards associated with the task, make a shock and arc flash risk assessment and follow all procedures, special precautions and energy source controls. This assessment does not always require a formal job briefing/planning document. Exception: if the job involves any of the following, then the supervisor or the Responsible Individual shall document a job plan and conduct a formal job briefing: multiple staff, multiple trades, multiple energy sources, complex LO/TO, or energized work. Briefings will be performed per ECU protocols and the briefings checklist shall be used. The job briefing will identify job assignments, procedures to be followed and the actions that will be taken to protect workers in the performance of their assigned tasks. Additional briefings will be conducted as tasks, assignments or conditions warrant.

## **Safety Talks/Shop Meetings**

EH&S will ensure that periodic safety talks, activities and meetings are conducted by Facilities Services. Refresher training will be provided to workers as well as training to introduce new policies, procedures, and hazard controls to be applied. The meetings will also serve as a means for workers to bring safety concerns to the attention of management.

## **Management/Supervisor Training**

Training will be provided to management and supervisors. This training will address the requirements of OSHA regulations and best safety practices used in our industry. Training will be provided on an on-going basis so that our safety program is kept current and effective. All

## **ESP Trainers**

ECU will ensure that those individuals responsible for providing in-house training are competent and stay current on the subject matter. This will include regular training to maintain proficiency and qualifications for delivering curriculum

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## F. SAFETY EVALUATIONS AND INSPECTIONS

Each employee will perform a safety check of the work area at the beginning of each work assignment. They will also check equipment, tools and personal protective equipment **before each use**.

The supervisor will evaluate their campus for hazards and ensure that a plan is established to abate any known hazards. They will ensure that hazards are abated in accordance with federal, state, and local regulations as well as the policies, procedures and rules established by ECU.

Supervisors will monitor activity throughout each workday so that incidents/accidents are prevented.

The Electrical Safety Program Team and EH&S will perform periodic audits. A report of the inspections will be generated, and action taken to improve the safety and health of workers.

Facilities Services, in consultation with the ESPT, will develop a comprehensive university plan for conducting an Arc Flash Hazard Analysis of all campus buildings in order to identify the arc flash hazards present and install labeling.

## G. MULTI-EMPLOYER WORKSITE POLICY

The Facilities Services Project Manager or an assigned representative will ensure that all safety procedures are reviewed with Affected Contractors before a job begins. Specific written policies and procedures will be shared. This review will include materials safety data sheets, emergency action plans, and the interpretation of signs and tags. All relevant information will be communicated to their supervisors and workers.

## H. VISITORS

No visitors will be allowed on ECU jobsites unless they have received permission from a designated company representative and completed all necessary paperwork.

Visitors entering will be escorted by designated personnel and receive a briefing on appropriate safety precautions to be observed. Required protective equipment will be provided as needed.

## I. DISCIPLINARY POLICY

ECU strives to create a safe and healthy workplace for all employees. To achieve this objective will require the cooperation of everyone. Supervisors must enforce all safety policies and procedures.

**If any employee deliberately fails to follow the prescribed safe work procedures or deliberately fails to use the prescribed safety equipment, as detailed in this program document, this will be considered unacceptable personal conduct: specifically, the willful violation of known or written work rule; and will be subject to disciplinary action as prescribed under the Disciplinary Policy and Procedures for Employees subject to the Personnel Act, up to and including dismissal.**

**Incidents that involve imminent danger or, in the opinion of the supervisor, show a complete disregard for safety, shall be immediately referred to management for appropriate action!**

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## J. RESOURCES AND REFERENCES

To effectively execute the policy and procedures identified in this section of the safety manual the following documents may be used. The documents will be filed with ECU's records (personnel files, OSHA Recordkeeping, etc.) as noted in the table.

TITLE	PURPOSE	MAINTENANCE
ECU Job Risk Assessment Form (FSSP 33-4016.4)	Used to assess project or task specific electrical hazards	Filed with Department Supervisor
Facilities Services Electrical Field Work Safety Audit Checklist (FSSP 33-4016.2)	Used to perform reviews of the Facilities Services Electrical Safety Program effectiveness and identify opportunities for improvement	Filed with Electrical Safety Program Team Chairman on MS Teams site in Audit Folder
Electrical Safety Job Planning Checklist (FSSP 33-4016.3)	Conducted as needed to evaluate and address jobsite hazards in preparing for a job briefing	Filed with Department Supervisor
Accident Investigation Forms	Used to collect data for investigation, entry into OSHA Logs and company database	Filed with ECU EH&S OSHA records
Job Briefings Checklist	Checklist for performing Job Briefings	Filed with Department Supervisor
Electrical Safety Program Team Meeting Minutes	Used to maintain a record of Committee activities and recommendations	Filed with Electrical Safety Program Team records on MS Teams Site
Training Attendance Rosters	Documents used to identify training completed and employees present	Filed with Facilities Services staff records
Non QEW Acknowledgement Letter	Used to document the understanding by an employee their positions classification	Filed with Electrical Safety Program Team records on MS Teams Site
Disciplinary Actions	Used to identify actions taken	Filed with Facilities Services staff records
ESP Employee Acknowledgement	Used to document receipt of a copy of the ESP during training	Filed with ESPT

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## **3. ELECTRICAL SAFETY PROGRAM**

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### **3.0 ELECTRICAL SAFETY**

#### **A. PURPOSE AND SCOPE**

**A universal safety concept is to control all forms of hazardous energy. This applies to all forms of energy including, mechanical, pneumatic, hydraulic, steam and electric. This Electrical Safety Program will focus on safely working with electrically hazardous energy. The NFPA 70E is the recognized standard for Electrical Safe Work Practices.**

Facilities Services normally does work covered by OSHA's 29 CFR 1910.147, Subpart S Electrical of the General Industry Standards & Subpart K Electrical of the Construction Industry Standards and the National Electrical Code (NEC). Medium voltage distribution work is covered by OSHA's 29 CFR 1910.269 & 1926 Subpart V and the National Electrical Safety Code (NESC). It also recognizes that NFPA 70E the Standard for Electrical Safety in the Workplace offers guidance on certain electrical safety procedures.

#### **OSHA and the NFPA 70E:**

OSHA requirements are not recommendations. There are a number of OSHA requirements that address the hazards of working on or near exposed energized parts for maintenance work. These requirements are often written in performance language, requiring compliance without necessarily stating how to comply.

The NFPA 70E, Standard for Electrical Safety in the Workplace, is written in prescriptive language and is an important national consensus standard that defines the requirements for an overall electrical safety program.

As such, the procedures found within this policy are taken directly from the most current edition of **NFPA 70E** and will cover the majority of the work locations and tasks our staff face. It is NOT all encompassing.

#### **B. RESPONSIBILITIES**

##### **Outside Contractors**

Outside Contractor will:

- Review the documentation provided by ECU on Contractor electrical related hazards and responsibilities.
- Inform the ECU Project Manager of known hazards associated with electrical installation, maintenance or repair that is related to the work they will be performing and might not be recognized by ECU's employees

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- Inform the ECU Project Manager about the installation that the contractor needs to make the assessments on
- Report any safety violations by ECU employees that are observed to ECU Project Manager

## **Facilities Services Directors**

The Facilities Services Directors or their assigned representative will:

- Monitor this Electrical Safety Program. Questions regarding this program and any information associated with it should be directed to the Electrical Safety Program Team.
- Must authorize any energized work and preparation of the Energized Electrical Work Permit required for work to begin.
- With the assistance of the supervisor and/or their designees and the Electrical Safety Program team, perform periodic assessments of employees to ensure their abilities are appropriate for the tasks performed.
- With the assistance of the Electrical Safety Program Team, will perform an annual audit of the electrical safety principles identified in this program.
- Ensure the preventative maintenance programs are in place to properly maintain electrical equipment pursuant the OEM recommendations of NFPA 70B.

## **Supervisors**

Supervisors will:

- Ensure that all employees are properly trained for the tasks they will perform. Only persons specifically approved by their supervisor in consultation with the Electrical Safety program team, may install, modify, repair, or work on electrical conductors and equipment.
- Ensure that safe work methods and procedures are being utilized.
- Ensure that the right tools and personal protective equipment are available and used for the jobs performed.
- Ensure required inspections, testing and maintenance are performed. Where tools or equipment are found to be defective, they shall be tagged, removed from service, and reported to Electrical Safety Program Team as soon as possible.
- Ensure that all electrical equipment is maintain pursuant the manufactures recommendation or NFPA 70B in the absence of documentation from the manufacture.
- Ensure that the ESPT is made aware of any changes in staffing (new hires, terminations, job changes, etc.).

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## **Employees**

All employees:

- Must continuously remain alert to his or her surroundings and the work activities being performed.
- Will follow all safety procedures described in this program as well as the information covered in the e-Hazard High Voltage and Low Voltage Qualified Student Workbooks
- Will perform inspections on all equipment and tools before each use. NEVER use damaged equipment. Tag defective tools and equipment out of service and notify a supervisor.
- Shall report any conditions or activities which pose a risk to themselves or others. Remember, when you see that a safety rule is being violated, that **silence is consent!**
- Will refer all questions to the Electrical Safety Program Team or their Supervisor

## **C. ELECTRICAL SAFETY PRINCIPLES AND CONTROLS**

The following basic principles are the foundation upon which this electrical safety program has been established. All ECU employees including Management, the Electrical Safety Program Team, Supervisors and employees shall apply these principles to all tasks.

- The inspection and evaluation of electrical equipment shall be part of all procedures.
- All electrical conductors and circuit parts shall be considered energized until tested and proven otherwise.
- The integrity of equipment enclosures and insulation shall be maintained unless exposure is absolutely necessary, and actions have been taken to provide the appropriate protection (e.g., work cannot be performed with the enclosure in place and equipment and conductors have been placed in an electrically safe work condition or an Energized Electrical Work Permit has been completed in accordance with this program.)
- Where the potential for energized circuits exists, work will not begin on a task unless a written plan is in place identifying the procedures to be used. Tasks which have not been performed and for which no plan exists will require the development of a new plan.
- The primary method for ensuring safety shall be to deenergize (create an electrically safe work condition) in accordance with ECU's Lockout/Tagout (LOTO) program in Section 3.1.
- Work that must be performed energized shall be justified as follows and requires completion and approval of an Energized Electrical Work Permit.
  1. Energized work shall only be justified when it can be demonstrated 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

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- *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.*
  - *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.*
- In preparing for a job, an effort will be made to anticipate unexpected events through a hazard/risk evaluation, completion of a planning checklist, and job briefing.
  - Based on the hazard/risk evaluation, actions will be taken to minimize or eliminate hazards and protect employees from shock, burn, blast, and other hazards due to the working environment.
  - Employees shall not knowingly be permitted to work on electrical circuits, parts or equipment when their alertness is recognizably impaired due to illness, fatigue, or other reasons or where obstructions or the lack of illumination prevent a clear view of the work to be performed.
  - Only individuals who have been designated may serve as the responsible individual for job planning and job briefings

## D. EMPLOYEE INFORMATION AND TRAINING

All employees shall be trained in and familiar with:

- Safety related work practices
- Safety related work procedures
- Safety related protective equipment
- Safety related personal protective equipment
- Safety related to the hazards of electricity (Arc Flash and Shock)

Qualified Electrical Workers are knowledgeable, trained and have demonstrated proficiency in:

- Skills and techniques necessary to distinguish exposed live parts from other parts
- Skills and techniques to determine nominal voltage of exposed live parts
- Minimum approach distances corresponding to those that the employee may be exposed
- The proper use of special precautionary techniques, personal protective equipment (PPE), insulating and shielding materials, and insulated tools as required to perform the assigned work



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- Recognizing and avoiding the hazards involved in the task at hand
- **A person can be considered qualified with respect to certain equipment and methods, but still be unqualified for others**

Refresher training will be conducted prior to performing those tasks which have not been performed within the past year, or when observation of the employee's work performance demonstrates the need for refresher training.

