Electrical Safety Program

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1. Purpose

The purpose of Clemson University's (CU) Electrical Safety Program is to protect all staff, students, and faculty from electrical hazards. This will be accomplished through compliance with the work practices described in this program along with effective application of engineering controls, administrative controls and the use of Personal Protective Equipment (PPE).

2. Policy

It is the policy of Clemson University to avoid energized work unless it is absolutely necessary. Live parts will be de-energized before an employee works on or near them unless one of the following conditions apply:

1. **Greater Hazard.** Energized work shall be permitted where supervision can demonstrate that de-energizing introduces additional hazards or increased risk.
2. **Infeasibility.** Energized work shall be permitted where supervision can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.
3. **Less Than 50 Volts.** Energized electrical conductors and circuit parts that operate at less than 50 volts shall not be required to be de-energized where the capacity of the source and any overcurrent protection between the energy source and the worker are considered and it is determined that there will be no increased exposure to electrical burns or to explosion due to electrical arcs.

3. Scope

This program applies to all workers authorized by management to install, modify, repair, or work on electrical conductors and equipment in or on University facilities. It also applies to electrical conductors and equipment operating at 50 volts nominal, or greater; and to live parts operating at less than 50 volts nominal, if there is an increased risk of exposure to electrical burns or to explosion due to electrical arcs.

4. Definitions

Arc Flash: An arc flash is a phenomenon where a flashover of electric current leaves its intended path and travels through the air from one conductor to another, or to ground. The results are often violent and when a human is in close proximity to the arc flash, serious injury and even death can occur. Arc flash can be caused by many things, including:

- Dust
- Dropping tools
- Accidental touching
- Condensation
- Material Failure
- Corrosion
- Faulty Installation

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 and the appropriate levels of PPE.

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

Arc Flash Suit: A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet. This includes pants, jacket, and balaclava.

Arc Rating: The maximum incident energy resistance demonstrated by a material (or layered system of materials) prior to "breaking open" or at the onset of a second-degree skin burn. This rating is assigned to electrical protective clothing and is normally expressed in calories per square centimeter (cal/cm^2).

Balaclava (sock hood): An arc-rated AR hood that protects the neck and head except for facial area of the eyes and nose.

Bare Hand Work: A technique of performing work on energized electrical conductors or circuit parts, after the employee has been raised to the potential of the energized electrical conductors or circuit part.

De-energized. Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from the earth.

Energized. Electrically connected to or having a source of voltage.

Electrically Safe Working Condition: A state in which an electrical conductor or circuit part to be worked on or near has been disconnected from all sources of power including storage devices such as batteries and capacitors. In addition, the equipment disconnects have been locked/tagged out in accordance with CU Lockout/Tagout policy.

AR Apparel: Arc resistance apparel designed specifically to protect Qualified Workers from electrical arc events during the completion of energized tasks. Apparel is marked with cal/cm^2 rating.

Ground-fault circuit-interrupter (GFCI) is a protective device that compares the amount of current going into electrical equipment with the amount of current returning from the equipment and if a targeted deviation (0.005 amperes) is exceeded, the circuit is quickly broken, often within as little as 25 milliseconds.

Hazard/Risk Categories (HRC) refers to categories of treated protective clothing which are determined by the minimum amount of calories per square centimeter (Arc Thermal Performance Value (ATPV) or Cal/cm^2). Any treated garment must pass through with a 50% probability of a 2nd or 3rd degree burn occurring, which is how the protective level of the treated clothing is determined. The higher the ATPV, the higher the HRC level attained, the greater the protection that is needed.

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

Job Hazard Analysis (JHA). A technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. See attachment F for a sample and attachment G for a blank form.

Limited Approach Boundary. An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Lockout / Tagout. A procedure where equipment or machinery systems have had (1) all potential energy sources isolated (i.e., turned off); (2) all potential energy sources secured from reactivation (e.g. locked out); (3) all residual energy relieved from the system; and (4) all system controls activated, with safety verified. *See the CU Policy, "Lock Out / Tag Out" for more details.*

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

Qualified Person. One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

Restricted Approach Boundary. 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 the energized electrical conductor or circuit part.

Unqualified Person. A person who has not been trained as a qualified individual.

5. Responsibilities

Environmental Safety (ES) is responsible for reviewing hazards associated with electrical safety during annual shop inspections. ES is responsible for reviewing and updating the Electrical Safety Program. ES will assist departments in implementing the provisions of this program and developing task specific safety training and procedures. ES and Supervisors also work jointly in the development of Job Hazard Analysis (JHA) to document first-time procedures.

Supervisors are responsible for implementing the Electrical Safety Program within their areas and ensuring that employees comply with the program. Supervisors develop and maintain a list of all qualified employees in their areas. They must ensure employees are provided with and use appropriate protective equipment. They must also conduct the Electrical Safety Program Audit. Supervisors are responsible for administering progressive discipline in accordance with the SC State Personnel Manual and Clemson University guidelines when subordinate personnel repeatedly fail to comply with this procedure as required.

Qualified **Employees** must perform electrical work in accordance with this program. They must conduct a visual inspection of PPE, equipment and tools prior to each use to ensure good working condition. Employees must notify their supervisor if PPE, equipment or tools are found to be defective. They must also keep unqualified people outside of the qualified worker boundary (Limited Approach Boundary).

Contractors Safety programs used by contractors must meet or exceed all applicable guidelines of the CU Electrical Safety Program. Contractors may be required to submit copies of their program to the CU representative associated with the work. After the work is complete, contractors must notify CU in writing of any hazards created by the work.

6. Training Requirements

Training shall be conducted in the classroom, on-the-job, or a combination of the two. The degree of training provided shall be determined by the risk to the employee. Employees will be classified in one of two categories, qualified workers and unqualified workers.

