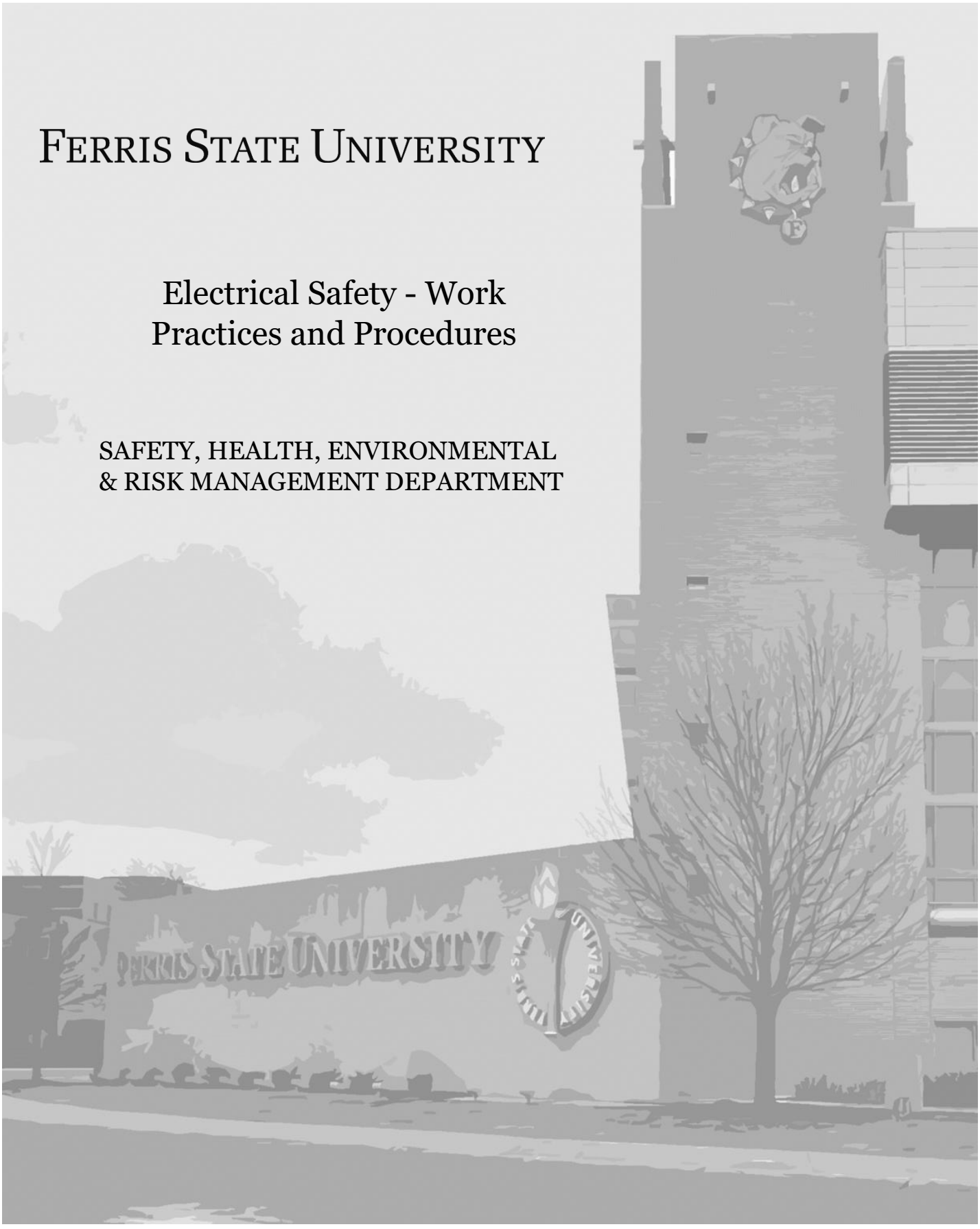
FERRIS STATE UNIVERSITY

Electrical Safety - Work Practices and Procedures

SAFETY, HEALTH, ENVIRONMENTAL
& RISK MANAGEMENT DEPARTMENT



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Purpose

Ferris State University is committed to providing a safe and healthy work environment and to protecting employees from injury or death caused by uncontrolled electrical hazards in the workplace. The purpose of Ferris State University's Electrical Safety Program is to establish work policies, practices, and procedures to train employees in basic electrical hazard recognition and safe work practices, and to ensure compliance with 29 CPR 1910 Subpart S – Electrical, and MIOSHA's adoption of the standard, along with Subpart R (Electric Power Generation, Transmission, and Distribution), when applicable along the course of duties performed by employees of Ferris State University.

Scope

This program applies to all employees of Ferris State University who will be exposed to electricity as part of their job.

Definitions

Arc Blast - a pressure wave that can occur after an electrical fault. Arc blasts are a more advanced phenomenon that can happen during an arc flash. Noise levels from an arc blast can reach up to 160 decibels which can immediately rupture unprotected ear drums.

Arc Flash - a phenomenon where a flashover of electric current leaves its intended path and travels through the air from one conductor to another, or to the ground.