ECU has two separate training programs for QEWS one for "LV Qualified" (Under 600 VAC) and "HV Qualified" (Over 600VAC). Full training will occur with new employees and after an update to NFPA 70E with annual refreshers between updates. Classes are based on the curriculum produced by "e-Hazard".

ECU Power Distributions Electricians or anyone working with nominal voltages above 600 VAC shall complete both the LV and HV training.

- During the LV Qualified Class staff learn:
  1. Practical compliance with NFPA 70E electrical safety in the workplace
  2. How to do table-based hazard assessments using NFPA 70E
  3. How to choose Personal Protective Equipment (PPE) based on the NFPA 70E tables
  4. Differences between the NEC, NESC, NFPA 70E and OSHA standards
  5. Selection and inspection of PPE
  6. PPE do's and don'ts for workers exposed to shock and electric arc hazards
  7. Standards to use in clothing and PPE selection
  8. Explanations of arc ratings ATPV and EBT, and how they are applied
  9. The ins and outs of flame resistant (FR), arc-rated (AR) clothing and other shock and arc PPE
- During the HV Qualified Class staff learn:
  1. Regulations related to being HV Qualified and working safely, including OSHA 1910.269
  2. Safe practices working on or near energized equipment
  3. Live line work, tools and equipment
  4. Mobile equipment and electrical hazards
  5. De-energized testing
  6. Creating a safe work zone (tape in/tape out)
  7. Public safety (limited approach) boundaries
  8. Minimum approach distance
  9. When is it live-line work
  10. What tasks do not require a live-line permit
  11. Testing and verifying equipment is de-energized
  12. Why you must ground
  13. Creation of an equipotential zone
  14. Field testing requirements
- ECU Power Distribution Electricians shall also complete the four levels of the Electricities Underground Career Development Program training. This is an on-line,

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self-paced program. The Career Development Program exceeds the training mandates as outlined in the Federal Register 1910.269 Subpart R and 1926.95 Subpart V of the OSHA regulations guide.

- Test will be administered at the conclusion of both the LV and HV classes to confirm the comprehension of the material. The quizzes are developed by e-Hazard as part of the training materials. Any individuals not achieving a score of 70%, will receive additional training and be required to retest

## **Practical Skills Demonstration**

Upon completion LV and HV Qualified Classes staff will demonstrate their understanding of the procedures and policies covered in the classroom portion. Upon completion of the LV Qualified class staff will completed Procedures 1.0 and 2.0. Upon completion of the HV Qualified class staff will complete Procedure 3.0 (see Appendix)

1. **Procedure 1.0 – Inspect, Use, and Maintenance of Electrical Personal and Other Protective Equipment** - Upon completion of this exercise, trainees will have demonstrated the proper techniques to inspect, use and maintain personal and other protective equipment typically used in the performance of their job duties.
2. **Procedure 2.0 – Verify an Electrically Safe Work Condition and Apply Lockout/tagout** - Follow appropriate safety procedures, select proper test instruments, select and inspect appropriate PPE, establish safe work area boundaries, observe hazards in area, safely complete task required, leave area in safe condition, properly store PPE, tools and equipment.
3. **Procedure 3.0 – Rack-out and Rack-in a Circuit breaker from a Switchgear Cubicle and Install and remove Personal Protective Grounds** -Follow appropriate safety procedures, select proper test instruments, select and inspect appropriate PPE/tools, establish safe work area boundaries, observe hazards in area, safely complete task required, leave area in safe condition, properly store PPE, tools and equipment.

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## **E. RESOURCES AND REFERENCES**

To effectively execute this program and procedures identified in this section of our safety manual here the following documents may be used. The documents will be filed with company records as noted in the table.

TITLE	PURPOSE	MAINTENANCE
e-Hazard LV and HV Student Workbooks	Curriculum provided to staff for consideration as "Qualified" pursuant NFPA 70E	Copies provided to each staff member during training. Updated with updates to NFPA 70E
LV & HV Qualified Course Quizzes	Used to verify comprehension of course materials	Filed with the ESPT Chairman, Training records
Practical Skills Demonstration Checklist (1.0, 2.0 and 3.0)	Used to verify comprehension of course materials	Filed with the ESPT Chairman, Training Records
Job Risk Hazard Form Exercise	Used to verify comprehension of methodology for evaluating electrical and arc hazards	Filed with the ESPT Chairman, Training Records
Training Attendance Rosters	Used to identify training completed and employees present	Filed with the ESPT Chairman, Training Records

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### **3.1 LOCKOUT/TAGOUT (LOTO) PROGRAM**

#### **A. PURPOSE AND SCOPE**

This procedure shall be used to prevent employee exposure to hazardous electrical energy. It establishes the minimum requirements for lockout (tagout) of electrical energy sources. It provides procedures for ensuring conductors and circuit parts are disconnected from electrical energy sources and that stored energy sources are controlled. Control includes release of the stored energy as well as the prevention of re-accumulation of energy.

An individual employee control procedure will not be required when executing lockout tagout under the following circumstances:

- **A single energy source and a qualified individual is responsible for their own lockout/tagout**

However, all steps in Section C shall be completed to ensure individual employee control is appropriate and all energy sources are identified and controlled.

- **When more than six (6) individuals must participate in a LOTO event or if there are more than three (3) energy sources, the Group Lockout/Tagout Procedure shall be followed. A Group LOTO shall be considered a Complex LOTO and shall adhere to the requirements noted.**

#### **B. TRAINING AND RESPONSIBILITIES**

All employees shall receive training as prescribed in Section B (Training) of this program. All new or transferred employees and all other persons whose work operations are or might be in the area shall be instructed in the purpose and use of this procedure.

##### **Training**

All employees engaged in LOTO shall receive the following training:

- The importance of LOTO and its impact on safety
- The purpose and procedures set forth in this program as well as any individual LOTO plans developed for a specific operation
- Recognizing LOTO devices
- Installing LOTO devices
- Duty of ECU in writing procedures
- Duty of employee in executing procedures
- Duty of Responsible Individual (RI)
- Authorized and unauthorized removal of locks/tags
- Enforcing execution of LOTO procedures
- Individual employee control of energy
- Simple LOTO
- Complex LOTO
- Group LOTO
- Use of tags and warning signs
- Release of stored energy
- Personnel accounting methods
- Grounding needs/requirements

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- Safe use of voltage detecting instruments
- Additional training as needed to address specific hazards associated with a given operation

## C. PREPARATION FOR LOCKOUT (TAGOUT)

1. All disconnecting means shall be identified and located to ensure that energy is interrupted by a physical break and not deenergized by a circuit interlock. This shall be accomplished by reviewing current diagrammatic drawings or other means, tags, labels, and signs. A list of disconnecting means to be locked (tagged) will be developed and attached to the plan for each LOTO operation.
2. Each disconnecting means shall be evaluated to determine adequacy of their interrupting ability. Based on the evaluation, it will be determined if verification of a visible open point is possible, or if other precautions are needed.
3. Work activity where any personnel might be exposed to sources of electrical energy hazards will be identified (inside the Limited Approach Boundary). It will be determined if there are any other energy sources in the area where employees may be exposed to other types of energy. Energy control methods will be established for all hazardous energy sources.
4. A voltage detector rated for voltage to which employees may be exposed will be selected for the operation. The voltage detector shall be tested before and after each operation to determine that the voltage detector is operating properly.

**Solenoid voltage testers (Wiggys™) or non-contact voltage testers shall not be used for the verification of an absence of voltage for LO/TO in low voltage (<600 VAC) applications.**

5. The possibility of induced voltages or stored electrical energy will be identified. Conductors shall be bled of stored energy and personal protective grounds will be applied as needed before touching conductors or circuit parts (Personal Protective Grounds shall not be applied to low voltage systems without the approval of Facilities Services Management to insure they are properly sized for the potential fault current).
6. ECU staff shall always participate in the LOTO process with contractors. If LOTO shall need to proceed beyond normal business hours (0800-1700) it shall be coordinate in advance with Facilities Services and considered a **Complex LOTO**.

## D. LOCKOUT (TAGOUT) STEPS

The following identifies the basic steps for LOTO. In addition to these steps, it shall be determined whether a Simple or Complex LOTO can be performed. The Complex LOTO plan shall address any additional steps required.

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A Complex LOTO will be performed when any of the following exist:

- Multiple energy sources (more than one)
- Multiple crews
- Multiple crafts
- Multiple locations
- Multiple employers
- Unique disconnecting means
- Complex or particular switching sequences
- Continues for more than one shift, that is, new workers

Steps:

1. Notify employees a lockout (tagout) is going to be implemented and the reason. A qualified employee knowledgeable of hazards associated with electrical energy shall implement the Lockout - Tagout. He/She shall know the location of disconnecting means for all sources of electrical energy and stored energy.
2. The qualified person shall deenergize and disconnect the electric supply and relieve all stored energy.
3. All disconnecting means will be locked and tagged out with the ECU standard lockout (tagout) devices. Refer to Section G for appropriate devices.
  - **Application of only a tag is NOT permitted at any ECU facilities.**
  - **Application of a lockout device without a tag is NOT permitted at any ECU facilities.**
  - **Until all equipment and conductors are verified as deenergized, they shall be treated as energized.**
4. To determine that operation is prohibited, the person applying the LOTO shall attempt to operate the disconnecting means and the normal mode of Start/Stop if applicable
5. A voltage-detecting instrument shall be used to verify a zero energy state. Refer to Section G for appropriate devices. Inspect the device and do not proceed if it is damaged. Secure an undamaged device and proceed.
6. Verify proper operation of the device, then test for absence of voltage.
7. Then repeat verification of device after testing for absence of voltage.
- 8.** Where needed, install grounds on the phase conductors or circuit parts, bleed conductors to eliminate induced voltage or stored energy. Where it has been determined that contact with other exposed energized conductors or circuit parts is possible, apply ground connecting devices rated for the available fault duty. **Grounds shall not be applied to low voltage systems without consulting the Facilities Director. Grounds must be applied using Live-Line tools.**
9. Apply Magnetic Warning Signage stating grounds applied at the location of the ground as well as the disconnecting means where the LOTO is applied. Equipment enclosures should be closed and secure where possible.
10. All employees working on the equipment shall place their own lock and tag on the disconnecting means or on a multi-lock hasp or lock box for a complex lockout/tagout.

*Note: for high voltage work where personal protective grounds are applied, the grounding set*

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*identification tags will also be attached to the LOTO device as a reminder that grounds have been applied.*

11. LOTO Complete

## E. REMOVAL OF LOTO

1. Visually verify work is complete.
2. Clean up and remove all tools, equipment, and unused materials.
3. Remove all grounds and magnetic warning signage
4. Notify all personnel involved that the lockout (tagout) is complete, electrical energy will be restored, and to remain clear of equipment and electrical energy.
5. Perform quality control checks.
6. Remove lockout (tagout) devices. This must be done by the person(s) who installed them.
7. Notify staff that the equipment and/or electrical supply is ready to be returned to normal operation.
8. Return the disconnecting means to their normal condition.
9. Removal of LOTO Complete

## F. SPECIAL PROCEDURES

**Each person shall install his/her own personal lockout (tagout) device for all LOTO operations where more than one person is involved.**

Group Lockout/Tagout

1. Definitions

- a) Authorized Person (AP)- A person who has completed the required LOTO training (general and procedure-specific) and is authorized by their supervisor or Lead Worker to perform LOTO on energy isolation points to perform service or maintenance. Only LOTO Authorized Persons shall apply locks and tags to control hazardous energy.
- b) Responsible Individual (RI) - The LOTO Responsible Individual (RI) is a Person In Charge of a LOTO who has been trained to properly execute and manage LOTO procedures of a more complex nature than those allowed by a LOTO Authorized Person. This will typically be a Supervisor or Lead person.
- c) Person In Charge (PIC) – The designated person accountable for the safe execution of the lockout.