A. Employee Training

1. **Qualified persons**: For a person to be considered qualified, the employee must receive general electrical safety training as stated above as well as training listed in this section:
   - Skills and techniques necessary to distinguish exposed energized electrical parts from other parts of electrical equipment
   - Skills and techniques necessary to determine the nominal voltage of exposed energized electrical parts
   - Approach distances and the corresponding voltages to which the qualified person will be exposed
   - Decision-making process necessary to determine the degree and extent of the hazard and job planning to perform the task safely
   - In the selection of PPE and tools, including a dry run practice to ensure PPE does not limit the person's dexterity or vision.
   - **NOTE:** A person can be considered qualified with respect to certain equipment and methods but still unqualified for others.
   - In the selection of appropriate voltage detector and shall demonstrate how to use the device to verify the absence of voltage. The employee should also understand the limitations of each detector.
   - Employees undergoing training to become a qualified worker are considered qualified if he or she is under the direct supervision of a qualified worker.
   - Supervisors shall determine, through regular supervision or through inspections conducted on at least an annual basis that each employee is complying with safety-related work practices.

2. **Unqualified persons** shall be trained in and familiar with any electrical safety-related practices necessary for their safety.

3. **Retraining.** An employee shall receive additional training (or retraining) under any of the following conditions:

   a. If the supervision or annual inspections indicate that the employee is not complying with the safety-related work practices.
   b. If new technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those that the employee would normally use.
   c. If he or she must employ safety-related work practices that are not normally used during his or her regular job duties.
   d. If there are changes to the Electrical Safety Program.
   e. If an employee is required to perform tasks less often than once per year, they shall be retrained before beginning the work.
   f. Retraining shall be performed at intervals not to exceed 3 years.

B. Safety Training: Employees who face a risk of electrical hazard that is not reduced to a safe level shall be trained to understand the specific hazards associated with electrical energy. They 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. Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury.

C. Emergency Procedures: Employees exposed to shock hazards and those employees responsible for taking action in case of emergency shall be regularly instructed in methods of first aid and emergency procedures, such as approved methods of resuscitation, if their duties warrant such training. Training of employees in approved methods of resuscitation, including cardiopulmonary resuscitation, shall be certified by CU annually.

D. Training Documentation. The Supervisor, the Training Office and ES shall maintain a record of all electrical training provided to employees along with a list of all employees classified as qualified workers. The documentation shall contain the content of the training, the employee's name, instructor name, and dates of training. Per state guidelines, employee training records must be kept for five years after termination.

7. Standard Operating Procedures

CU employees shall use the written safe electrical work procedures, reviewed and approved by management, which describe the specific safety procedures for working within the Limited Approach Boundary of energized electrical conductors and circuit parts operating at 50 volts or more or where an electrical hazard exists before work is started. Every electrical conductor or circuit part is considered energized until proven otherwise.

The most current edition of the referenced standards shall be used.

- NFPA 70E, Standard for Electrical Safety in the Workplace;
- IEEE Standard C2-2007 – National Electrical Safety Code;
- 29 CFR 1910.301 thru 29 CFR 1910.399 Occupational Safety & Health Standard Subpart S - Electrical;
- 29 CFR 1910.147 Occupational Safety & Health Standard - Control of Hazardous Energy (Lockout/Tagout);
- CU Policy on Lockout/Tagout;
- CU Policy General Safety - *Personal Protective Equipment (PPE)*

A. Job Briefing

1. **General.** Before starting each job, the employee in charge shall conduct a job briefing with the employees involved. The briefing shall cover such subjects as hazards associated with the job, work procedures involved, special precautions, energy source controls, PPE requirements, and the information on the energized electrical work permit, if required. Additional job briefings shall be held if changes that might affect the safety of employees occur during the course of the work.

    a. Repetitive or Similar Tasks. If the work or operations to be performed during the day or shift are repetitive and similar, at least one job briefing shall be conducted before the start of the day or shift. Additional job briefings shall be held if significant changes occur during the course of the work.

b. Routine Work. Prior to starting work, a brief discussion shall be satisfactory if the work involved is routine and if the employee is qualified for the task. A more extensive discussion shall be conducted if the work is more complicated than usual or is particularly hazardous.

See *Attachment A* for the Job Briefing and Planning Checklist.

B. Establishing an Electrically Safe Work Condition

An electrically safe work condition shall be achieved when performed in accordance with the CU Policy "Lock Out / Tag Out" and verified by the following process:

1. Determine all possible sources of energy to the specific equipment by checking applicable up-to-date drawings, diagrams, and identification tags.
2. After properly interrupting the load current, open the disconnecting device(s) for each source.
3. Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.
4. Apply lockout/tagout devices in accordance with the CU Policy "Lock Out / Tag Out".
5. Use an adequately rated voltage detector to test each phase conductor or circuit part to verify that it is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily.
6. Where the possibility of induced voltage or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts could contact other exposed live parts, apply ground connecting devices rated for the available fault duty.

C. Work Involving Electrical Hazards - Approach Boundaries to Live Parts

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

2. Safe approach distances to fixed live parts can be determined by referring to Table 1 and 1A.

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

4. Qualified persons may not cross or take any conductive objects closer than the Restricted Approach Boundary unless:

   a. The qualified person is insulated or guarded from the live parts and no uninsulated part of the body crosses the Prohibited Approach Boundary.
   b. The live parts are insulated from the qualified person and from any other conductive object at a different potential.

7. Crossing the Prohibited Approach Boundary is considered the same as making contact with energized parts. Qualified persons may only cross this boundary when all of the following precautions have been taken:
   a. The qualified person has specific training to work on energized parts.
   b. The qualified person uses PPE appropriate for working on energized parts, which is rated for the voltage and energy level involved.

D. Energized Electrical Work Permit.

1. **When Required.** When working within the limited approach or arc flash boundary of live parts, work to be performed shall be considered energized electrical work and shall be performed by written permit only. *See Attachment B*.

2. **Exemptions to Work Permit**. Work performed within the Limited Approach Boundary of live parts by qualified persons related to tasks such as testing, troubleshooting, voltage measuring, etc., shall be permitted without an energized electrical work permit, provided appropriate safe work practices (JHA's) and PPE are provided and used.