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

De-energized – free from any electrical connection to a source of potential difference and from electric charge.

Electrically safe working condition – a state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, locked/tagged in accordance with OSU policy, tested to ensure the absence of voltage, and grounded if determined necessary.

Energized – electrically connected to or having a source of voltage.

Exposed (as to live parts) – capable of being inadvertently touched or approached from closer than a safe distance by a person.

Flash Hazard – a dangerous condition associated with the release of energy caused by an electric arc.

Flash Hazard Analysis – a study investigating a worker's potential exposure to arc flash energy, conducted for the purpose of injury prevention, the determination of safe work practices, and the appropriate levels of personal protective equipment (PPE).

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

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, with or without subsequent removal of the ignition source.

Flash Suit – a complete flame-resistant clothing and equipment system that covers the entire body, except for the hands and feet.

Incident Energy – the amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event.

Limited Approach Boundary – an approach limit at a distance from an exposed live part within which a shock hazard exists.

Minimum Approach Distance (MAD) – the safe distance between people or equipment and an energized exposed line or equipment.

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

Qualified person – one who has skills and knowledge related to the construction and operation of the electrical equipment and installation and has received training on the hazards involved.

Restricted Approach Boundary – an approach limit at a distance from an exposed live part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the live part.

Step Potential - the voltage difference between a person's feet when standing near an energized object.

Introduction

Electricity is a serious workplace hazard, capable of causing both employee injury and property damage. It is the policy of Ferris State University (FSU) to protect all employees, students, and other personnel from potential electrical hazards. This will be accomplished through compliance with the work practices described herein along with the effective application of engineering controls, administrative controls and the use of personal protective equipment (PPE). FSU seeks to put forth an organized effort to reduce the potential for injury.

The FSU Electrical Safety Program is founded on the principle of avoiding energized work unless it is absolutely necessary. Live parts will be de-energized before a *qualified* employee works on or near them *unless* any of the following conditions apply:

- De-energizing introduces additional or increased hazards. Examples of “additional or increased” hazards would include interruption of life support equipment, deactivation of emergency alarm systems or shutdown of hazardous location ventilation systems.
- De-energizing is not possible due to equipment design or operational limitations. Examples of this situation would increase testing of electrical circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous process that would

otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

- When troubleshooting – assuming troubleshooting cannot be performed if de-energized and other safety measures are still taken into place, such as, but not limited to, minimum acceptable distances, arc flash PPE, and insulated tools.
- Live parts are operating at less than 50 volts to ground and there is no increased exposure to electrical burns or to explosion due to electrical arcs.

Live parts are to be de-energized in accordance with Ferris State University Lockout/Tagout Program. If live parts are not placed in an electrically safe condition, the work practices described in this program must be used to protect employees. If there is any uncertainty on the ability to perform work on energized or de-energized equipment, you must reach out to the SHERM department before proceeding.

Responsibilities

Safety Health Environmental and Risk Management (SHERM) is responsible for:

- Provides oversight and guidance on the Electrical Safety Program
- Assists with consultation and arrangement of training, as needed
- Periodically reviews and updates the Electrical Safety Program

Supervisors/Project Managers are responsible for:

- Implement the Electrical Safety Program in their work area
- Ensure employees who perform electrical work on the requirements of this program prior to conducting any repair are trained and qualified
    - The training must be documented
- Provide the engineering controls and safety equipment to reduce the risk of foreign body injuries to all employees in the area
- Ensure the necessary PPE is provided, used as intended, and maintained
- Remove defective PPE and tools from service immediately
- Conducting annual inspections on work performed and equipment Identifying work tasks that need to be performed by a qualified employee
- Correcting electrical safety hazards as soon as possible
- Maintaining a list of all qualified employees
- Ensure all work performed on live equipment is performed with insulated tools
- Implement Contractor Safety Requirements
    - Ferris State University shall inform contract employers of:
        - Known electrical hazards related to the contract employer's work that might not be recognized by the contract employer or its employees.
        - Information about the employer's installation that the contract employer needs to make the assessments required by NFPA 70E Chapter 1.

- Ferris State University shall report observed contract-employer-related violations of this standard to the contract employer.

Employees are responsible for:

- Attend all required training sessions
- Use all required personal protective equipment (PPE) and report any defects to your supervisor or instructor
  - Inspect all PPE and tools before every use
- Do not tamper with safety devices
- Reporting electrical safety hazards to their supervisor
- Following the safe work practices outlined in this program
- Visually inspecting electrical equipment, tools and cords before each use
- Following the lockout/tagout procedures on all electrical equipment while completing maintenance work
- Always notify DPS of electrical work conducted before 8 a.m. and after 5 p.m. weekdays on weekends and holidays

Outside Contractors are responsible for:

- Must comply with the requirements of their company's Electrical Safety Program, which at a minimum must meet the MIOSHA and NFPA 70E standards, and FSU Electrical Safety Program
- Following their company's Lockout/Tagout Procedures and FSU Lockout/Tagout Procedures on all electrical equipment while completing maintenance work
- All proper PPE must be used and is to be provided by the contractor
- Must notify the FSU Project Manager/Supervisor prior to conducting electrical work on campus
- To ensure that each employee is instructed in the hazards communicated to the contract employer by Ferris State University. This instruction is in addition to the basic required training.
- Must advise the Ferris State University of:
  - Any unique hazards presented by contract employer's work
  - Hazards identified during the contract employer's work that Ferris State University did not mention, and
  - The measures taken to correct any violations reported to contract employer by Ferris State University under 110.5(A)(2) to prevent recurring violations.