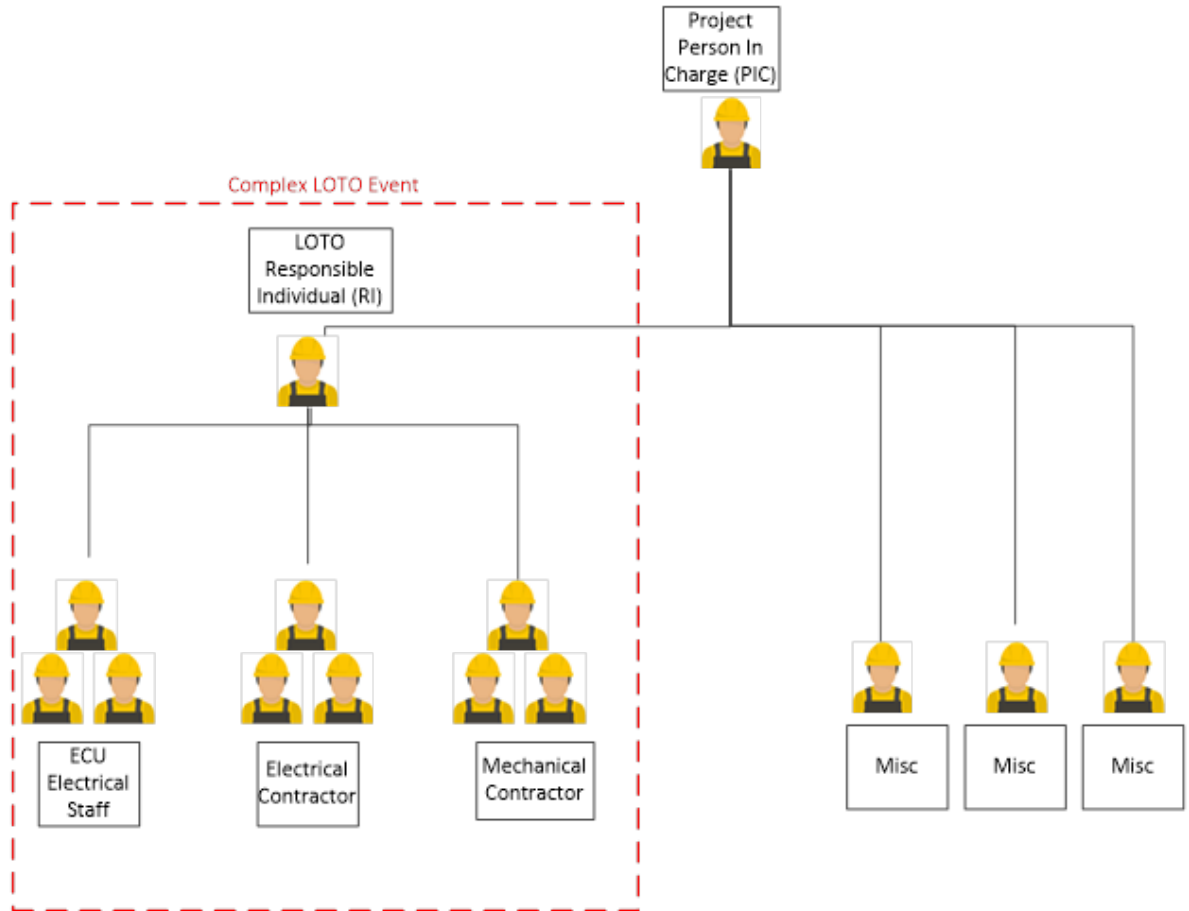
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- d) LOTO Procedure - A formal written document, approved by a Supervisor, that details the scope of work performed under the LOTO, the energy isolations to be established, and all the steps required to execute the LOTO.
- e) Group LOTO – A process to coordinate a complex LOTO so that LOTO Authorized Persons only have to apply personal LOTO locks to a lockbox instead of each energy isolation.
- f) Complex LOTO – Shall require a written LOTO sequence by the RI which will be covered in a job briefing.
- g) Group LOTO Locks – Each Electrical Department Supervisor shall maintain one set of Group LOTO locks. There will be twelve (12) red locks that are keyed to a single key. The sets will be individually marked to identify each lock in the set. An additional set shall be maintained by the ESPT Chair for use as required.
- h) Group Lockout Tagout procedure will apply anytime a LOTO procedure:
  - I. Includes the use of a Gang/Group Box, not a hasp, or
  - II. The number of individual points of isolation is greater than 3, or
  - III. The LOTO and involves more than six individuals



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## 2. Procedure:

- i) The RI and will conduct the pre job planning process to determine all the points of energy isolation that must be made in order to establish an electrically safe work condition for the project(s). Will include completing the Electrical Safety Program, Job Planning Form (FSSP 33-4016.3)
- j) The RI will document a step by step process for isolating and locking at each source of energy utilizing the Lockout Sequence Form (FSSP 33-4016.5).
- k) A second Qualified Individual, potentially the PIC, will review the job planning information and the LOTO Sequence to help ensure that no oversights have been made in the planning process.
- l) During the job briefing the PIC and/or the RI will review the LOTO sequence and where the Group LOTO Box will be held. Anyone who desires to personally witness any or all steps of the LOTO Process should be identified at this point.
- m) After the job briefing and when given clearance by the PIC, the RI will then begin the LOTO sequence as prescribed in the LO Sequence Form. Noting on the document as each step is completed.
- n) The RI with the support of qualified staff will isolate, LOTO, and verify a zero energy state at each location.
- o) The RI will apply one "Group" LOTO lock and a "Group Lockout" tag at each location.
- p) The RI will then place the Group LOTO Lock key in a Group LOTO box.
- q) The RI will then affix his personal LOTO lock and a "Group Lockout Master Lock" tag to the hasp on the box.
- r) Then each LOTO Authorized person will affix their lockout device and tag to the group LOTO box.
- s) The RI will communicate to the PIC that the LOTO process is complete.

## 3. Locks:

- t) The Group locks are identical with unique tags verses those used for individual LOTO. Clearly indicating by the lock type and color "this lock is for the protection of people" There are 12 locks per set, all locks in a set are keyed the same. The 12 locks are permanently identified by an alphabetical set (A, B, or C). The 12 locks, and tags will be store in a Group box, maintained by the Electrical Department Supervisors. A spare set will be maintained by the ESPT Chair.

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4. Tags



This tag would be applied at each Isolation point by the RI utilizing with one of the Group, Red, LOTO Locks

u)



This tag would be applied at the Gang Box by the RI utilizing His/Her Individual, Red, LOTO Lock

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Table 3.1 ECU Facilities Services Categories for LOTO Control Methods				
Condition	Simple LOTO	Complex LOTO with Written LOTO Procedure	Assigned Responsible Individual with LOTO Briefing	Lockbox
	(A)	(B)	(C)	(D)
<b>None of the Following Conditions Note Below</b>	Permitted	Permitted	Permitted	Permitted
<b>Isolation Not Identifiable</b> Isolation is not readily identifiable	Not Permitted	Required	Permitted	Permitted
<b>Multiple LOTO Devices (1 to 3)</b> The work to be performed involves two (2) or three (3) isolation points	Not Permitted	Required	Permitted	Permitted
<b>Multiple LOTO Devices (4 or more)</b> The number of isolation points exceeds three (3)	Not Permitted	Required	Required	Required
<b>Stored Energy</b> The machine or equipment has a potential for <b>stored or residual energy</b> or reaccumulating of stored energy after shutdown which could endanger staff	Not Permitted	Required	Permitted	Permitted
<b>Prior Incidents</b> Any prior incidents involving simple LOTO on this equipment	Not Permitted	Required	Permitted	Permitted
<b>Multiple Employees (7 or more)</b> The work to be performed involves seven (7) or more employees	Not Permitted	Required	Required	Required
<b>Multiple Employers</b> The work to be performed involves multiple employers	Not Permitted	Required	Required	Permitted
<b>Temporary Partial Restoration</b> The work will require temporary restoration of power for repositioning or testing	Not Permitted	Required	Required	Permitted
<b>Multiple Energy Sources</b> The equipment is fed from multiple energy sources.	Not Permitted	Required	Required	Required
<b>Group LOTO</b> Using a lockbox for the LOTO	Not Permitted	Required	Required	Required
<b>Tagout Only</b> One or more isolations cannot be locked and require the use of the Tagout Only method	Not Permitted	Not Permitted	Not Permitted	Not Permitted

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w) Responsibilities The Responsible Individual must:

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- I. Complete job planning process to develop the LOTO procedure that will be completed and document the switching order
  - II. Implement and coordinate the LO/TO of hazardous energy sources.
  - III. Apply LOTO devices to all energy sources and tag with "Group LOTO" Tags.
  - IV. Apply their personal LOTO lock and "Master Group LOTO" tag to the group LOTO box.
  - V. Verify that the steps taken, in accordance with the specific written energy control procedure, have in fact isolated the machine or equipment effectively from the hazardous energy sources. This must be accomplished before authorized employees participating in the group LO/TO affix their personnel lockout device to the group LO/TO box and before performing servicing/maintenance activities.
  - VI. Inform each authorized employee participating in the group LO/TO of their right to verify the effectiveness of the lockout measures and allow each authorized employee to personally verify that hazardous energy sources have been effectively isolated, if they so choose. In addition to the Responsible Individual, an authorized employee, who opts to verify the effectiveness of the isolation measures, must perform this verification after affixing his or her personal lockout device to the lock box and before performing servicing/maintenance activities.
  - VII. Provide for an orderly exchange of group LO/TO with a new Responsible Individual when work continues over multiple shifts.
  - VIII. Whenever work is performed over a period of time and is not continuous, the Responsible Individual shall walk through the affected work area(s) to verify effective isolation prior to beginning work.
- x) Procedures Involving More Than One Person: If more than one individual is required to lockout equipment, each shall place his/her own personal lockout tagout device on the energy-isolating device(s). When an energy-isolating device cannot accept multiple locks, a multiple lockout device (hasp) or Gang Box shall be used. A single lock may be used to lockout the machine or equipment with the key being placed in a gang lockout box which allows the use of multiple locks to secure it. Each employee will then use his/her own lock to secure the box. As each person no longer needs to maintain his or her lockout protection, that person will remove his/her lock from the box.
3. When the lockout (tagout) extends for more than one day, the lockout (tagout) shall be verified to be still in place at the beginning of the next day. Where the lockout (tagout) is continued on successive shifts, the lockout (tagout) is considered to be a complex lockout (tagout).
  4. When a lock must be removed for an absent individual, **The Lockout/Tagout Program Lock Removal Form** shall be completed. (FSSP 33-4016.1). Authorization to remove a lock for an absent person must be authorized by a Director or Assistant Director in their absence.
  5. **Medium Voltage Distribution:**
    - a. Locks used for the purpose of securing medium voltage equipment enclosures shall be of the type noted below. Only HV Qualified individuals will be issued keys to these locks by the appropriate Electrical Department Supervisor. These locks shall not be used for the purpose of protecting individuals from hazardous energy when work is

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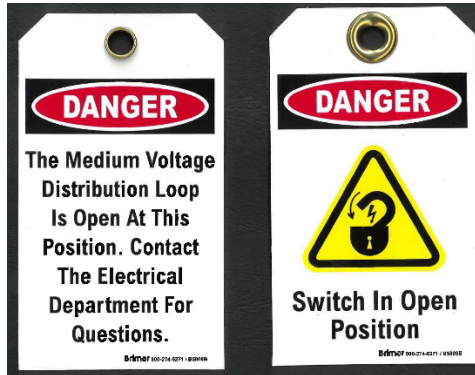
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being conducted. They are solely for the purpose of securing equipment enclosures when they are unsupervised.