E. Alerting Techniques.

1. Barricades. Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing live parts. Barricades shall be placed no closer than the Limited Approach Boundary given in Table 1 and Table 1a.

2. Attendants. If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.

F. Use of Equipment

1. Portable Power Tools, Equipment and Extension Cords shall be visually inspected prior to use and handled in a manner that will not cause damage. These devices shall not be altered in a manner that was not intended by the manufacturer. Adapters that interrupt the continuity of the equipment-grounding conductor shall not be used. Additionally, GFCI protection is required.

2. Flexible electric cords connected to equipment shall not be used for raising or lowering the equipment. They shall not be fastened with staples or hung in such a manner that could damage the outer jacket or insulation. They shall not be spliced or taped.

3. Extension cords and cables must be (3) wire, 14 gauge or heavier with a ground plug. Damaged or worn cords must be taken out of service and tagged defective and repaired or removed. When cords/cables are passing through the work area, they shall be elevated or covered for protection, and arranged to eliminate any tripping hazards.

G. Test Instruments and Equipment

1. Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring within the limited approach boundary of live parts operating at 50 volts or more or where an electrical hazard exists.

2. Test instruments, equipment and their accessories shall be rated for circuits and equipment to which they will be connected. They shall also be designed for the environment to which they will be exposed, and for the manner in which they will be used.

4. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before each use. If there is a defect or evidence of damage that might expose an employee to injury, the item(s) shall be removed from service.

H. Other Precautions for Personnel Activities.

1. **Alertness.** Employees shall be instructed to be alert at all times while working within the Limited Approach Boundary of energized electrical conductors or circuit parts. They will not knowingly be permitted to work while their alertness is recognizably impaired due to illness, fatigue, or for any other reason.

2. **Blind Reaching.** Employees shall be instructed not to reach blindly into areas that might contain exposed energized electrical conductors or circuit parts where an electrical hazard exists.

3. **Conductive Articles Being Worn.** 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 energized electrical conductors or circuit parts.

4. **Conductive Materials, Tools, and Equipment Being Handled.** Conductive materials, tools, and equipment that are in contact with any part of an employee's body shall be handled in a manner that prevents accidental contact with energized electrical conductors or circuit parts.

5. **Conductive Work Locations.** Portable electric equipment used in highly conductive work locations (such as those inundated with water or other conductive liquids) or in job locations where employees are likely to contact water or conductive liquids shall be approved for those locations. In job locations where employees are likely to contact or be drenched with water or conductive liquids, GFCI protection shall also be used.

6. **Confined or Enclosed Work Spaces.** When an employee works in a confined or enclosed space containing exposed energized electrical conductors or circuit parts, management shall provide, and the employee shall use, protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee.

7. **Housekeeping Duties** Good housekeeping must be maintained at all times. Poor housekeeping in mechanical spaces presents many hazards including fire, trip and accidental contact; as well as code violations.
    - The OSHA Standard (29 CFR 1910.303 (g)) requires sufficient access and working space around all equipment serving 600 volts or less.
    - The National Electric Code (NFPA 70 110.26) requires a minimum of 36 inches of clear working space in the direction of any access to live parts.
    - For equipment serving between 120 and 250 volts, the regulations require a minimum of three feet of clearance. The width of the working space in front shall be 30 inches minimum or width of the equipment.
    - Employees shall not perform housekeeping duties inside the limited approach boundary where there is a possibility of contact with energized electrical conductors or circuit pars, unless adequate safeguards (such as insulating equipment or barriers) are provided to prevent contact.

8. **Illumination** Employees shall not enter spaces containing electrical hazards unless illumination is provided that enables the employees to perform the work safely.

I. Personal and Other Protective Equipment

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 body part to be protected and for the work to be performed.

Department supervisors are responsible for providing electrical protective equipment required by this program at no cost to employees, such as AR apparel, eye protection, head protection, hand protection, insulated footwear and face shields. Department supervisors are not responsible for providing non-AR under layers to employees.

All PPE shall be maintained in safe, reliable condition by the employee to whom it is issued and shall conform to the standards of Table 130.7(C)(15)(a) of NFPA 70E.

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

Employees shall wear PPE for the eyes whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion.

Employees shall wear rubber insulating gloves where there is danger of hand and arm injury due to contact with live parts or possible exposure to arc flash burn. The following ratings can be found on voltage rated gloves:

Class 00 = Protect against voltage up to 500 volts
Class 0 = Protect against voltage up to 1,000 volts
Class 1 = Protect against voltage up to 7,500 volts

Class 2 = Protect against voltage up to 17,000 volts
Class 3 = Protect against voltage up to 26,500 volts
Class 4 = Protect against voltage up to 36,000 volts

Where insulated footwear is used as protection against step and touch potential, dielectric overshoes shall be required. Insulated footwear shall not be used as the primary protection.

Face shields without an arc rating shall not be used for electrical work. Safety glasses or goggles must always be worn underneath face shields.

J. Insulated Tools and Equipment

Only insulated tools and equipment shall be used within the limited approach boundary of exposed energized parts.

1. Requirements for Insulated Tools

a. Insulated tools shall be rated for the voltages on which they will be used and shall be inspected prior to each use.
b. 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.
c. Ropes and hand lines used within the Limited Approach Boundary shall be nonconductive.
d. Fiberglass-reinforced plastic rod and tube used for live line tools shall meet the requirements of electrical codes and standards.
e. Portable ladders shall have nonconductive side rails and shall meet the requirements of ANSI standards for ladders.
f. Protective shields, protective barriers, or insulating materials shall be used to protect employees from shock, burns, or other electrically related injuries while that employee is working within the Limited Approach Boundary.
g. Rubber insulating equipment shall meet the ASTM standards.
h. Plastic guard equipment shall meet ASTM standards.
i. Physical or mechanical (field fabricated) barriers shall be installed no closer than the restricted approach distance give in Table 1 and Table 1a. While the barrier is being installed, the restrictive approach distance specified in Table 1 and Table 1a shall be maintained, or the energized electrical conductors or circuit parts shall be placed in an electrically safe work condition.