Training Requirements

- Employees who are exposed to an electrical hazard that is not reduced to a safe level by the electrical installation (panel cover, outlet cover, etc.) must be trained in accordance with the following guidelines, MIOSHA Part 40 Electrical Safety-Related Work Practices, 29 CFR 1910 Subpart S and NFPA 70E, Electrical Safety in the Workplace. All training must be up-to-date and reflect the most recent editions.

- Such 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.
- Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury.
- Training must be provided before the employee performs duties that involve work near or on electrical systems.
- The training required by this section shall be classroom or on-the-job type, or a combination of the two. The level of electrical safety training provided is dependent on the risk to the employee.
- Employees working on or near exposed energized electrical conductors or circuit parts shall be knowledgeable in responding to electrical shock accident. The university will make training for First Aid, CPR, the use of the automatic defibrillator (AED) available to employees.
- A "qualified person" shall be trained and knowledgeable in all the following topics:
    - Construction and operation of equipment on which work is assigned.
    - Skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.
    - Skills and techniques necessary to determine the nominal voltage of exposed live parts or the absence of voltage.
        - An individual can obtain knowledge in the three topics listed above through a combination of methods including the individual's education, past work experience, apprenticeships, and on-the-job training.
    - The minimum approach distances (MAD) specified in this program and the corresponding voltages to which the qualified employee will be exposed.
    - The process necessary to determine the degree and extent of electrical hazards along with the PPE and job planning necessary to perform the task safely.
- A person can be considered qualified with respect to certain equipment and methods but unqualified for others.
- An employee who is undergoing on-the-job training and who, during such training, has demonstrated an ability to perform duties safely at his/her level of training and who is under the direct supervision of a qualified person shall be considered to be a qualified person for the performance of those duties (NFPA 70E Art. 110, OSHA 29 CFR 1910.399).
- An "unqualified person" shall be trained in the inherent hazards of electricity and any related work practices that are necessary for their safety. This training is considered an awareness level of training.
- Supervisors shall maintain a record of all electrical training provided to their employees along with a listing of all employees classified as qualified persons.

Retraining

Mandatory retraining (or refresher) training is required a minimum of every three (3) years or when conditions change, or whenever this procedure is updated, or whenever a new arc flash edition or standard is released with significant updates. The interval between retraining shall not exceed 36 months. In

addition, an employee must receive additional training (or retraining) when any of the following conditions are met:

- Supervision or annual inspections indicate that the employee is not complying with the established safety-related work practices
- Safety-related work practices not normally used during regular job duties are employed
- New technology, new types of equipment, or changes requiring using new safety-related work practices different from those normally used

Documenting Training and Experience

- Each department shall document and maintain electrical training and experience. Documentation is necessary to demonstrate that individuals have met the training and experience requirements for the types of work they performed. The documentation shall contain the training content and be maintained for the duration of employment.

Electrical Protective Equipment

- General Requirements
  - Electrical protective equipment must meet the criteria established by the National Fire Protection Association (NFPA) and Michigan Occupational Safety and Health Administration (MIOSHA).
  - Department supervisors are responsible for providing electrical protective equipment required by this program at no cost to employees, such as flame resistant (FR) apparel, eye protection, head protection, hand protection, insulated footwear and face shields. Department supervisors are not responsible for providing non-FR under layers to employees.
    - The PPE must be appropriate for the specific work to be performed.
  - PPE must be maintained in a safe, reliable condition and be inspected by the qualified wearer for damage before each day's use and immediately following any incident that can reasonably be suspected of having caused damage.
    - Protective equipment that becomes damaged contaminated with grease, oil flammable liquids, or combustible liquids shall not be used. Any PPE with holes, cuts, punctures, or tears, or any other defect or damage shall not be used. Even the smallest hole can compromise your safety.
    - To perform a pre-use inspection:
      - Inspect gloves for holes, tears, punctures, cuts, ozone damage, and foreign objects
      - Check for changes in texture, such as swelling, softening, hardening, or becoming sticky or inelastic
      - Inspect for signs of chemical deterioration
      - Perform an air test to check for leaks
        - An air test can be performed with or without special testing equipment
    - Gloves should be electrically tested every 6 months after they are first issued.

- Electrical tools and protective equipment must be specifically approved, rated, and tested for the levels of voltage of which an employee may be exposed.
    - Electrically insulated tools shall be inspected before each use, with an-depth and documented inspection no less than once every 12 months.
- If an arc flash hazard is present, then additional PPE is required, including arc resistant clothing and class E hardhat with arc rated face shield is required.
    - All other PPE shall be inspected in intervals consistent with manufacturer's specifications.