- b. Only specially identified tags may be used in combination with enclosure locks to identify switching positions, Red LOTO locks nor tags may be used for this purpose



## G. EQUIPMENT

1. Individual Lock (Also known as LOTO Lock): A lock issued to an LOTO-Authorized Employee for which no other employee has the key or means of opening without using destructive force. Locks used for control of hazardous energies shall be unique in design and color, shall not be used for any other purpose, and shall be easily distinguishable from other standard locks (Administrative Lock, multi-key, combination, and other non-LOTO locks).
2. Group Lockout Box: A box used to contain the LOTO lock key(s) of designated LOTO-Authorized Employee(s) during a group LOTO procedure. Individual LOTO locks are placed on the gang box by each LOTO-Authorized Employee covered under the designated LOTO-Authorized Employee. The gang lock box shall be constructed in such a way as to permit multiple individual LOTO locks to be attached to the outside of the enclosure, preventing it from being opened except by removal of every individual LOTO lock.
3. Group Lockout Hasp: A hasp is used to permit multiple individuals to LOTO a single piece of equipment during a group LOTO procedure. Individual LOTO locks are placed on the hasp by each LOTO-Authorized Employee covered under the designated LOTO-Authorized Employee. The hasp shall be constructed in such a way as to permit multiple individual LOTO locks to be attached to the hasp, preventing it from being opened except by removal of every individual LOTO lock.
4. Administrative Lock: Any lock that is used for a purpose other than LOTO. The lock may serve a safety function other than LOTO, a configuration control function, or other purpose. An administrative lock, unlike a LOTO lock, may be controlled by one or more individuals. An administrative lock shall not be labeled with a danger tag or sticker. An administrative lock is not a substitute for a LOTO lock. A LOTO lock cannot be used as an administrative lock

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5. Only the following type of locks shall be used for Individual LOTO:
  - Type: American Lock
  - Model: A1106RED (Grainger # 1TDB6)
6. Only the following type of tags shall be used for Individual LOTO:
  - Type: Brady
  - Model: 66050 (Grainger # 6T895)
7. Only the following type of locks shall be used for Administrative Lock:
  - Type: American Lock
  - Model: A1106BLU (Grainger # 1TDB8)
8. Only the following type of tags shall be used for Administrative Locks:
  - Type: Grainger
  - Model: 2RMW1A
9. Only the following type of locks shall be used for Group LOTO:
  - Type: American Lock
  - Model: A1106KARED SETOF12 (Grainger # 9CEF6)
10. Only the following type of Group Lockout Box shall be used:
  - Type: Condor
  - Model: 437R32 (Grainger # 437R32)
11. Only the following hasp shall be used for group lockout:
  - Type: American Lock, Red
  - Model: ALO802 (Grainger# 40CL95)
12. Only the following hasp shall be used for MV switch position indication:
  - Type: Brady, Yellow
  - Model: T220 (Grainger# 3PDD4)
13. Only the following type of locks shall be used for securing equipment enclosures, not for the purpose of protecting individuals from hazardous energy:
  - Main Campus:
    - a. Corbin Russwin
    - b. Model: PL5180
  - Health Sciences and West Research Campuses:

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- a. Wilson Bohannon
- b. Model: 92110-1-87878A

14. The following voltage detecting device(s) shall be used depending on the applicable voltage:

- A. Digital Multimeter (DMM)
  - Voltage Range: 0-600VAC
  - Type: Fluke
  - Model: 117 and 323 Kit (Grainger # 46N342)
- B. Permanently Mounted Test Device
  - Voltage Range: 0-600 VAC
  - Type: VeriSafe
  - Model: VS-AVT Absence of Voltage Tester
- C. Self-Testing Voltage Detector
  - Voltage Range: 600 – 15k VAC
  - Type: Salisbury
  - Model: 4544 NCV Self-Testing

## H. AUDIT

An audit of this program and procedures shall be conducted no less than annually. The annual audit shall be dated and filed with the Electrical Safety Program Team. Procedure 2.0 Verify an Electrically Safe Work Condition and Apply Lockout/Tagout shall be used for the audit.

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## I. RESOURCES AND REFERENCES

To effectively execute this program and procedures identified in this section of our safety manual here the following documents may be used. The documents will be filed with company records as noted in the table.

TITLE	PURPOSE	MAINTENANCE
Complex LOTO Plan	Written Program needed for LOTO involving multiple crews, circuits, etc.	Filed with Department Supervisor
Absent Person LOTO Lock Removal Form (FSSP 33-4016.1)	Form documenting process and authorization for the removal of a LOTO Lock	Completed forms maintained by EH&S
Administrative Lock Log	Form used for documenting the location and justification for application of all Administrative locks	Maintained on the ESPT MS Teams site
Electrical Field Work Safety Audit Checklist	Form used for auditing fields work to verify compliance with ESWP	Filed with the ESPT Chairman, Training Records
Procedure 2.0 Verify ESWC and apply LOTO	Practical Skills Demonstration Checklist for LOTO	Filed with the ESPT Chairman, Training Records



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### **3.2 ENERGIZED ELECTRICAL WORK**

#### **A. PURPOSE AND SCOPE**

This program has been established to keep our staff safe from hazards associated with energized electrical work tasks. Using this policy will help keep ECU compliant with state and federal requirements for employee safety in the workplace.

**OSHA and NFPA 70E standards require that all energized circuit parts and equipment be DE-ENERGIZED before any employee works on or near them. De-energizing must be used as the primary method of worker protection from electrical hazards.**

***Exemptions to Work Permit.** There are very few exceptions to this rule. 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, provided appropriate safe work practices and personal protective equipment in accordance with this procedure are provided and used.*

#### **B. DEFINITIONS**

**1. ARC FLASH HAZARD ANALYSIS:**

A study investigating a worker's potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices, arc flash protection boundary, and the appropriate levels of PPE.

**2. ARC FLASH PROTECTION BOUNDARY:**

An approach limit at a distance from exposed live parts at which a person has a 50% chance of receiving a second-degree burn if an electrical arc flash were to occur. Refer to NFPA 70E Article 130.3 (A) (1)

**3. ARC RATING:**

The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to breakopen or at the onset of a second-degree skin burn. Arc rating is normally expressed in calories per centimeter squared.

**4. CALORIE PER CENTIMETER SQUARED (cal/cm<sup>2</sup>):**

The unit of measurement used to express the amount of thermal energy released during an arc flash event.

**5. ELECTRICAL HAZARD:**

A dangerous condition such that contact and/or equipment failure can result in electrical shock, arc flash burn, thermal burn, or blast.

**6. ELECTRICAL HAZARD ANALYSIS:**

Appropriate safety-related work practices shall be determined before any person is exposed to the electrical hazards involved by using both shock hazard analysis and arc flash hazard analysis. NFPA 70E (110.8 (B) 1)

**7. ELECTRICALLY SAFE WORK CONDITION:**

A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked and tagged in accordance with established standards, tested to ensure the absence of voltage and grounded if determined necessary.

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**8. EMERGENCY PROCEDURES:**

Employees exposed to shock hazards shall be trained and regularly instructed in methods of release and resuscitation of victims from contact with exposed energized electrical conductors or circuit parts.

**9. ENERGIZED ELECTRICAL WORK:**

Working on or near exposed energized parts 50 volts or greater and / or within the Prohibited Approach protection boundary.

**10. ENERGIZED ELECTRICAL WORK PERMIT:**

If live parts are not placed in an electrically safe work condition, work by a qualified person shall be performed by written permit only.

*Exception: Diagnostics, testing, troubleshooting, voltage measuring shall be permitted to be performed without an EEWP permit, provided appropriate safe work practices PPE is provided and used.*

**11. EQUIPMENT LABELING:**

Equipment shall be field marked with a label containing the available incident energy, Arc Flash Boundary, Incident Energy, Nominal Voltage, Glove Class, and the shock boundaries (Limited, Restricted, and Prohibited).

**12. EXPOSED:**

(As applied to energized electrical conductors or circuit parts) Capable of being inadvertently touched or approached nearer than a safe distance by a person. It applies to energized parts that are not suitably guarded, isolated or insulated.

**13. FLAME-RESISTANT (FR):**

The property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or non-flaming source of ignition.

**14. HAZARD/RISK EVALUATION PROCEDURE:**

An electrical safety program shall identify a hazard/risk evaluation procedure to be used before work is started within the Limited Approach Boundary of energized electrical conductors and circuit parts operating at 50 volts or more or where any electrical hazards exists.

**15. HOST AND CONTRACT EMPLOYER RESPONSIBILITIES:**

Facilities Services and the contract employer(s) shall inform each other of existing hazards, personal protective equipment, FR clothing requirements, safe work practice procedures, and emergency & evacuation procedures applicable to the work to be performed.

**16. INCIDENT ENERGY:**

The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. The unit used to measure incident energy is cal / cm<sup>2</sup>.

**17. JOB BRIEFING:**

Before starting each job, the employee in charge shall conduct a job briefing with the employees involved. The briefing shall cover subjects identified on the Energized Electrical Work Permit such as hazards associated with the job, work procedures involved, special precautions, energy source controls, and PPE requirements. Job briefing documentation is to be maintained on file by the appropriate Electrical Department Supervisor.

**18. LESS THAN 50 VOLTS:**

For voltages of less than 50 volts, the decision to de-energize should include consideration of the capacity of the source and any overcurrent protection between the energy source and the worker.

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## 19. NORMAL OPERATING CONDITION

The equipment condition is considered to be "Normal" when all of the following apply: 1) properly installed and maintained in accordance with manufacture's recommendations and applicable industry codes and standards, 2) used in accordance with manufactures recommendations and in the listing and labeling, 3) doors are closed and secured, 4) covers are in place and secure, **5) there is no evidence of impending failure such as arching, overheating, lose or bound parts, visible damage, or deterioration ( history of past failures should also be a consideration)**

## 20. PERSONAL PROTECTIVE EQUIPMENT (PPE):

Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body and for the work to be performed. The equipment shall be maintained in a safe, reliable condition and **shall be visually inspected before each use.**

## 21. QUALIFIED ELECTRICAL WORKER (QEW):

Qualified Electrical Workers are knowledgeable, trained and have demonstrated proficiency in:

- Skills and techniques necessary to distinguish exposed live parts from other parts
- Skills and techniques to determine nominal voltage of exposed live parts
- Minimum approach distances corresponding to those that the employee may be exposed,
- The proper use of special precautionary techniques, personal protective equipment (PPE), insulating and shielding materials, and insulated tools as required to perform the assigned work.
- Has received Safety Training to recognize and avoid the hazards involved in the task at hand.
- **A person can be considered qualified with respect to certain equipment and methods, but still be unqualified for others.**
- **Only the Department Supervisor or Lead can determine an individual qualifications to perform a certain task.**

## 22. RATING:

Test instruments, equipment, and their accessories shall be rated for circuits and equipment to which they will be connected. They shall be inspected, and correct operation verified before and after an absence of voltage test is performed.

## 23. SAFETY TRAINING:

Employees shall be trained in safety-related work practices and procedural requirements as necessary to provide protection from the electrical hazards associated with their respective job or task assignments.

## 24. SHOCK HAZARD ANALYSIS:

A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the PPE necessary in order to minimize the possibility of electric shock to personnel.

## 25. SHOCK HAZARD 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 energized electrical conductors and circuit parts.

**Limited** – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists. The Limited Approach Boundary is to only be crossed by qualified persons (at a distance from a live part) which is not to be crossed by unqualified persons unless escorted by a qualified person".