K. Work within the Limited Approach Boundary or Arc Flash Boundary of Uninsulated Overhead Lines.

Where work is performed in locations containing uninsulated energized overhead lines which are not guarded or isolated, precautions shall be taken to prevent employees from contacting such lines. Where the work to be performed is such that contact with uninsulated energized overhead lines is possible, the lines shall be de-energized and visibly grounded at the point of work, or suitably guarded.

1. A qualified person shall determine if the overhead electrical lines are insulated for the lines' operating voltage.

2. If the lines are to be de-energized, arrangements shall be made with the person or organization that operates or controls the lines to de-energize them and visibly ground them at the point of work. If arrangements are made to use protective measures, such as guarding, isolating, or insulation, these precautions shall prevent each employee from contacting such lines directly with any part of his or her body or indirectly through conductive materials, tools, or equipment.

3. When unqualified persons are working on the ground or in an elevated position near overhead lines, the location shall be such that the employee and the longest conductive object the employee might contact cannot come closer to any unguarded, energized overhead power line than the Limited Approach Boundary in Table 1, Column 2 or Table 1a, column 2.

4. If any vehicle or mechanical equipment is intentionally grounded, employees working on the ground near the point of grounding shall not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades, dielectric overshoe footwear, or insulation, shall be taken to protect employees from hazardous ground potentials (step and touch potential.

L. Arc Flash Safety

It is the goal of CU to control the arc flash hazard which occurs during the maintenance of electrical building components throughout all facilities. To reduce the potential for arc flash incidences, the following procedures shall be followed:

a. De-energize all circuits before performing work on them (follow departmental policies when de-energizing circuits).
b. Ensure that all possible sources of supply are found and open disconnecting devices for each source.
c. Apply Lockout/Tagout devices in accordance with the CU Lockout/Tagout Policy.
d. Test voltage on each conductor to verify that it is de-energized.
e. Apply grounding devices where stored energy or induced voltage could exist or where de-energized conductors could contact live parts.
f. If work is necessary on energized parts, the following procedures shall be followed:
    1. Establish boundaries keeping those not involved with the work at least ten (10) feet away.
    2. Use insulated tools along with insulated floor mats.
    3. Wear safety glasses/goggles and voltage rated gloves.
    4. Wear hard-soled leather work shoes or dielectric overshoes.
    5. Wear appropriate arc flash protection.
    6. Voltages 50-120 = standard cotton shirt and cotton pants.
    7. Voltages 120-600 = category 2 arc flash coat over standard uniform, low voltage gloves, hardhat with arc flash shield, balaclava and earplugs.

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

1. At least one of the following:
   a. Available incident energy and the corresponding working distance
   b. Minimum arc rating of clothing
   c. Required level of PPE
   d. Highest Hazard/Risk Category (HRC) for the equipment.
2. Nominal system voltage
3. Arc flash boundary

M. Safety Requirements for Special Equipment

1. SAFETY-RELATED WORK PRACTICES FOR USE OF LASERS

The requirements of this section apply to the use of lasers in the laboratory and the workshop.

For the purposes of this section, the following definitions apply.

Fail Safe. The design consideration in which failure of a component does not increase the hazard. In the failure mode, the system is rendered inoperative or nonhazardous.

Fail Safe Safety Interlock. An interlock that in the failure mode does not defeat the purpose of the interlock, for example, an interlock that is positively driven into the off position as soon as a hinged cover begins to open, or before a detachable cover is removed, and that is positively held in the off position until the hinged cover is closed or the detachable cover is locked in the closed position.

Laser. Any device that can be made to produce or amplify electromagnetic radiation in the wavelength range from 100 nm to 1 mm primarily by the process of controlled stimulated emission.

Laser Energy Source. Any device intended for use in conjunction with a laser to supply energy for the excitation of electrons, ions, or molecules. General energy sources, such as electrical supply services or batteries, shall not be considered to constitute laser energy sources.

Laser Product. Any product or assembly of components that constitutes, incorporates, or is intended to incorporate a laser or laser system.

Laser Radiation. All electromagnetic radiation emitted by a laser product between 100 nm and 1 mm that is produced as a result of a controlled stimulated emission.

Laser System. A laser in combination with an appropriate laser energy source with or without additional incorporated components.

a. Safety Training.

Clemson University will provide training for all operator and maintenance personnel. The training shall include, but is not limited to, the following:

I. Familiarization with laser principles of operation, laser types, and laser emissions
II. Laser safety, including the following:

A. System operating procedures
B. Hazard control procedures
C. The need for personnel protection
D. Accident reporting procedures
E. Biological effects of the laser upon the eye and the skin
F. Electrical and other hazards associated with the laser equipment, including the following:

- High voltages (> 1 kV) and stored energy in the capacitor banks
- Circuit components, such as electron tubes, with anode voltages greater than 5 kV emitting X-rays
- Capacitor bank explosions
- Production of ionizing radiation
- Poisoning from the solvent or dye switching liquids or laser media
- High sound intensity levels from pulsed lasers

III. Proof of qualification of the laser equipment operator shall be available and in possession of the operator at all times.

b. Safeguarding of Employees in the Laser Operating Area.

I. Employees shall be provided with eye protection as required by federal regulation.
II. Warning signs shall be posted at the entrances to areas or protective enclosures containing laser products.
III. High power laser equipment shall include a key-operated master control.
IV. High-power laser equipment shall include a failsafe laser radiation emission audible and visible warning when it is switched on or if the capacitor banks are charged.
V. Beam shutters or caps shall be utilized, or the laser switched off, when laser transmission is not required. The laser shall be switched off when unattended for 30 minutes or more.
VI. Laser beams shall not be aimed at employees.
VII. Laser equipment shall bear a label indicating its maximum output.
VIII. Personnel protective equipment shall be provided for users and operators of high-power laser equipment.

c. Employees shall be responsible for the following:

I. Obtaining authorization for laser use
II. Obtaining authorization for being in a laser operating area
III. Observing safety rules
IV. Reporting laser equipment failures and accidents to supervision.