- Personal Protective Equipment
    - Personal Protective Equipment (PPE) shall be worn whenever qualified workers are inside the Arc Flash Boundary of energized equipment or Restricted Approach Boundary of exposed energized parts (using the greater of the two distances). The required PPE can be determined from the incident energy value listed on the equipment's arc flash label. If an arc flash analysis has not been done, then Arc Flash Category Classification and PPE tables in NFPA 70E should be consulted. Copies of NFPA 70E are available in the Electrical Department.
    - Classification for rubber insulating gloves:
        - Two types of gloves are designated as Type I, non-resistant to ozone, and Type II, resistant to ozone. The following show the classification, along with the maximum use voltage:
            - Class 00: (beige) 500 AC/750 DC
            - Class 0: (red) 1,000 AC/1,500 DC
            - Class 1: (white) 7,500 AC/11,250 DC
            - Class 2: (yellow) 17,000 AC/25,500 DC
            - Class 3: (green) 26,500 AC/39,750 DC
            - Class 4: (orange) 36,000 AC/54,000 DC
    - The Minimum PPE for electrically powered equipment that is de-energized is safety glasses and leather gloves or similar protection (this work may be performed by trained individuals who would *not* be exposed to energized parts or an arc flash hazard and may be of non-electrical occupations).
    - All other PPE not specifically listed within this procedure, such as fall protection equipment, shall be made of non-conducting equipment, when working on energized parts or parts that are likely to become energized.
    - The minimum PPE required for electrical work that is performed by electrically qualified persons on electric equipment is long sleeve shirt (natural fiber), long pants (natural fiber), safety glasses or goggles, hearing protection (foam inserts) and leather gloves. PPE must be donned prior to starting electrical work. Employees shall wear at least the following:
        - Eye protection whenever there is a danger of injury from electric arcs, flashes, or from flying objects resulting from an electrical explosion
        - Nonconductive head protection whenever there is a danger of head injury from electric shock or burns due to contact with live parts or from flying objects resulting from an electrical explosion. Hard hats must have an "E" rating

- Rated rubber insulated gloves where there is a danger of hand or arm contact with live parts or possible exposure to arc flash burn
- Voltage rated gloves with leather protectors when using electrical testing meters on exposed energized electrical conductor or circuit parts 50 volts and above
- Dielectric overshoes when insulated footwear is used as protection against step and touch potential. Insulated soles shall not be used as primary electrical protection.

- Protective shields, barriers, or insulating materials must be used to protect each employee from shock, burns, or other electrical injuries while that person is working near exposed energized parts that might be accidentally contacted or where dangerous electric heating or arcing might occur. Face shields without arc rating shall not be used for electrical work. Safety glasses or goggles must always be worn underneath face shields. Additional illumination may be needed when using tinted face shields as protection during electrical work.
- Arc Rated Apparel & Under layers worn to protect an employee must cover potentially exposed areas as completely as possible, cover all ignitable clothing, and allow for movement and visibility. Arc-resistant shirtsleeves must be fastened at the wrist and arc-resistant shirts or jackets must be closed at the neck. Arc-rated garments worn as outer layers over arc-rated apparel (i.e., jackets or rainwear) must also be made from arc- rated material. Arc-Rated flash suits must permit easy and rapid removal by the user. Follow the garment manufacturer's instructions arc-resistant apparel care and maintenance in order to maintain protective properties.
- Non-melting, flammable garments (e.g., cotton, wool, rayon, silk, or blends) may be used as under layers beneath arc-resistant apparel; however, arc-resistant undergarments are recommended. Melting fibers such as acetate, nylon, polyester, polypropylene, and spandex is not permitted in fabric under layers next to skin; however, an incidental amount of elastic on non-melting fabric underwear or socks is permitted.
- The following is the PPE requirements for each category of work, and is based off of Table 130.7(c)(15)(c):
  - Category 1
    - Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm2 (16.75 J/cm2) A
    - Arc-rated long-sleeved shirt and pants OR arc-rated coverall
    - Arc-rated face shield OR arc flash suit hood
    - 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
      - Leather footwear (AN)
  - Category 2
    - Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm2 (33.5 J/cm2)
    - Arc-rated long-sleeved shirt and pants or arc-rated coverall

- Arc-rated flash suit hood or arc-rated face shield and arc-rated 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
    - Leather footwear

- Category 3
    - Arc-Rated Clothing Selected So That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm2 (104.7 J/cm2) A
    - Arc-rated long-sleeved shirt (AR)
    - Arc-rated pants (AR)
    - Arc-rated coverall (AR)
    - Arc-rated arc flash suit jacket (AR)
    - Arc-rated arc flash suit pants (AR)
    - Arc-rated arc flash suit hood
    - Arc-rated gloves
    - 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 footwear
- Category 4
    - Arc-Rated Clothing Selected So That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm2 (167.5 J/cm2) A
    - Arc-rated long-sleeved shirt (AR)
    - Arc-rated pants (AR)
    - Arc-rated coverall (AR)
    - Arc-rated arc flash suit jacket (AR)
    - Arc-rated arc flash suit pants (AR)
    - Arc-rated arc flash suit hood
    - Arc-rated gloves
    - 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 footwear
- NOTE: (AN) As needed (optional), (AR) As required, (SR) Selection required.