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TITLE:

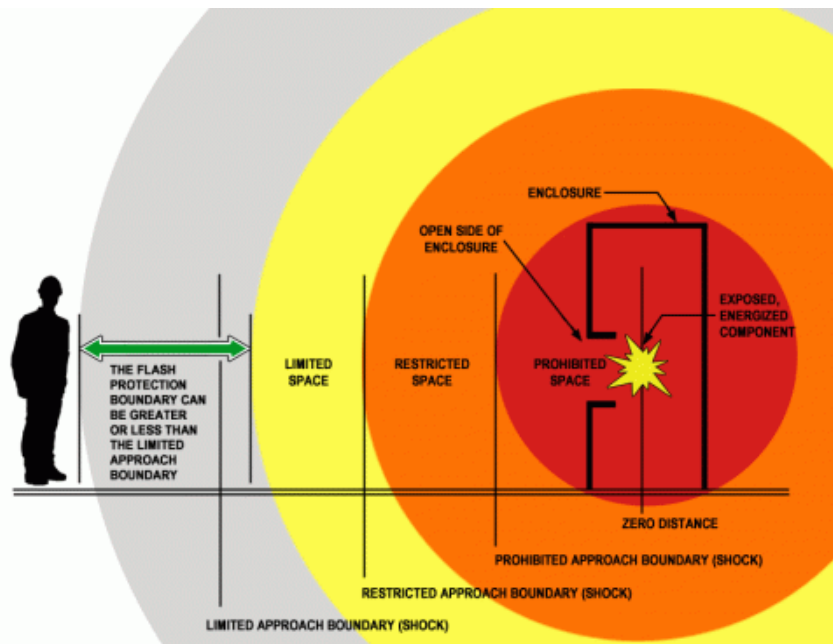
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**Restricted** - An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to an energized electrical conductor or circuit part.

**Prohibited** – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part.



## 26. WORK DE-ENERGIZED:

Live parts shall be put into an electrically safe work condition (by de-energizing and using lockout/tagout) before an employee is exposed to electrical hazards. (See Lockout / Tagout Procedures)

When the supervisor can demonstrate that de-energizing introduces additional or increased hazards or it is infeasible due to equipment design or operation limitations, energized work may be allowed with the approval of the Director of Facilities Services.

Examples of increased or additional hazards:

- Interruption of life support equipment.
- Deactivation of emergency alarm systems.
- Shutdown of hazardous location ventilation equipment.

Examples of infeasibility due to equipment design or operational limitations:

- Diagnostics and testing/troubleshooting.
- 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.

Keep in mind that Arc Flash Protection Boundary distances vary based on the amount of available fault current and the clearing times of overcurrent protection devices. Shock Protection Boundaries vary based

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on the nominal voltage and fixed electrical parts (buss) vs. moveable conductors (overhead lines = 10' clearance).

## C. RESPONSIBILITIES

### Director of Facilities Services

The Director:

- Will receive all requests to work energized.
- Will coordinate the completion and approval of the Energized Electrical Work Permit and Hazard/Risk Assessment.
- Shall ensure that all employees are qualified and have receive specific training needed to work energized on the project.

### Supervisor

The Supervisor will:

- Ensure that an Energized Electrical Work Permit is completed and approved before allowing work to begin on an energized circuit.
- Confirm the individuals assigned to work energized on the jobsite are authorized and qualified.
- Ensure PPE is provided and worn in accordance with the Hazard Assessment and Energized Electrical Work Permit.
- Ensure that any required insulated tools are provided and inspected prior to the work.
- Ensure that someone certified in First Aid and CPR is **dressed-out and standing by on site with the first responder bag and rescue hook.**
- Ensure all boundaries are maintained.

### Employee

Employees will:

- Not perform any energized work for which they have not been authorized.
- Comply with the Energized Electrical Work Permit and all safety principles including the electrical safety principles contain in this document as well as the e-Hazard student workbooks.

### Outside Contractors

Contractors will:

- Not perform any energized work for which they have not been authorized by ECU.
- Apply a LOTO lock and tag along with ECU. This will be considered a Complex LO/TO and will require the associated documentation as well as a job briefing.

## D. ACTIONS

An Electrical Hazard Analysis shall be performed for any energized work. This involves conducting both a shock hazard and arc flash hazard analysis.

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Where planning has determined a phase of a project requires work to be performed energized, the responsible individual will consult with the Director of Facilities Services.

The following will be documented on the appropriate forms that project:

- Shock Hazard Analysis Results  
Limited, Restricted, and Prohibited Approach Boundary requirements
- Flash Hazard Analysis
- Flash Protection Boundary (FPB) PPE when inside the FPB.
- PPE required
- Location and method of barricades

The Energized Electrical Work Permit shall be completed and approved for each task before work can begin. The Permit must include:

- A description of the circuit and equipment to be worked on and the location
- Justification for why the work must be performed in an energized condition
- A description of the safe work practices to be employed
- Results of the shock hazard analysis
- Determination of shock protection boundaries
- Results of the flash hazard analysis
- The Flash Protection Boundary
- The necessary PPE and insulated tools to safely perform the assigned task
- Means employed to restrict access of unqualified persons from the work area
- Evidence of completion of a job briefing, including a discussion of any job-specific hazards
- Energized work approval signatures

### ***Exemptions to Work Permit.***

- 1. 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, provided appropriate safe work practices and personal protective equipment in accordance with this procedure are provided and used.*
- 2. A single Energized Electrical Work Permit may be allowed for work that is routine and/or repetitive in nature, such as trouble shooting on a construction project. This permit must be on file with the supervisor and a list of the specific tasks to which it applies identified. Employees must notify their supervisor of any conditions that change or if new hazards are introduced and a new permit is created.*

The Energized Electrical Work Permit shall be reviewed by each employee performing the work and will be maintained in the immediate work area.

Employees working in areas where electrical hazards are present shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body to be protected and for the work to be performed. Clothing and equipment shall comply with the specification set forth by an Arc Flash Hazard Analysis or NFPA 70E for the task to be performed and the incident energy level to which they may be exposed.

### **Energized Work is prohibited when incident energy exceeds 40 cal/cm<sup>2</sup> at the working distance.**

Protective equipment shall be maintained in a safe, reliable condition. The protective equipment shall be visually inspected before each use. The requirements for periodic testing of electrical protective equipment found in the ANSI and ASTM standards referenced in sections 130.7(C)(8)

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and 130.7(F) of NFPA 70E shall be used for this purpose.

Electrical PPE, to include insulated gloves, leather glove protectors, arc flash suits, arc rated face shields, balaclavas, arc rated hoods, all live-line tools, test equipment and personal grounding sets will be issued through the campus's designated Electrical Safety Program Team Representative:

Protective clothing (i.e., AR apparel) shall be inspected before each use. The garment manufacturer's instructions for care and maintenance of AR apparel shall be followed.

Clothing shall cover potentially exposed areas completely. Shirt sleeves shall be fastened at the wrists, and shirts and jackets shall be closed at the neck.

Work clothing or flash suits that are contaminated, or damaged to the extent their protective qualities are impaired, shall not be used. Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used and should be turned in for cleaning and inspection.

### **Employees are not authorized to make any repairs or alterations to Arc Rated clothing**

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.

Employees shall use insulated tools and/or handling equipment when working inside the Limited Approach Boundary of exposed live parts where tools or handling equipment might make accidental contact. Insulated tools shall be protected from damage to the insulating material.

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.

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 handlines used shall be nonconductive.

Fiberglass reinforced plastic rod and tube used for live line tools shall meet the requirements of ASTM F 711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used; in Live Line Tools*, 1989 (R1997).

Portable Nonconductive ladders shall meet the requirements of ANSI standards for ladders listed in NFPA 70E, Table 130.7(D).

Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near live parts that might be accidentally contacted or where dangerous electric heating or arcing might occur.

Normally enclosed live parts that are exposed for maintenance or repair shall be guarded to protect unqualified persons from contact with the live parts.

Rubber insulating equipment used for protection from accidental contact with live parts shall meet the requirements of the ASTM standards listed in NFPA 70E, Table 130.7(G).

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Plastic guard equipment for protection of employees from accidental contact with live parts, or for protection of employees or energized equipment or material from contact with ground, shall meet the requirements of the ASTM standards listed in NFPA 70E, Table 130.7(G).

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 and tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, bull floats, and chains.

When an employee works in a confined or enclosed space (such as a manhole or vault) protective shields, protective barriers, or insulating materials shall be used as needed to prevent inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed live parts.

Employees shall not perform housekeeping duties inside the Limited Approach Boundary where there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided to prevent contact and they are a "Qualified Individual"

Barricades, signs, danger tape, and attendants shall be used to identify and maintain boundaries as determined by the Electrical Hazard Analysis.

## E. EMPLOYEE INFORMATION AND TRAINING

Qualified Electrical Workers (i.e., authorized to work energized) shall be trained in:

- The applicable procedures associated with securing and implementing an Energized Electrical Work Permit
- NFPA 70E
- OSHA Electrical Safety Work Practices
- Electrical safety work practices as need for the tasks to be performed.

Non-Qualified Electrical Workers (workers who will assist, such as a maintenance mechanic but only after and ESWC has been established) shall be trained in:

- The applicable procedures associated with securing and implementing an Energized Electrical Work Permit
- NFPA 70E
- OSHA Electrical Safety Work Practices

Qualified and Non-Qualified Personnel shall:

- Receive re-training as needed.
- Participate in the job debriefing and understand all safety precautions determined by the applicable Energized Electrical Work Permit



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**F. RESOURCES AND REFERENCES**

To effectively execute this program and procedures identified in this section of our safety manual here the following documents may be used. The documents will be filed with company records as noted in the table. **See sample *Energized Electrical Work Permit* in the Appendix.**

TITLE	PURPOSE	MAINTENANCE
Energized Electrical Work Permit	Completed for approval to work on energized parts and circuits	Posted on site and then filed with EH&S upon completion of work
Job Briefing Form	Inform contractor of Hazards	Maintain on job site and then filed with Department Supervisor
Hazard/Risk Assessments	Completed to determine hazard controls including the appropriate PPE and clothing needed	Filed with department records as needed

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## **4. PERSONAL PROTECTIVE EQUIPMENT**

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### **4.0 GENERAL**

#### **A. PURPOSE AND SCOPE**

The goal of the Personal Protective Equipment (PPE) program is to protect employees exposed to electrical hazards in the workplace. This can be accomplished through pre-planning and careful implementation of all applicable federal, state and local safety and health regulations/standards.

This written program works to create and maintain a safe work environment as required by 29 CFR 1910 Subpart E and 29 CFR 1926 Subpart E.

#### **B. RESPONSIBILITIES**

##### **Electrical Safety Program Team**

The ESPT or their assigned designee will:

- Maintain an inventory of all insulated gloves, insulated blankets, and live-line tools to insure they are collected and tested pursuant NFWA 70E and ANSI.
- Ensure a system is in place to track when gloves are tested, received, issued and collected. Gloves shall be tested after six months of use or 12 months from the last date of testing, whichever comes first. Adequate spares shall be maintained so that a sufficient number of gloves are maintained on campus while testing is being completed.
- Maintain a database of all PPE that has been issued to each individual, size, and issue date
- Ensure a system is in place to track when live-line tools are tested. Adequate spares shall be maintained so that a sufficient number of tools are maintained on campus while testing is being completed.
- Ensure that ECU provided protective equipment is appropriate for the task and is properly cleaned, maintained, and stored.
- Conduct field audits to validate that employees, who are required to use PPE, use it correctly and consistently.

##### **Facilities Services Directors**

Directors or assigned representative will:

- Strive to eliminate work site hazards (safety, health or environmental) through modifications to work practices and procedures or by implementing engineering revisions.
- Ensure that employees are trained in the use, care, storage, maintenance, and limitations of the PPE.

##### **Supervisor**

The Supervisor will:

- Participate in conducting Jobsite Hazard Assessments to determine the appropriate PPE for the electrical hazards that are present.
- Ensure that ECU provided protective equipment is appropriate for the task and is properly

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cleaned, maintained, and stored.