2. SAFETY RELATED WORK PRACTICES FOR POWER ELECTRONIC EQUIPMENT

This section applies to safety-related work practices around power electronic equipment, including the following:

- Electric arc welding equipment
- High-Power radio, radar, and television transmitting towers and antenna
- Industrial dielectric and RF induction heaters
- Shortwave or radio frequency diathermy devices
- Process equipment that includes rectifiers and inverters such as the following:
  - Motor drives
  - Uninterruptible power supply systems
  - Lighting controllers

a. **Hazardous Effects of Electricity on the Human Body.**

The following hazards are associated with power electronic equipment.

I. Results of Power Frequency Current.

A. At 5 mA, shock is perceptible.
B. At 10 mA, a person may not be able to voluntarily let go of the hazard.
C. At about 40 mA, the shock, if lasting for 1 second or longer, may be fatal due to ventricular fibrillation.
D. Further increasing current leads to burns and cardiac arrest.

II. Results of Direct Current.

A. A dc current of 2 mA is perceptible.
B. A dc current of 10 mA is considered the threshold of the let-go current.

III. Results of Voltage.

A. A voltage of 30 V rms, or 60 V dc, is considered safe except when the skin is broken. The internal body resistance can be as low as 500 ohms, so fatalities can occur.

IV. Results of Short Contact.

A. For contact less than 0.1 second and with currents just greater than 0.5 mA, ventricular fibrillation may occur only if the shock is in a vulnerable part of the cardiac cycle.
B. For contact of less than 0.1 second and with currents of several amperes, ventricular defibrillation may occur if the shock is in a vulnerable part of the cardiac cycle.
C. For contact of greater than 0.8 second and with currents just greater than 0.5 A, cardiac arrest (reversible) may occur.
D. For contact greater than 0.8 second and with currents of several amperes, burns and death are probable.

V. Results of ac at Frequencies Above 100 Hz.

A. When the threshold of perception increases from 10 kHz to 100 kHz, the threshold of let-go current increases from 10 mA to 100 mA.

VI. Effects of Waveshape.

A. Contact with voltages from phase controls usually causes effects between those of ac and dc sources.

VII. Effects of Capacitive Discharge.

A. A circuit of capacitance of 1 microfarad having a 10 kV capacitor charge may cause ventricular fibrillation.
B. A circuit of capacitance of 20 microfarad having a 10 kV capacitor charge may be dangerous and probably cause ventricular fibrillation.

3. HAZARDS ASSOCIATED WITH POWER ELECTRONIC EQUIPMENT.

Employees shall be made aware of the hazards associated with the following:

a. High voltages within the power supplies
b. Radio frequency energy – induced high voltages
c. Effects of radio frequency, RF, fields in the vicinity of antennas and antenna transmission lines, which can introduce electrical shock and burns
d. Ionizing (X-radiation) hazards from magnetrons, klystrons, thyratrons, cathode-ray tubes, and similar devices
e. Non-ionizing RF radiation hazards from the following:
   I. Radar equipment
   II. Radio communication equipment, including broadcast transmitters
   III. Satellite earth-transmitters
   IV. Industrial scientific and medical equipment
   V. RF induction heaters and dielectric heaters
   VI. Industrial microwave heaters and diathermy radiators

4. SPECIFIC MEASURES FOR PERSONNEL SAFETY.

a. Management shall be responsible for the following:

I. Proper training and supervision by properly qualified personnel including the following:

A. The nature of the associated hazard
B. Strategies to minimize the hazard
C. Methods of avoiding or protecting against the hazard
D. The necessity of reporting any hazardous incident

i. Properly installed equipment.
ii. Proper access to the equipment.
iii. Availability of the correct tools for operation and maintenance.
iv. Proper identification and guarding of dangerous equipment.
v. Provision of complete and accurate circuit diagrams and other published information to the employee prior to the employee starting work. The circuit diagrams should be marked to indicate the hazardous components.
vi. Maintenance of clear and clean work areas around the equipment to be worked.
vii. Provision of adequate and proper illumination of the work area.

II. The employee is responsible for the following:

A. Understanding the hazards associated with the work.
B. Being continuously alert and aware of the possible hazards
C. Using the proper tools and procedures for the work
D. Informing supervision of malfunctioning protective measures, such as faulty or inoperable enclosures and locking schemes
E. Examining all documents provided by Management relevant to the work, especially those documents indicating the hazardous components location
F. Maintaining good housekeeping around the equipment and work area
G. Reporting any hazardous incident
H. Using and appropriately maintaining the PPE and tools required to perform the work safely.

5. SAFETY-RELATED WORK REQUIREMENTS FOR RESEARCH AND DEVELOPMENT LABORATORIES

The requirements of this section apply to the electrical installations in those areas, with custom or special electrical equipment, designated for research and development (R&D) or as laboratories.

For the purposes of this section, the following definitions apply.

Competent Person. A person meeting all of the requirements of a qualified person, as defined in Section IV of this document and, in addition, is responsible for all work activities or safety procedures related to custom or special equipment, and has detailed knowledge regarding the electrical hazard exposure, the appropriate controls for mitigating those hazards, and the implementation of those controls.

Field Evaluated. A thorough evaluation of non-listed or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction. The evaluation approval ensures that the equipment meets appropriate codes and standards, or is similarly found suitable for a specified purpose.

Laboratory. A building, space, room, or group of rooms intended to serve activities involving procedures for investigation, diagnostics, product testing, or use of custom or special electrical components, systems, or equipment.

Research and Development (R&D). An activity in an installation specifically designated for research or development conducted with custom or special electrical equipment.

a. **Applications of Other Articles**. The electrical system for R&D and laboratory applications shall meet the requirements of this document.