Insulating Materials and Tools

Employees must use insulated tools and handling equipment rated for the voltages encountered when working inside the Limited Approach Boundary and Restricted Approach Boundary near exposed energized circuits, conductors, or parts. Insulated tools must be designed and constructed to meet the demands of use and the environment to which they are exposed. Insulating equipment made of materials other than rubber shall provide electrical and mechanical protection at least equal to that of rubber equipment. If the insulating capability of protective equipment is subject to damage during use, the insulating material must be protected by an outer covering of leather or other appropriate material. Insulating rubber equipment such as gloves, sleeves, blankets, and matting must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that my cause damage. In addition to being tested according to the schedule supplied by the manufacturer, rubber insulated equipment must be

- Inspected for damage before each day's use
- Annually inspected and documented
- Air tested before each use
- Inspected immediately following any incident that could have caused damage
- Dielectrically tested within 6 months of first use or 1 year of purchase if not used (rubber gloves used without the leather protectors must be removed from service until dielectrically tested)
- Not stored in vehicles or areas where exposed to UV light or temperatures that could damage equipment

Rubber insulated equipment found to have defects that might affect its insulation properties must be removed from service until testing indicates that it is acceptable for continued use. Do not repair defective rubber insulated equipment. Fuse handling equipment insulated for the circuit voltage shall be used to remove or install a fuse if the terminals are energized. Ropes and handlines used near exposed energized parts shall be nonconductive and portable ladders used for electrical work shall have nonconductive side rails. Tools and handling equipment should be replaced if the insulating capability is decreased due to damage. If there is any uncertainty with equipment, please reach out to the SHERM department.

Working on or Near Electrical Equipment that is or may become Energized

The most important principle of electrical safety is to assume all electric circuits are energized unless each involved worker ensures they are not. Every circuit and conductor must be tested every time work is done on it. Proper PPE must be worn until the equipment is proven deenergized. The process of de-energizing is "energized" work and can result in an arc flash due to equipment failure. Both NFPA 70E 130.1 and OSHA 1910.333 state:

> *Energized electrical conductors and circuit (live) parts to which an employee might be exposed shall be put into an electrically safe work condition before an employee works (on or near) within the Limited Approach Boundary of those conductors or parts, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.*

Energized electrical conductors and circuit (live) parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

Examples of increased or additional hazards include, but are not limited to:

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

Departments must provide training and adopt written standard operating procedures (SOPs) for common tasks where work on or near live circuits may be required. When working on live circuits an employee is actually touching energized parts with tools. When working near live circuits, an employee inside the restricted approach boundary is close enough to energized parts to pose a risk, even though other parts are de-energized. Common tasks include:

- Opening electric equipment doors for inspection
- Opening and closing disconnects and breakers
- Taking voltage measurements
- Racking breakers on and off the bus
- Removing panels and dead fronts

Example SOP statement:

"When opening and closing disconnects, use the "left-hand rule" when possible. Stand to the right side of the equipment and operate the disconnect switch with the left hand."

Normal Operation of Electric Equipment

Normal Operation of electrical powered equipment shall be permitted where all of the following conditions are satisfied:

1. The equipment is properly installed.
2. The equipment is properly maintained
3. The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
4. The equipment doors are closed and secured.
5. All equipment covers are in place and secured.
6. There is no evidence of impending failure such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

Use of the information in Table 130.5(C) provides guidance on assessing criteria for Normal Operation and the likelihood of an arc flash occurrence.

For any electrical equipment where an arc flash hazard may be present, a hazard assessment shall be performed by an electrically qualified worker on the equipment to ensure it meets the criteria for Normal Operation. The hazard assessment should be documented and noted in the equipment SOP. Conditions

that do not meet the criteria of Normal Operation are consider abnormal operation and an electrical hazard assessment should be performed to determine necessary electrical safe work practices and PPE.

Where working on live parts that have not had Lockout/Tagout devices applied in accordance with FSU Lockout/Tagout Program the following shall apply to the work:

- If the live parts are not placed in electrically safe work conditions, other safety-related work practices shall be used to protect employees who might be exposed to the electrical hazards involved.
- Such work practices shall protect each employee from arc flash and from contact with live parts directly with any part of the body or indirectly through some other conductive object.
- The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the live parts.

Energized Electrical Work Permit:

- If live parts are not placed in an electrically safe condition, work shall be considered energized electrical work. All live electrical work, with the exception of testing and troubleshooting, shall be referred to the Electrical Department. Live work shall be performed by written permit only (Appendix A).