- Ensure that staff only work around the hazard level for which they are considered "Qualified": low voltage, high voltage, or both
- Ensure that employees, who are required to use PPE, **use it correctly and consistently.**

## **Employees**

Employees will:

- Be trained in the proper use, cleaning, storage, maintenance, and limitations of any protective equipment that will be used at each jobsite.
- Use the appropriate PPE whenever a jobsite electrical hazard is present.
- Select PPE based on:
  - a. Arc Flash Hazard Analysis Label when present
  - b. Arc Flash Decision Tree for single phase circuits supplied by a 35 amp breaker or fuse
  - c. NFPA 70 Tables when a label is not present, and the Arc Flash decision tree cannot be used

## **Arc Flash PPE Decision Tree**

- An Engineering Firm was contracted to provide a recommendation for the evaluating the Arc Flash Hazard when working with single phase circuits for which the tables in NFPA 70E may be overly conservative and result in wearing an unwarranted level of PPE. This process is only applicable for equipment for which no engineering study has been conducted. **Only qualified LV individuals should utilize this tool.**

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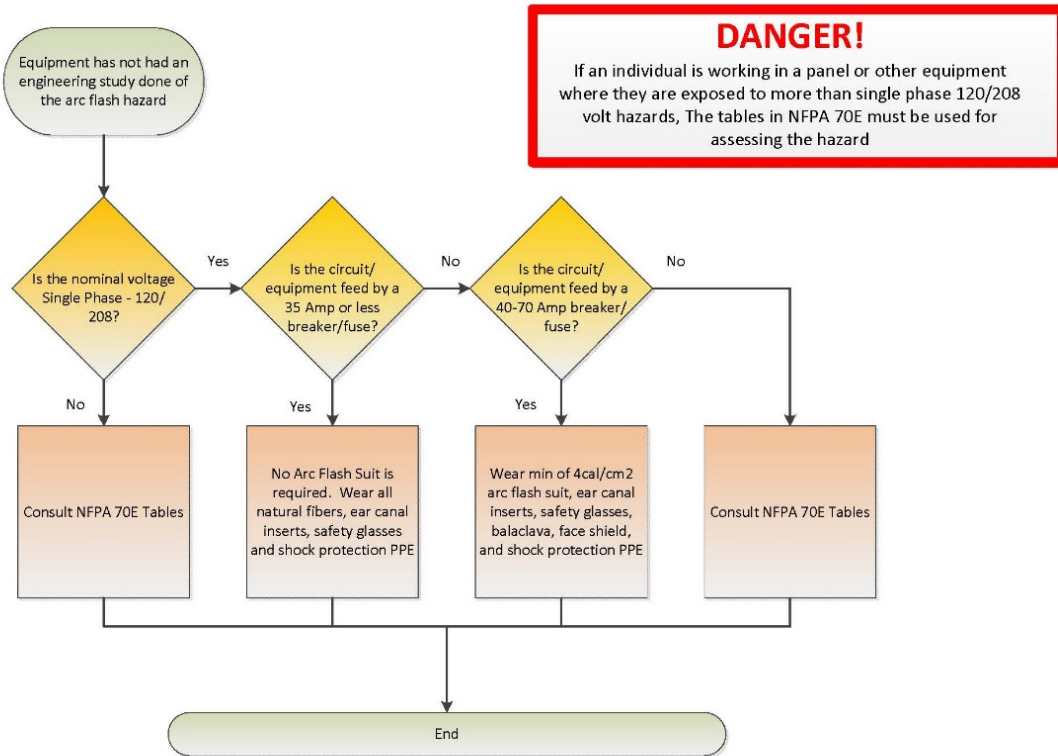
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## Decision Tree for Single Phase Circuits Where No Engineering Study Has Been Completed



### C. ACTION DETAILS

**General**

All employees will wear appropriate PPE when working per OSHA and job site conditions. Specialized PPE will be provided as needed by Facilities Services for employees. This may include, but is not limited to:

- Head protection
- Hearing protection devices
- Eye protection
- Fall protection devices
- Hand protection equipment
- Life-lines and harnesses
- Respirators
- Specialty Footwear,
- Specialty illumination equipment
- Any other specialty equipment or devices required to be safe on the jobsite
  - Arc Flash suits
  - Rubber insulating gloves and protectors
  - Rubber insulating blankets
  - Rubber insulating line hose

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- Rubber insulating hoods
- Insulating shields and/or barriers
- Rubber insulating sleeves, if required
- Rubber matting for use around an electrical apparatus.
- Live line tools
- Safety grounding sets

PPE that has been modified in a way that is not supported by the manufacturer or that reduces its effectiveness will be repossessed, repaired or destroyed.

Any PPE that has been previously worn or used, will not be reissued to another employee until it has been inspected, repaired, if necessary, according to manufacturer's recommendations, cleaned, and repackaged.

## Two Category Approach- Arc Flash Protection

ECU has selected to use a two category approach for our PPE Program, ARC 2: Maximum of 12  $Cal/cm^2$  or ARC 4: Maximum of 40  $Cal/cm^2$ .

**ECU Two Category PPE Table\***

	ARC 2		ARC 4
	12 $Cal/cm^2$	Rating	40 $Cal/cm^2$
Head	Hard hat, ear canal inserts, safety glasses, AR rated face shield, and balaclava	$< 12 Cal/cm^2$  $12 Cal/cm^2 \geq$	Rated arc flash hood, ear canal inserts, and safety glasses
Body	Rated Coverall or Suit		Rated Coverall or Suit
Hands	Insulated gloves and leather protectors		Insulated gloves and leather protectors
Feet	EH rated leather safety shoes		EH rated leather safety shoes

\*There may be staff who's Arc Flash PPE is rated 8, 10 or 11  $Cal/cm^2$  until such time as all arc rated suits have been switched out to the 12  $Cal/cm^2$ . Staff must always evaluate each job and the hazards for which they will be exposed. If the incident energy is equal to or exceeds the rating of their lowest rated garment, they shall be required to proceed to the next highest level of protection.

### Live Line Tools

Live Line tools to include FRP rods/sticks and attachments and insulated hand tools shall be issued by an ESPT member upon completion and approval of an Energized Electrical Work Permit. The tools issued will only be those noted on the permit. Upon completion of the job task, the tools will be cleaned, inspected, bagged, and turned back into the ESPT member. The ESPT member will inspect and return the tools back into the secured tool crib. Tools found to be damaged or inoperable in any way will be tagged not for use and taken out of the inventory until such time as they can be repaired and tested.

### Personal Protective Grounding Sets (PPGS)

Personal Protective Grounding Sets (to include magnetic warning signs) shall be issued by an ESPT member upon completion and approval of an Energized Electrical Work Permit or Complex LO/TO Plan. The set # issued will be noted on the permit. Upon completion of the job task the set will be cleaned, bagged,

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and turned back into the ESPT member. The ESPT member will inspect and return the set back into the secured tool crib. Sets found to be damaged or inoperable in any way will be tagged not for use and taken out of the inventory until such time as they can be repaired and tested. **PPGS shall be selected based on the available fault current and clearing time for the location at which they are to be applied. PPGS shall be applied using live-line tools and are not to be applied by hand.**

## **Employee Compliance and Enforcement**

The Supervisor will conduct daily field inspections to ensure employees are wearing all necessary PPE.

All PPE will meet or exceed the applicable requirements of NIOSH, OSHA, ANSI and/or any other applicable agency or standard.

## **Employee Safe Work Practices**

Employees will follow these safety rules as appropriate for job site conditions:

- An appropriate hard hat will be worn when there is danger of impact, falling or flying objects, or electrical shock. Hard hats are to be replaced five years from the manufactures stamp.
- Impact-resistant safety glasses with side shields will be worn when there is danger of materials striking the eye
- Non-vented safety goggles will be worn if working with materials or chemicals that could damage the eyes
- Face shields will be worn, as needed, to protect the face from flying objects (also must be arc rated if inside the AFB)
- Proper shoes or boots will be worn to protect against foot injuries (also must be EH rated).
- Protective clothing, appropriate for the task at hand, will be worn, where specified in the job briefing document.
- Wear all required PPE for protection from shock and arc flash hazards when working inside of the limited approach boundary

## **D. TRAINING**

Employee training will include, but not be limited to:

- Recognizing hazards on the jobsite that require PPE
- How to determine the appropriate PPE to avoid potential injuries,
- The correct way to inspect, put on, remove, use, care, store, clean, and maintain each piece of PPE, as needed
- The limitations of the PPE employees are required to use.
- Training will take place through Formal classes (on and off campus), Toolbox talks, and on the job.

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## **E. REPLACEMENT OF PPE**

PPE shall replace based on the recommendations of the manufacture or sooner if it becomes unserviceable. Certain items that do not have a formal expiration dates shall be replaced based on industry best practices to include:

- Arc Flash garments (coats, bibbs, over pants, hoods) – every 10 years
- Arc Flash face shields – when the hardhat is replaced – every 5 years

## **F. RESOURCES AND REFERENCES**

To effectively execute the policy and procedures identified in this section of our safety manual the following documents may be used. The documents will be filed with our company records (personnel files, OSHA Recordkeeping, etc.) as noted in the table.

<b>TITLE</b>	<b>PURPOSE</b>	<b>MAINTENANCE</b>
PPE and tool inventory	Maintain an active inventory of all PPE that is either deployed, being tested or is in reserve	Filed with ESPT and on the MS Teams Site
Testing reports for insulated gloves and live line tools	Maintain test documentation of all PPE and equipment	Filed with ESPT and on the MS Teams Site

TITLE:

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## **5. FIRST-AID**

### **A. PURPOSE AND SCOPE**

The goal of the First Aid program is to develop first aid procedures that will provide employees with timely and reliable emergency first aid treatment. This written program works to create and maintain First aid and medical attention as referenced in 1910.269 regarding first aid.

### **B. RESPONSIBILITIES**

#### **Electrical Safety Program Team**

The ESPT in collaboration with EH&S and Prospective Health will:

- Formulate and implement ECU's first-aid program.
- Ensure that trained individuals are on site that can provide basic first-aid treatment within four (4) minutes of a non-serious injuries and illnesses and emergency treatment for serious injuries or illnesses until the employee can be placed under the care of Emergency Medical Services.
- Prepare and maintain current and complete ECU first aid records and logs in compliance with OSHA and State Workers' Compensation Commission.
- Ensure that first aid equipment and supplies are properly maintained.

#### **Supervisor**

The Supervisor will:

- Arrange for selected employees to attend First-aid and CPR/AED training as required (All staff who conduct electrical work are required).
- Ensure that first aid equipment and supplies are readily available to staff.

#### **Business Services Coordinator – HSC**

The BSC will:

- Annually inspect all first responder bags to ensure each kit contains all the items noted in the First Responder Bag Contents Inventory Checklist.
- Replace any first aid supplies that have been used.
- Ensure that first aid equipment and supplies are properly maintained.
- Maintain spare supplies as well as AED parts so that bags can be restocked as needed.
- Maintain employee records of training and establish/manage biannual recertification of all affected employees

#### **Employees**



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Employees will:

- Report an emergency condition (medical, fire, spill etc.)
- Call **911 immediately** for any serious or life threatening injury
  
- Know the location of first aid first responder bags. Bags are maintained at each utility plant:
  
- Know the location of eye wash stations and showers, fire extinguishers, chemical spill kits, site evacuation routes and emergency procedures before starting a job.
  
- Immediately report work-related personal injuries or illnesses to their supervisor.
  
- Immediately report any exposure to blood in the course of administering first aid to the Office of Prospective Health 252-744-2070
  
- Report to the Business Services Coordinator if any items in the first responder bag require replacement.

## C. FIRST AID ACTIONS

Trained first responders will follow ECU's procedures when responding to a jobsite injury. This procedure is in place to help reduce the occurrence of injuries to employees rushing in to assist injured coworkers. By following these steps, the injured will be taken care of with no additional injuries.

1. Survey the scene of the accident
  - a. Look at the victim, but also the entire scene of the accident
  - b. Check for fallen wires, toxic fumes and fire
  - c. Is the individual being electrocuted
  
2. Call Emergency Medical Services - **911**
  - a. Give a thorough description of the accident scene, the victim's condition and what first-aid are being given.
  