Note: Examples of these applications include low voltage-high current power systems; high voltage-low current power systems; dc power supplies; capacitors; cable trays for signal cables and other systems, such as steam, water, air, gas, or drainage; and custom-made electronic equipment.

b. **Specific Measures and Controls for Personnel Safety**. Each laboratory or R&D system application shall be assigned a competent person to ensure the use of appropriate electrical safety-related work practices and controls.

c. **Listing Requirements.** The equipment or systems used in the R&D area or in the laboratory shall be listed or field evaluated prior to use.

Note: Laboratory and R&D equipment or systems can pose unique electrical hazards that might require mitigation. Such hazards include ac and dc, low voltage and high amperage, high voltage and low current, large electromagnetic fields, induced voltages, pulsed power, multiple frequencies, and similar exposures.

8. Periodic Audits

A. The Electrical Safety Program shall be audited to verify the principles and procedures are in compliance with NFPA 70E. The frequency of the audit shall not exceed 3 years and shall be documented.

B. 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 Attachment C.

C. The Department shall conduct a periodic, documented audit of live electrical work safety procedures. Supervisors/Electrical Engineers will perform the audit. Departments may use this audit to correct any deviations or inadequacies identified.

D. The audit shall include direct observation of electrical work methods and verification that procedures are appropriate, understood and implemented. See Attachment C.

Table 1 – Approach Boundaries to Energized Electrical Conductors and Circuit Parts for Shock Protection for Alternating-Current Systems. (All dimensions are distance from live part to employee.)

1	2	3	4	5
Nominal System Voltage Range, Phase to Phase[a]	**Limited Approach Boundary[b]**		**Restricted Approach Boundary[b], Includes Inadvertent Movement Adder**	**Prohibited Approach Boundary[b]**
	Exposed Movable Conductor[c]	**Exposed Fixed Circuit Part**		
Less than 50	Not specified	Not specified	Not specified	Not specified
50 to 300	10 ft. 0 in.	3 ft. 6 in.	Avoid contact	Avoid contact
301 to 750	10 ft. 0 in.	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.
751 to 15 kV	10 ft. 0 in.	5 ft. 0 in.	2 ft. 2 in.	0 ft. 7 in.
15.1 kV to 36 kV	10 ft. 0 in.	6 ft. 0 in.	2 ft. 7 in.	0 ft. 10 in.
36.1 kV to 46 kV	10 ft. 0 in.	8 ft. 0 in.	2 ft. 9 in.	1 ft. 5 in.
46.1 kV to 72.5 kV	10 ft. 0 in.	8 ft. 0 in.	3 ft. 3 in.	2 ft. 2 in.
72.6 kV to 121 kV	10 ft. 8 in.	8 ft. 0 in.	3 ft. 4 in.	2 ft. 9 in.
138 kV to 145 kV	11 ft. 0 in.	10 ft. 0 in.	3 ft. 10 in.	3 ft. 4 in.
161 kV to 169 kV	11 ft. 8 in.	11 ft. 8 in.	4 ft. 3 in.	3 ft. 9 in.
230 kV to 242 kV	13 ft. 0 in.	13 ft. 0 in.	5 ft. 8 in.	5 ft. 2 in.
345 kV to 362 kV	15 ft. 4 in.	15 ft. 4 in.	9 ft. 2 in.	8 ft. 8 in.
500 kV to 550 kV	19 ft. 0 in.	19 ft. 0 in.	11 ft. 10 in.	11 ft. 4 in.
765 kV to 800 kV	23 ft. 9 in.	23 ft. 9 in.	15 ft. 11 in.	15 ft. 5 in.

[a] For single-phase systems, select the range that is equal to the system's maximum phase-to-ground voltage multiplied by 1.732.
[b] See definition and text in 7.C.3 for elaboration.
[c] This term describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

Table 1a Approach Boundaries[a] to Energized Electrical Conductors or Circuit Parts for Shock Protection, Direct-Current Voltage Systems

1	2	3	4	5
Nominal Potential Differences	**Limited Approach Boundary**		**Restricted Approach Boundary, Includes Inadvertent Movement Adder**	**Prohibited Approach Boundary**
	Exposed Movable Conductor[b]	**Exposed Fixed Circuit Part**		
Less than 100 V	Not specified	Not specified	Not specified	Not specified
100 V – 300 V	10 ft. 0 in.	3 ft. 6 in.	Avoid contact	Avoid contact
301 V – 1kV	10 ft. 0 in.	3 ft. 6 in.	1 ft. 0 in.	0 ft. 1 in.
1.1 kV – 5 kV	10 ft. 0 in.	5 ft. 0 in.	1 ft. 5 in.	0 ft. 4 in.
5 kV – 15 kV	10 ft. 0 in.	6 ft. 0 in.	2 ft. 2 in.	0 ft. 7 in.
15.1 kV – 45 kV	10 ft. 0 in.	8 ft. 0 in.	2 ft. 9 in.	1 ft. 5 in.
45.1 kV – 75 kV	10 ft. 0 in.	8 ft. 0 in.	3 ft. 2 in.	2 ft. 1 in.
75.1 kV – 150 kV	10 ft. 8 in.	10 ft. 0 in.	4 ft. 0 in.	3 ft. 2 in.
150.1 kV – 250 kV	11 ft. 8 in.	11 ft. 8 in.	5 ft. 3 in.	5 ft. 0 in.
250.1 kV – 500 kV	20 ft. 0 in.	20 ft. 0 in.	11 ft. 6 in.	10 ft. 10 in.
500.1 kV – 800 kV	26 ft. 0 in.	26 ft. 0 in.	16 ft. 5 in.	16 ft. 5 in.

[a] All dimensions are distance from exposed energized electrical conductors or circuit parts to worker.
[b] This term describes a condition in which the distance between the conductor and a person is not under the control of the person. The term is normally applied to overhead line conductors supported by poles.