  Examples of such work include:

  - Working within the restricted approach boundary.
  - Interacting with equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.
  - Modifying electrical installations (e.g. removing face plates, connecting to bus heads, rewiring electrical boxes).
- The permit shall be originated by the individual requesting that the energized work be completed.
- The Electrical Supervisor shall approve the permit prior to commencing work.
- The permit shall be present in the area where the energized work is taking place for the duration of the task.
- At least two qualified employees shall be present for all energized work requiring a permit.
  - If both qualified employees are working on the circuit, an attendant is required to prevent any unqualified person from entering the limited approach boundary and to summon emergency response personnel if needed.
  - The attendant can be an unqualified person as long as they remain outside the arc flash boundary.
  - A method of contacting emergency personnel shall be present on all live work job sites.
- Energized electrical work permits shall be issued prior to the work and shall be good for a maximum of one shift.
- Copies of all energized electrical work permits shall be retained by the Electrical Department for a minimum of the current plus one year and available for review.

Pre-Job Briefings:

- Pre-job briefings associated with work requiring completion of an energized electrical work permit shall be conducted and documented on the Pre-Job Checklist for Live Electrical Work (Appendix B) or similar form. The briefing shall include, but not be limited to, the following topics:
  - Electrical hazards associated with the work tasks.
  - Procedures that shall be followed.
  - Special precautions required by working conditions.
  - Energy source controls.
  - Required PPE.
- Additional job briefings shall be held if significant changes occur that might affect the safety of the employees such as:
  - The work is complicated or particularly hazardous or,
  - The employee cannot be expected to recognize and avoid the hazards involved in the job.
- The Pre-Job Briefing shall allow the involved employees to provide feedback as appropriate.

Approach Distances to Exposed Energized Parts

NFPA 70E defines three (3) boundaries for electrical work. Two (2) boundaries are approach distances related to shock hazards and the third boundary is related to arc flash protection. Approach boundary tables are available from the Electrical Department.

Shock Protection Boundaries

The distance for the Limited and Restricted Approach boundaries are found in NFPA 70E tables 130.4(D)(a) and (b).

Within the **limited approach boundary**, an electric shock hazard exists. Wherever it is necessary for an unqualified worker to cross the limited approach boundary, the worker should be supervised and accompanied by a qualified worker while inside the limited approach boundary. However, if the arc flash boundary is within or outside the limited approach boundary, the rules for the arc flash boundary have priority.

Within the **restricted approach boundary**, only qualified persons with proper PPE and tools may cross. This boundary is where the highest likelihood of shock hazards exists. Inside this boundary, accidental movement can put a part of the body or conductive tools in contact with live parts or inside the prohibited approach boundary. To cross the restricted approach boundary, the qualified person must:

1. Perform hazard identification and risk assessment
2. Have an energized work permit that is approved by the supervisor when performing work beyond testing and trouble shooting
3. Use PPE rated for working near exposed energized parts and rated for the voltage and energy level involved
4. Ensure that no part of the body enters the prohibited space

5. Minimize risks from unintended movement by keeping as much of the body as possible out of the restricted space (body parts in the restricted space should be protected)

Within the **arc flash boundary,** a worker without appropriate PPE could receive second degree burns from an arc flash. Like the restricted boundary, under no circumstance should an unqualified worker ever be permitted to cross the arc flash boundary.

Arc Flash Protection Boundary

An Arc Flash Analysis has not been performed. An arc flash study is not required under OSHA requirements; however, it is required under NFPA 70E. NFPA requirements are considered voluntary consensus standards and may be used or enforced under certain circumstances. Ferris State University will put forth best efforts to conduct an Arc Flash Survey in order to fully ensure all areas are addressed.

For systems of 600 volts and less where an arc flash analysis has not been performed, and no incident energy levels are listed:

1. Use Table130.7(C)(15)(a) and/or Table 130.7(C)(15)(b) to determine the arc-flash PPE category.
2. Use Table 130.7(C)(15)(c) to choose the appropriate clothing and PPE
3. Table 130.4(D)(a) and/or Table 130.5(D)(b) will provide the limited and restricted approach boundaries.
4. Table130.7(C)(15)(a) and/or Table 130.7(C)(15)(b) will provide arc flash boundary distance, provided the equipment meets the maximum short circuit current and fault clearing time criteria in the tables

For copies of NFPA 70E tables contact the Electrical Department

Working on or near De-Energized Electrical Equipment

Lockout/Tagout Program

Each department shall follow the written Ferris State University Control of Hazardous Energy (Lockout/Tagout) Program and train employees in the program. Only authorized individuals shall perform energy isolation. All affected individuals should be aware of energy isolation when taking place. Written lockout/tagout procedures should be developed for each machine or piece of equipment that will require servicing. The program should cover planning for

- Locating and labeling energy sources
- Identifying at-risk employees, who de-energized the equipment and how
- Releasing of stored energy
- Verifying that the circuit is de-energized and can't be restarted
- Voltage testing
- Grounding requirements
- Shift changes
- Coordination with other jobs in progress and a procedure for keeping track of all involved personnel
- Applying and removing lockout/tagout devices

- Return to service
- Temporary re-energizing for testing/positioning

Electrically Safe Condition

The 2018 edition of NFPA 70E lists six steps to ensure for electrically safe work conditions. Always follow these steps.