3. Do a primary survey of the victim
  - a. Is the victim in immediate danger? If not leave them where they are. If they must be moved do so as trained in basic first aid.
  - b. If victim is conscious ask how the injury occurred and the extent of the injuries.
  - c. If the victim is unconscious, check for breathing and pulse. Administer CPR if needed.
  
4. If an individual is being electrocuted (still in contact with energized parts):
  - a. Do not touch the person
  - b. Turn off energy source, if possible
  - c. Dislodge the person from the energy source using a non-conductive rescue hook (wear insulated gloves)

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## RESOURCES AND REFERENCES

To effectively execute the policy and procedures identified in this section of our safety manual the following documents may be used. The documents will be filed with our company records (personnel files, OSHA Recordkeeping, etc.) as noted in the table.

	PURPOSE	MAINTENANCE
First- Aid/CPR Certification Information	Used to identify and keep up to date those employees certified	Filed with HSC Facilities BSC
AED Quarterly Inspection PM	Used to document the inspection of all AEDs	AIM CMMS Work order System

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## **6. BLOODBORNE PATHOGENS EXPOSURE CONTROL PROGRAM**

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### **A. PURPOSE AND SCOPE**

The goal of the following Exposure Control Plan (ECP) is to eliminate or minimize occupational exposures to Bloodborne pathogens for First Responders.

The basis of this Plan is the OSHA Bloodborne Pathogens Standard, 29 CFR 1910.1030. Although this is a General Industry standard, it can be applied to maintenance activities where exposure may occur, such as protection for first-aid responders. As required by OSHA in 1910.269 Medical services and first aid, and consistent with the direction in NFPA 70E Standard for Electrical Safety in the Workplace, 110.2(C) Emergency Response Training, first-aid responders will be available on ECU work sites. Facilities Services will adhere to the University's Bloodborne Pathogen Exposure Control Plan.

### **B. EMPLOYEE EXPOSURE DETERMINATION**

Occupational exposure to blood and body fluids is limited to our trained first-aid responders. However, any employee who in the unlikely event has been exposed to blood or body fluids should immediately report it their supervisor and the Office of Prospective Health to determine the appropriate action as it relates to possible exposure to bloodborne pathogens.

Facilities Services will request that all affected employees receive Hepatitis B vaccinations. Staff may elect not to receive the requested vaccination but shall be required to complete a Hepatitis B Vaccine Declination Form.

### **C. RESPONSIBILITIES**

#### **Prospective Health**

Prospective Health will:

- Maintain reports of any exposure incident.
- Train first responders on the Bloodborne Pathogen requirements including the specifics required for reporting procedures.
- Administer Hepatitis Vaccinations and Titer test
- Will maintain and administer the universities bloodborne pathogen exposure control plan

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## **First Responders**

First Responders will:

- Be trained on the Bloodborne Pathogen Control Plan under the direction of Prospective Health.
- Report all first aid incidents where blood or potentially infectious materials are present to their supervisor and Prospective Health immediately.
- Use appropriate Personal Protective Equipment (PPE) when administering first aid.
- Properly dispose of or sanitize materials that may have been exposed to blood or infectious materials

## **Employees**

All employees will:

- Abide by all engineering controls and safe work practices in place to minimize potential exposure. This includes, but is not limited to, hand washing and use of the appropriate PPE.

## **D. PERSONAL PROTECTIVE EQUIPMENT**

First-aid responders will use PPE appropriate for administering the first-aid required. All first responder bags will contain:

- Gloves
- Eye protection
- Resuscitation mouthpieces
- Sanitizing wipes
- Blood Clean up Kits

## **E. HOUSEKEEPING**

In the event of a first-aid incident, the first-aid responders exposed will take precautions to decontaminate work surfaces, tools and equipment. PPE will be used during cleanup. Only trained and qualified personnel will perform clean up. The Housekeeping Department will be contacted to support the cleanup of the site as required.

## **F. POST EXPOSURE EVALUATION AND FOLLOW-UP**

Prospective Health is to be contacted immediately following an exposure incident. A healthcare professional will conduct a confidential medical evaluation and follow-up.

## **G. RECORDKEEPING**

### **Medical Records**

Medical records are maintained for each employee with exposure in accordance with 29 CFR 1926.33 or 1910.20 by the Office of Prospective Health

### **Training Records**

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Bloodborne pathogen training records will be maintained by the Office of Prospective Health at a designated location.

## H. RESOURCES AND REFERENCES

To effectively execute the policy and procedures identified in this section of our safety manual the following documents may be used. The documents will be filed with our company records (personnel files, OSHA Recordkeeping, etc.) as noted in the table.

<b>TITLE</b>	<b>PURPOSE</b>	<b>MAINTENANCE</b>
Exposure Control Plan	Document the university's Bloodborne Pathogen Exposure Control Plan	Reviewed and maintained by the Infection Control and Biological Safety Committees
Training Attendance Rosters	Documents used to identify training completed and employees present	Filed with Prospective Health
Hepatitis B Vaccination Declination	Allows the university to track employees that refuse vaccination	Prospective Health

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## **7. ELECTRICAL HAZARD COMMUNICATION**

### **A. PURPOSE AND SCOPE**

The goal of this program is to ensure that all employees receive adequate information relevant to the possible hazards that may be involved when working around electricity at ECU.

The following program outlines how this objective will be accomplished. This policy covers all potential workplace exposures involving electricity as defined by federal (29 CFR 1910.1200/1926.59), state and local regulations.

### **B. RESPONSIBILITIES**

#### **EH&S**

EH&S will:

- Monitor this specific Hazard Communication program as part of the larger university program. Questions regarding this particular program and any information associated with it should be directed to the Electrical Safety Program Team.

#### **Electrical Safety Program Team**

The ESPT will:

- Will conduct an annual audit of all high voltage yards to inspect signage and lighting
- Will audit a sample of rooms containing electrical distribution equipment to verify proper signage is in place
- Will participate in the application of Arc Flash Hazard Analysis labels as requested
- Will request resources to update or replace signage as needed

#### **Supervisors**

Supervisors will:

- Report needs to hazard communication signage to the ESPT as needs arise

#### **Employees**

All employees will:

- Follow all safety procedures described in this program, consult with their supervisor as needed for additional safety precautions, and report all labeling issues with electrical equipment or areas. All questions should be referred to the ESPT or their Supervisor.

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## D. BARRICADES

Caution tape or barricading:

- Only red tape, **DANGER HIGH VOLTAGE** or ropes/chains with signs that state **DANGER HIGH VOLTAGE** shall be used for establishing approach boundaries for electrical equipment
- In high traffic areas, or areas where there may be unsupervised minors, an attendant shall be posted in addition to the barricades.

An attendant may not be engaged any other aspect of the job task and shall concentrate solely on ensuring unqualified people do not enter the boundary.

## E. HIGH VOLTAGE EQUIPMENT

ECU does not have any areas that contain exposed, high voltage (12,470 VAC), energized equipment. All equipment shall be properly secured (Locked) at all times unless an attendant is present to prevent the entry of unauthorized individuals

All areas containing high voltage equipment shall have ANSI & OSHA compliant, bilingual, signage at all points of entry to the area as well as any other potential points of entry



Hazard warning signage shall be audited annually to ensure that it is still present in the required areas and is legible and the colors have not faded.

## F. ARC FLASH HAZARD EQUIPMENT LABELS

All new construction as well as major renovations requires either an Arc Flash Hazard Analysis be conducted or that the preexisting study be updated to reflect any modifications. Additionally, studies shall be reviewed every five years to determine if any updates are needed.

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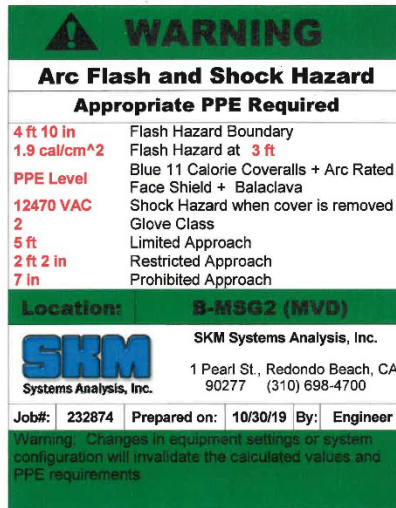
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ECU's labels shall contain the following information:

1. Flash Hazard Boundary
2. Incident Energy  $cal/cm^2$
3. Nonminimal voltage
4. Glove Class
5. Limited Approach Boundary
6. Restricted Approach Boundary
7. Prohibited Approach Boundary
8. Location
9. Date Prepared

Example of ECU Standard Label



## G. EMPLOYEE INFORMATION AND TRAINING

Hazard communication as pertains to conducting electrical work is covered in both the LV Qualified Class as well as the HV Qualified class through the e-Hazard curriculum. Copies of the e-Hazard workbook are provided to all students during the training.



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## H. RESOURCES AND REFERENCES

To effectively execute this policy and procedures identified in this section of our safety program the following documents may be used. The documents will be filed with ECU records as noted in the table.

<b>TITLE</b>	<b>PURPOSE</b>	<b>MAINTENANCE</b>
Electrical Hazard Communication Audit Form	PM Conducted annually	AIM CMMS
Training Attendance Rosters	Documents used to identify training completed and employees present	Filed with ESPT Chairman

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## 8. APPENDIX

### Appendix A – Risk Assessment Process

The intent of this process is to describe processes for performing a risk assessment, which includes a review of the electrical hazards, the associated foreseeable tasks, and the protective measures that are required in order to maintain a tolerable level of risk. A risk assessment should be performed before work is started.

#### A. Risk Assessment Steps:

1. Identify the electrical hazards associated with the task and the electrical system, or electrical process involved (example: shock hazard risk; arc flash hazard risk).
2. Identify the electrical work to be performed within the electrical system or process.
3. Define the possible failure modes that result in exposure to electrical hazards and the potential resultant harm.
4. Assess the severity of the potential injury from the electrical hazards.
5. Determine the likelihood of the occurrence for each hazard.
6. Define the level of risk for the associated hazard.
7. If the level of risk is not acceptable, identify the additional measures or corrective actions to be taken. Example: wear appropriate PPE and if the risk too great, do not perform the task.

The risk related to an identified hazard may be thought of as being composed of the severity of the injury and the likelihood of occurrence of that injury.

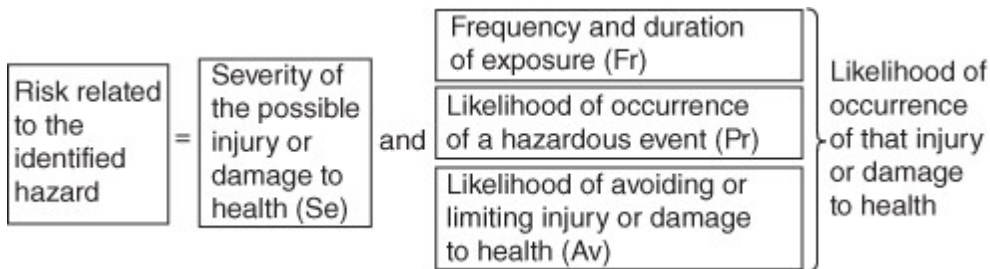


Figure 1.0 Elements of Risk Score

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**B. Risk Assessment Calculation**

The following are two examples of methods that can be used to conduct electrical risk assessments.

In the first, **The Risk Register Method**, the risk is derived using the risk parameters as shown in Figure 1.0 In the second, the risk is derived from using a **Risk Assessment Matrix** as shown in Figure 2.0

**C. Risk Register Method:**

1. Severity of the Possible Injury or Damage to Health (Se) – Severity of injuries or damage to health, can be estimated by taking into account: a) reversible injuries, b) irreversible injuries, and c) death. Typically, the types of hazards to be considered include, but are not limited to: a) shock and electrocution, b) arc flash, and arc blast. Choose the appropriate Severity value from Table 1.0 below. Add value to the Risk Register (Table 5.0)

Severity of Injury of Damage to Health	Se Value
Irreversible – trauma, death.	8
Permanent – skeletal damage, blindness, hearing loss, third degree burns.	6
Reversible – minor impact, hearing damage, second degree burns.	3
Reversible – minor laceration, bruises, first degree burns.	1

**Table 1.0**

2. Frequency and Duration of Exposure (Fr) - The following aspects should be considered to determine the level of exposure:
  - a. Need for access to the hazard zone based on all modes of use; for example, normal operation and maintenance
  - b. Nature of access, for example, examination, repair, and troubleshooting.