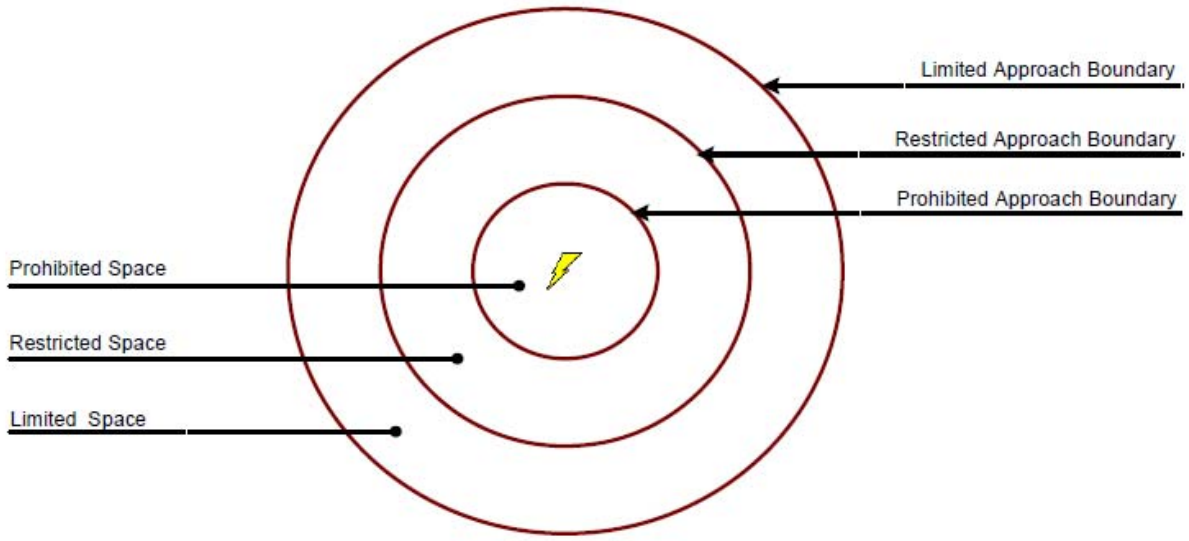

Table 2 – Protective Clothing and Personal Protective Equipment (PPE)

Hazard/Risk Category	Protective Clothing and PPE
0	**Protective Clothing, Nonmelting or Untreated Natural Fiber (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a Fabric Weight of at Least 4.5 oz/yd^2** Shirt (long sleeve) Pants (long)
	Protective Equipment Safety glasses or safety goggles (SR) Hearing Protection (ear canal inserts) Leather gloves (AN) (Note 1)
1	**Arc-Rated Clothing, Minimum Arc Rating of 4** *(Note 3)* Arc-rated long-sleeve shirt or pants or arc-rated coverall Arc-rated face shield *(see Note 2)* or arc flash suit hood Arc-rated jacket, parka, or rainwear, or hard hat liner (AN)
	Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (Note 1) Leather work shoes (AN)
2	**Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm^2** *(Note 3)* Arc-rated long-sleeve shirt and arc-rated pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield *(See Note 2)* and arc flash balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
	Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy duty leather gloves (Note 1) Leather work shoes

Table 2 *Continued*

Hazard/Risk Category	Protective Clothing and PPE
3	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm^2** *(See Note 3)* Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Are-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves *(See Note 1)* Arc-rated jacket, parka, or rainwear, or hard hat liner (AN)
	Protective Equipment Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes
4	**Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm^2** *(Note 3)* Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Are-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves *(See Note 1)* Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
	Protective Equipment
	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather work shoes

AN = As needed (optional).
AR = As required.
SR = Selection required
Notes:

1. If rubber-insulating gloves with leather protectors are required by Table 5, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
2. Face shields are to have wrap-around guarding to protect not only the face but also the forehead, ears, and neck, or, alternatively, an arc-rated arc flash suit hood is required to be worn.
3. *Arc rating* is defined in Section and can be either the arc thermal performance value (ATPV) or energy of break open threshold (E_{BT}). ATPV is defined in ASTM F 1959, *Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing*, as the incident energy on a material, or a multilayer system of materials, that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll curve, in cal/cm^2. E_{BT} is defined in ASTM F 1959 as the incident energy on a material or material system that results in a 50 percent probability of breakopen. Arc rating is reported as either ATPV or EBT, whichever is the lower value.

Attachment A – Job Briefing and Planning Checklist

Identify	
☐ The hazards	☐ The shock protection boundaries
☐ The voltage levels involved	☐ The available incident energy
☐ Skills required	☐ Potential for arc flash (Conduct a flash-hazard analysis.)
☐ Any "foreign" (secondary source) voltage source	☐ Flash protection boundary
☐ Any unusual work conditions	☐ Number of people needed to do the job
Ask	
☐ Can the equipment be de-energized?	☐ Is a "standby person" required?
☐ Are backfeeds of the circuits to be worked on possible?	
Check	
☐ Job plans	☐ Safety procedures
☐ Single-line diagrams and vendor prints	☐ Vendor information
☐ Status board	☐ Individuals are familiar with the facility
☐ Information on plant and vendor resources is up to date	
Know	
☐ What the job is	☐ Who is in charge
☐ Who else needs to know – Communicate!	
Think	
☐ About the unexpected event…What if?	☐ Install and remove grounds
☐ Lockout / Tagout	☐ Install barriers and barricades
☐ Test for voltage – FIRST	☐ What else….?
☐ Use the right tools and equipment, including PPE	
Prepare for an emergency	
☐ Is the standby person CPR trained?	☐ What is the exact work location?
☐ Is the required emergency equipment available? Where is it?	☐ How is the equipment shut off in an emergency?
☐ Where is the nearest telephone?	☐ Are the emergency telephone numbers known?
☐ Where is the alarm?	☐ Where is the fire extinguisher?
☐ Is confined space rescue available?	☐ Are radio communications available?