1. Identify all sources of power to the equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
2. Remove the load current and then open the disconnecting devices for each power source.
3. Where possible, visually verify that blades of disconnecting devices are fully open or that draw out-type circuit breakers are fully withdrawn.
4. Apply lockout/tagout devices in accordance with Ferris State University's Control of Hazardous Energy Program.
5. Test each phase conductor or circuit part with an adequately rated voltage detector to verify that the equipment is de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Check the voltage detector before and after each test to ensure it is working.
6. Properly ground all possible sources of induced voltage and stored electric energy (such as, capacitors) before touching. If conductors or circuit parts that are being de-energized could contact other exposed conductors or circuit parts, apply ground-connecting devices rated for the available fault current.

Other Precautions

When working on de-energized parts, but still inside the arc flash protection boundary for nearby energized exposed parts:

- If the parts cannot be de-energized, barriers (e.g., insulated blankets) must be used to protect against accidental contact or PPE must be worn.
- Employees shall not reach blindly into areas that might contain exposed live parts.
- Employees shall not enter spaces containing energized parts unless illumination is provided that allows the work to be performed safely.
- If a circuit breaker trips or blows a fuse more than once, it shall be investigated and corrected by a qualified employee or contractor before being cleared for continued use. If unsure on how to reset a breaker safely, do not attempt to reset a breaker.
- Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn where they present an electrical contact hazard with exposed live parts.
- Conductive materials, tools, and equipment that are in contact with any part of an employee's body shall not be handled inside the Limited Approach Boundary. If this is not possible, they shall be handled in a manner that prevents accidental contact with live parts. Such materials and equipment include but are not limited to long conductive objects such as ducts, pipes, tubes, conductive hose and rope, metal-lined rules and scales, steel tapes, pulling lines, metal scaffold parts, structural members, and chains.

- When an employee works in a confined space or enclosed spaces (such as a manhole or vault) that contains exposed live parts, the employee shall use protective shields, barriers or insulating materials as necessary to avoid contact with these parts. Doors, hinged panels, and the like shall be secured to prevent them from swinging into employees. Refer to the Ferris State University Confined Space Program.
- Understand that if power is disconnected at the point of what is being worked on, live energy is still going to that equipment/panel and the potential for shock still exists. Always disconnect energy at the earliest source if possible.

Work on or near Un-insulated Overhead Lines

- Un-insulated and Energized
  - Where work is performed in locations containing un-insulated energized overhead lines that are not guarded or isolated, precautions shall be taken to prevent employees from contacting such lines directly with any unguarded parts of their body or indirectly through conductive materials, tools, or equipment. Where the work to be performed is such that contact with un-insulated energized overhead lines is possible, the lines shall be de-energized and visibly grounded at the point of work, or suitably guarded.
- De-energizing or Guarding
  - 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.
  - The department supervisor and employee shall be responsible to ensure that guards or protective measures are satisfactory for the conditions. Employees shall comply with established work methods and the use of protective equipment.
- Approach Distances for Unqualified Persons
  - When employees without electrical training 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. If the voltage on the line exceeds 50 kV, the distance shall be 10ft plus 4 in. for every 10 kV over 50 kV.
- Vehicular and Mechanical Equipment
  - Where any vehicle or mechanical equipment structure will be elevated near energized overhead lines, they shall be operated so that the limited approach boundary distance is maintained. However, under any of the following conditions, the clearances shall be permitted to be reduced:
    - If the vehicle is in transit with its structure lowered, the limited approach boundary to overhead lines shall be permitted to be reduced by 6 ft.
    - If insulated barriers, rated for the voltages involved, are installed, and they are not part of an attachment to the vehicle, the clearance shall be permitted to be reduced to the design working dimensions of the insulating barrier.

    - If the equipment is an aerial lift insulated for the voltage involved, and if the work is performed by a qualified person, the clearance (between the un-insulated portion of the aerial lift and the power line) shall be permitted to be reduced to the restricted approach boundary.
- Employees standing on the ground shall not contact the vehicle or mechanical equipment or any of its attachments, unless:
    - The employee is using protective equipment rated for the voltage; or
    - The equipment is located so that no un-insulated part of its structure (that portion of the structure that provides a conductive path to employees on the ground) can come closer to the line than permitted in (a) above.
- If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employee working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials (step and touch potential), which can develop within a few feet or more outward from the grounded point.
- If a line is on the ground or contacting a piece of equipment, the ground may by energized and you may not be aware due how the electricity is flowing. However, the risk of electrocution may still be present. The voltage difference between a person's feet when they are standing near a live (energized) electrical wire that is in contact with the ground, creating a potential hazard where the current could flow through the body if a person takes a step, causing a shock due to the different voltage levels between their feet.
    - To avoid step potential, always maintain a safe distance from downed power lines and if you must move, shuffle your feet with them close together to minimize the voltage difference between them.
    - If you are in a vehicle with a live wire, stay inside the car and call 911 immediately; do not attempt to exit the vehicle unless there is a fire, and if you must leave, jump out with both feet together and shuffle away without touching the car and the ground at the same time; always treat a downed power line as live and dangerous, even if it appears inactive.

Summary

The purpose of this policy is to ensure Ferris State University employees and everyone onsite is safely protected from live electrical hazards. An on-going analysis of the potential hazards and work practices will ensure the safety of all personnel involved.