Choose the appropriate Frequency value from Table 2.0 below. Add value to the Risk Register (Table 5.0)

Frequency of Exposure	Fr Value (for Duration > 10 min)
≤ 1 per hour	5
> 1 per hour to < 1 per day	5
> 1 per day to < 1 every 2 weeks	4
> 1 every 2 weeks to < 1 per year	3
> 1 per year	2

**Table 2.0**

3. Likelihood of Occurrence of a Hazardous Event (Pr) – The occurrence of a hazardous event influences the likelihood of the occurrence of injury or damage to health. The possibility of the hazardous occurring should describe the likelihood of the event materializing during the use or foreseeable misuse, or both, of the electrical system or process. Subjectivity may have a substantial impact on the result of the risk assessment.

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The use of subjective information should be minimized as far as reasonably practicable.

The likelihood of occurrence of the hazardous event should be estimated independently of other related parameters (Fr and Av) and will typically be based on the results of the completed study of the arc flash potential. The worst-case scenario should be used for this parameter to ensure that short-circuit interruption device(s) have, where practicable, been properly selected and installed and will provide adequate protection.

Elements of the electrical system that are intended to ensure an intrinsically safe design shall be taken into consideration in the determination of the likelihood of the hazardous event(s). These can include, but are not limited to, the mechanical structure, electrical devices, and electronic controls integral to the system, the process, or both at the time of the analysis. Types of components that could contribute to an inherently safe design include, but are not limited to, current-limiting devices and ground-fault circuit interrupters.

This parameter can be estimated by taking into account the following factors:

- a. The predictability of the performance of component parts of the electrical system relevant to the hazard in different modes of use (e.g., normal operation, maintenance, fault finding).

*At this point in the risk assessment process, the protective effect of any personal protective equipment (PPE) and other protective measures should not be taken into account. This is necessary in order to estimate the amount of risk that will be present if the PPE and other protective measures are not in place at the time of the exposure.* In general terms, it must be considered whether the electrical system being assessed has the propensity to act in an unexpected manner. The electrical system performance will vary from very predictable to not predictable. Unexpected events cannot be discounted until it can be clearly demonstrated that the electrical system will perform as expected.

- b. The specified or foreseeable characteristics of human behavior with regard to interaction with the component parts for the machine relevant to the hazard, which can be characterized by one or both of the following:
  - i. Stress (e.g., due to time constraints, work task, perceived damage limitation).
  - ii. Lack of awareness of information relevant to the hazard.

Human behavior will be influenced by factors such as skills, training, experience, and complexity of the machine or the process.

These attributes are not usually directly under the influence of the electrical system designer, but a task analysis will reveal activities in which total awareness of all issues, including unexpected outcomes, cannot be reasonably assumed. "Very high" likelihood of occurrence of a hazardous event should be selected to reflect normal workplace constraints and worst-case considerations. Positive reasons (e.g., well-defined application and a high level of user competence) are required for any lower values to be used.

Any required or assumed skills, knowledge, and so forth, should be stated in the information for use.

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Select the appropriate value for Likelihood of Occurrence of Hazardous Event (Pr) from Table 3.0 below. Add value to the Risk Register (Table 5.0).

Likelihood of a Hazardous Event	Pr Value
Very high	5
Likely	4
Possible	3
Rare	2
Negligible	1

**Table 3.0**

Listed below are examples of general questions to consider in determining the likelihood of an event (risk):

- Has the equipment been installed in accordance with *NFPA 70®*, *National Electrical Code®* (*NEC®*)?
- Has the equipment been maintained and tested in accordance with the manufacturer's instructions?
- How old is the equipment?
- Is there any visual indication of overheating?
- Is any component, device, or equipment loose or damaged?

*The following are enclosure questions:*

- Do all enclosure doors operate and latch properly?
- Does the enclosure have all of its bolts and screws installed?
- Does the equipment or enclosure have ventilation openings?
- Is the enclosure arc rated?
- Are there openings in the enclosure that rodents or other vermin could enter?
- Is there an indication of moisture in the equipment?
- Has the enclosure been examined for dust, dirt, soot, or grease?
- Is there any indication of overheating of the bus work, etc., in the enclosure, such as discoloration?

*The following are circuit breaker (CB) condition questions:*

- Has the CB periodically been operated in accordance with the manufacturer's instructions?
- Has the CB been applied within its marked rating?
- Has the right type of CB been used?
- Have the proper conductor types and sizes been used to connect to the CB?
- Has the CB been checked for burn marks?
- Have the CB surfaces been examined for dust, dirt, soot, grease, or moisture? If any was found, have the CB surfaces been appropriately cleaned?
- Has the CB been examined for cracks?
- Have all electrical connections to the CB been checked to be certain that they are clean and secure?
- Is there any indication of discoloration of the CB's molded case, discoloration or flaking of external metal parts, or melting or blistering of adjacent wire insulation?

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- Is there any evidence of overheating or melting of the arc chute vent or area surrounding the vents?
  - Is there evidence of overheating or case blistering?
  - If the CB has interchangeable trip units, have the trip units been visually checked for overheating or looseness?
  - Have mechanical operation tests been performed on the CB and proper contact operation verified?
  - Have insulation resistance and/or individual pole resistance (millivolt drop) tests been performed on the CB?
  - Have inverse-time and/or instantaneous overcurrent trip tests been conducted on the CB?
  - What is the ampere rating of the CB involved?
4. Likelihood of Avoiding or Limiting Injury or Damage to Health (Av) – This parameter can be estimated by taking into account aspects of the electrical system design and its intended application that can help to avoid or limit the injury or damage to health from a hazard, including the following examples:
- a. Sudden or gradual appearance of the hazardous event; for example, an explosion caused by high fault values under short-circuit conditions.
  - b. Spatial possibility to withdraw from the hazard.
  - c. Nature of the component or system; for example, the use of touch-safe components, which reduce the likelihood of contact with energized parts. Working in close proximity to high voltage can increase the likelihood of personnel being exposed to hazards due to approach to live parts.
  - d. Likelihood of recognition of hazard; for example, as an electrical hazard, a copper bar does not change its appearance, whether it is under voltage or not. To recognize the presence of the hazard, an instrument is needed to establish whether or not electrical equipment is energized; thus both inadvertent and intentional contact need to be considered.

Select the appropriate value for Likelihood of Avoiding or Limiting Injury or Damage to Health (Av) from the Table 4. Add the value to the Risk Register (Table 5).

Likelihood of Avoiding or Limiting Injury or Damage to Health	Av Value
Impossible	5
Rare	3
Probable	1

**Table 4**

**Risk Register – Enter Values from Tables 1, 2, 3 & 4.**

Scenario No.	Hazard	Severity	Probability of Occurrence of Harm $P_o = (Fr+Pr+Av)$				Risk Score (R)
		Se	Fr	Pr	Av	Total	Se x Po

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Table 5

**A Risk Score (R) higher than 10 requires consideration of additional safety controls.**

## D. Matrix Method

A risk assessment matrix is a simple table that groups risk based on severity and likelihood. It can be used to assess the need for remedial action, such as the use of PPE for a given task, and to prioritize safety issues.

The following title categories are used to define the risk:

### 1. Likelihood of Occurrence:

- a. Definite – Almost certain of happening.
- b. Likely – Can happen at any time.
- c. Occasional – Occurs sporadically, from time to time.
- d. Seldom – Remote possibility; could happen sometime; most likely will not happen.
- e. Unlikely – Rare and exceptional for all practical purposes; can assume it will not happen.

### 2. Severity of Injury:

- a. Catastrophic – Death or permanent total disability (PTD).
- b. Critical – Permanent partial disability (PPD) or temporary total disability (TTD) 3-months or longer.
- c. Medium – Medical treatment and lost work injury (LWI).
- d. Minor – Minor medical treatment possible.
- e. Slight – First aid or minor treatment.

Likelihood of occurrence in period	Severity of the injury (consequences)				
	Slight	Minor	Medium	Critical	Catastrophic
Cal/cm <sup>2</sup>	< 1.2	> 1.2 to < 4	> 4 to < 8	> 8 to < 40	> 40
Unlikely	L	L	L	M	M
Seldom	L	L	M	M	H
Occasional	L	M	M	H	E
Likely	M	M	H	E	E
Definite	M	H	E	E	E

Figure 2 Risk Assessment Matrix

### 3. Interpretation of Risk Assessment Matrix:

- a. **Extreme (E) - Intolerable risk:** Do not proceed. Immediately introduce further controls. Detailed action plan required. Color code red.
- b. **High (H) - Unsupportable risk:** Review and introduce additional controls. Requires senior management attention. Color code orange.
- c. **Moderate (M) - Tolerable risk:** Incorporates some level of risk that is unlikely to occur. Specific management responsibility. Consider additional controls.

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- Take remedial action at appropriate time. Color code yellow.
- d. **Low (L) - Supportable risk:** Monitor and maintain controls in place. Manage by routine. Procedures. Little or no impact. Color code green.

## Protective Measures

The appropriate protective measures include the following:

- (1) Elimination
- (2) Substitution
- (3) Engineering controls
- (4) Awareness
- (5) Administrative controls (Procedures)
- (6) Training
- (7) Personal Protective Equipment (PPE)
- (8) Mitigation

Examples:

**Elimination:** Eliminate the hazard. Turn the equipment off and verify a safe work condition.

**Substitution:** Think through the entire procedure and substitute methods and procedures that constitute lower risk.

**Engineering Controls:** Engineering controls can have a substantial impact on risk. They should, where practicable, be considered and analyzed. Typically, engineering controls take the form of barriers and other

safeguarding devices such as GFCI protection, zone selective interlocking, differential relaying, energy reducing maintenance switches, high resistive grounding and current limiting devices.

**Awareness:** Awareness means can be used to complement the effects of engineering controls with regard to risk reduction. They should be chosen based on the design configuration for each specific application and their potential effectiveness during foreseen interaction. Each design and configuration can require unique awareness devices in order to have the desired impact on risk. Typically, awareness means take the form of signs and visual and audible alarms.

**Administrative Controls (Procedures):** Procedures and instructions that are required for individuals to safely interact with the electrical system should be identified. The procedures and instruction should include descriptions of the hazards, the possible hazardous events, hazardous situations, and the protective measures that need to be implemented. Procedures and instructions should also be used to communicate foreseeable misuse of the system that could contribute to an increased level of risk. Typically, formal procedures are provided in written form; however, in some cases, verbal instruction can be provided. Care should be taken in the latter case to ensure that the verbal instructions will have the desired impact on risk.

**Training:** Training, with regard to the proper interaction and for foreseeable inappropriate interaction with the electrical system, must be completed. The intent of the training is to ensure that all affected personnel are able to understand when and how hazardous situations can arise



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and how to best reduce the risk associated with those situations. Typically, training for individuals interacting with electrical systems will include technical information regarding hazards, hazardous situations, or both as well as information related to potential failure modes that could affect risk. This type of training generally will be provided by a trainer who has an in-depth understanding of electrical system design, as well as experience in the field of adult education. Less technical training content could be appropriate in situations in which only awareness of electrical hazards is needed to ensure that unqualified personnel do not interact with the electrical system.

**Personal Protective Equipment (PPE):** The electrical system must be analyzed in order to determine the appropriate PPE. Once the appropriate PPE has been determined, personnel must maintain and use it as required in order to ensure that residual risk remains at the desired level. PPE is the last line of defense.

**Mitigation** – Emergency procedures. Identify who is going to provide assistance and summon help if needed.