Attachment B - ENERGIZED ELECTRICAL WORK PERMIT

PART I: TO BE COMPLETED BY THE REQUESTER:

Work Order Number _____

1	Description of circuit/equipment/job location:	
2	Description of work to be done:	
3	Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:	

Requester/Title Date

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

		Check when Complete
1	Detailed job description procedure to be used in performing the above detailed work:	☐
2	Description of the Safe Work Practices to be employed:	☐
3	Results of the Shock Hazard Analysis:	☐
4	Determination of Shock Protection Boundaries:	☐
5	Results of the Flash Hazard Analysis:	☐
6	Determination of the Flash Protection Boundary:	☐
7	Necessary personal protective equipment to safely perform the assigned work:	☐
8	Means employed to restrict the access of unqualified persons from the work area:	☐
9	Evidence of completion of a Job Briefing including discussion of any job-related hazards:	☐
10	Do you agree the above-described work can be done safely? ☐ Yes ☐ No (If *no*, return to requester)	

Electrically Qualified Person(s) Date

Electrically Qualified Person(s) Date

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

Requesting Department Manager Maintenance/Engineering Manager

Safety Manager Electrically Knowledgeable Person

Maintenance Director Date

Note: Once the work is complete, forward this form to the UF Safety Coordinator for retention.

Attachment C – Energized Electrical Work Audit

Energized Electrical Work Audit

Date of Audit:		
Location of work:		
Specific Job audited:		
Personnel involved:		
Reason for Energized Electrical Work:		
Energized Electrical Work Checklist and Permit at job site:	☐ Yes	☐ No
Energized Electrical Work Procedure understood/followed:	☐ Yes	☐ No
Appropriate Lock-Tag-Try procedures followed:	☐ Yes	☐ No
List procedure(s):		
Appropriate JHA (Job Hazard Analysis) followed:	☐ Yes	☐ No
List JHA:		
Proper PPE utilized during energized electrical work:	☐ Yes	☐ No
List PPE:		

Audit Conducted by:

Attachment D - HAZARD/RISK EVALUATION PROCEDURE

Task: _____ Document no.: _____

Equipment: _____ Part of: _____

Date: _____ ☐ Pre-risk assessment

Issued by: ☐ Intermediate risk assessment

Signature: _____ ☐ Follow-up risk assessment

Print Name: _____

Black area = Safety measures required
Grey area = Safety measures recommended

Consequences	Severity Se	Class Cl 3-4	5-7	8-10	11-13	14-15	Frequency Fr		Probability Pr		Avoidance Av	
Irreversible trauma, death	4						Daily	5	Common	5		
Permanent, third-degree burn	3						Weekly	4	Likely	4		
Reversible, second-degree burn	2						Monthly	3	Possible	3	Impossible	5
Reversible, first aid	1						Yearly	2	Rarely	2	Possible	3
							Less	1	Negligible	1	Likely	1

Hzd. No.	Hazard	Se	Fr+	Pr+	Av+	= Cl	Severity Mitigators	Safe

Comments:

Attachment E – Hazard/Risk Evaluation Procedure Sample

HAZARD/RISK EVALUATION PROCEDURE

Task: *Voltage testing*

Equipment:

Date:

Issued by:

Signature:

Print Name:

Document no.:

Part of:

☐ Pre-risk assessment

☐ Intermediate risk assessment

☐ Follow-up risk assessment

Black area = Safety measures required
Grey area = Safety measures recommended

Consequences	Severity Se	Class Cl					Frequency Fr		Probability Pr		Avoidance Av	
		3-4	5-7	8-10	11-13	14-15						
Irreversible trauma, death	4						Daily	5	Common	5		
Permanent, third-degree burn	3						Weekly	4	Likely	4		
Reversible, second-degree burn	2						Monthly	3	Possible	3	Impossible	5
Reversible, first aid	1						Yearly	2	Rarely	2	Possible	3
							Less	1	Negligible	1	Likely	1

Hzd. No.	Hazard	Se	Fr+	Pr+	Av+	= Cl	Severity Mitigators	Safe
1	*Human factors*	*4*	*5*	*3*	*5*	*13*	*Use appropriate PPE and follow established safety procedures.*	*Y*
2	*Shortened test leads*	*3*	*5*	*2*	*5*	*12*	*Inspect leads before each use.*	*Y*
3	*Meter misapplication*	*4*	*5*	*3*	*5*	*13*	*Ensure that the meter is rated for the level of voltage being tested.*	*Y*
4	*Meter malfunctions*	*3*	*5*	*2*	*5*	*12*	*Ensure that the meter is CAT rated to the appropriate hazard level.*	*Y*

Comments:

PPE required: Voltage rated gloves and leather protectors, face and head protection, clothing rated for the incident energy exposure.

Attachment F – Job Hazard Analysis

JOB HAZARD ANALYSIS

Task:			
Conducted By:			
Reviewed By:			
Date:		Department:	

Task/Step	Potential Hazards	Safe Job Procedures

Attachment G – Job Hazard Analysis Sample

JOB HAZARD ANALYSIS

Task:	Install electrical conduit.		
Conducted By:	John Doe		
Reviewed By:	Jane Smith		
Date:	6/20/14	Department:	UF – Central Campus

Task/Step	Potential Hazards	Safe Job Procedures
Pre-job set up.	• Hand tools. • Power tools (electric, gas, hydraulic, pneumatic).	Check operating condition of hand and power tools; inspect power cords for frays and nicks. Use proper extension cord.
Install hangers.	• Elevated loads. • Elevated work platform or stairs. • Hand tools. • Lifting equipment (forklifts, hoists).	Use forklift to raise hangers to ceiling, mark area under platform. Tie hanger to platform to prevent dropping. Do not sort hangers on platform.
Drill hole for hanger.	• Elevated loads. • Elevated work platform or stairs. • Hand tools. • Power tools (electric, gas, hydraulic, pneumatic).	Mark area under platform; keep personnel out of area, falling object hazard. Locate tools and power cord to minimize tripping hazard. Gloves and eye protection required.
Place conduit.	• Elevated loads. • Elevated platform or stairs. • Hand tools. • Lifting equipment (forklifts, hoists).	Lift pipe with forklift. Block area under pipe from foot traffic. Tie pipe to lift until hangers are tight.

Figure 1 Hazard/Risk Evaluation Procedure Flow Chart