References and Further Information

1. America National Standards Institute (ANSI)
2. American Society of Testing and Materials (ASTM) F1506
3. American Society of Testing and Materials (ASTM) F1959
4. IEEE 1584-2018, “Guide for Performing Arc Flash Hazard Calculations”
5. NFPA 70E, “Standard for Electrical Safety in the Workplace”, 2018 edition
6. OSHA 1910 Subpart J “General Environmental Controls”, (29 CFR 1910.147, “The Control of Hazardous Energy (Lockout/Tagout).”)
7. OSHA 1910 Subpart R “Special Industries” (29 CFR 1910.269, “Electric Power Generation,

Transmission, and Distribution.")

8. OSHA 1910 Subpart S "Electrical" (29 CFR 1910.301 – 29 CFR 1910.399)
9. MIOSHA GI Part 40 Electrical Safety Related Work Practices
10. Ferris State University Lockout/Tagout Program
11. Ferris State University Confined Space Program
12. NFPA 70E Table 130.4(D)(a) - Alternating Current (ac) Shock Protection Boundaries
13. NFPA 70E Table 130.4(D)(b) – Direct Current (dc) Shock Protection Boundaries
14. NFPA 70E Table 130.7(C)(15)(a) – Arc Flash PPE Categories for ac systems
15. NFPA 70E Table 130.7(C)(15)(b) - Arc Flash PPE Categories for dc systems
16. NFPA 70E Table 130.7(C)(15)(c) – Personal Protective Equipment
17. NFPA Table 130.5(G) – Selection of Arc-Rated Clothing & Other PPE When Incident Energy Analysis Method is Used
18. OSHA 1910.262 The minimum approach distances (MAD)
19. Energized Electrical Work Permit (Appendix A)
20. Pre-Job Briefing Checklist for Live Electrical Work (Appendix B)

Appendix A

Ferris State University

Energized Electrical Work Permit

1. Location/Space *(To be completed by permit requestor)*		
Building:	Location:	
Date:	Issue Time:	Expiration Date/Time:

2. Work to be Performed *(To be completed by permit requestor)*
Description of the project and location (e.g. install circuit breaker in…):
Justification why the circuit/equipment cannot be de-energized:

3. Safety Precautions *(Completed by the qualified person doing the work)* **Enter the details for each step**		
Shock Risk Assessment	Voltage personnel will be exposed to:	
	Limited Approach Boundary (70E Table 130.4(D(a))	
	Restricted Approach Boundary (70E Table 130.4(D(a))	
Arc Flash Risk Assessment	Arc Flash PPE Category (From equipment label or 70E Table 130.7(C)15(a) or (b).	
	Arc Flash Boundary (From equipment label or 70E Table 130.7(C)15(a) or (b).)	
Safe Work Practices to be used		
Other Hazards Present (e.g. working at height)		

Additional Permits (check as appropriate)

☐Hot Work ☐Permit-required Confined Space ☐Other (describe)___

Required PPE

□ Hearing protection ☐ F/R clothing □ Safety glasses with side shields □ Hard hat

□ Voltage-rated gloves ☐ Arc-rated face shield □ Other (as required by NFPA 70E) □ Class E ☐ Class G

Class _____

How are unqualified persons restricted from the work area?	

4. Approvals *Electrical Supervisor or designee*			
Print Name	**Signature**	**Date**	**Approval**
			□ Approved ☐ Disapproved

5. Pre-Job Coordination		
Has a job briefing/discussion been conducted & documented to discuss hazards?	(check when complete)	☐
Is emergency communications equipment on site? ☐ Radio ☐ Phone ☐ Other	(check when complete)	☐

Do you agree the above described work can be done safely? ☐Yes ☐No (if no, do not perform the work)

Name of person(s) doing the work:_____ Signature_____

_____ Signature_____

6. Notification	
Personnel who may be in or near the area, and may be impacted, have been informed.	
☐Yes ☐No	**Name(s)**

7.Work Completion		
Electrical Work Complete:	Date:	Time:

Under NFPA 70E, there are only two instances in which an employee can work on live parts. In these situations, a work permit must be completed and approved by an authorized person.

1. When de-energizing would interrupt essential life support, emergency alarms or ventilation systems.
2. When the organization can demonstrate that de-energizing the system would introduce additional or increased hazards or that it is infeasible due to equipment design or operational limitations.

Appendix B

Ferris State University

Pre-Job Briefing Checklist for Live Electrical Work

Date:_____

	Name	Title
Person Authorizing Work		
Qualified Employee(s)		

Review and discuss the following with the qualified employees to be performing the assigned task.

1.) Description of Task to be performed:

2.) Electrical hazards associated with the work tasks:

3.) Safe Work Practices/Procedures that shall be followed:

4.) Any special precautions required by working conditions:

5.) Energy sources to be controlled:

6.) PPE required for the Job:

PRE-JOB BRIEFING SIGN OFF – INVOLVED EMPLOYEES

JOB POSITION	PRINT	SIGN

By: _____ **Date / Time:**_____