



UMBC OFFICE OF ENVIRONMENTAL SAFETY AND HEALTH (ESH) WRITTEN PLAN	TITLE: Electrical Safety
DATE CREATED: 11/2023	REVISION: 1.0

I. PURPOSE

The objective of this written plan is to establish minimum requirements in order to prevent the occupational exposure to electrical hazards, including shock, electrocution, burns, and explosions, as part of a comprehensive Electrical Safety Program.

Additionally, adherence to the requirements established in this plan will minimize the risk of fires and associated property damage resulting from damaged, faulty, or improperly functioning electrical equipment.

This written plan seeks to ensure compliance with the following Occupational Safety and Health Administration (OSHA) regulations and National Fire Protection Association (NFPA) consensus standards:

- OSHA – 29 CFR 1910 Subpart S – Electrical
- OSHA - 29 CFR 1910.269 - Electric Power Generation, Transmission, and Distribution
- NFPA 70E – Electrical Safety in the Workplace
- NFPA 70 - National Electric Code (NEC)

II. SCOPE

This written plan applies to all UMBC employees, including student employees, and contractors who handle electrically powered equipment, or work on or near components of the UMBC electrical system, including:

- Electrical Wiring
- Circuit breakers
- Fuses

- Switches
- Outlets
- Relays
- Electrical Panels
- Switchgears and Switch Boards
- Transformers
- Motor Control Centers
- Generators
- Switchyards and Substations

III. DEFINITIONS

- *Electrically Safe Work Condition* - A state in which the conductor or circuit part to be worked on or near has been disconnected from energized parts, locked/tagged out (or equivalent) in accordance with established standards, tested to ensure the absence of voltage, and grounded if determined necessary
- *On or Near* - Close enough to exposed line parts (by either personal contact or contact by tools or materials) for an employee to be exposed to any hazard they present.
- *Qualified Person* - One who has the skills and knowledge related to the construction and operation of electrical equipment and installations, and has received safety training on the hazards involved.
- *Unqualified Person* - A person that is not qualified to directly handle electrical components or work close enough to be exposed to energized electrical components, and, as such, does not have the level of skills, training and knowledge of a qualified person.

IV. PROCEDURE

General Electrical Safety Requirements

- As a general rule, work performed on or near electrical equipment or components of the UMBC electrical system requires the establishment of an electrically safe work condition through deenergization (Lockout Tagout) and verification of absence of voltage.
- Work that must be performed when electrical equipment or components are energized (live) requires the completion and approval of an Appendix E: Energized Electrical Work Permit. Only qualified persons are authorized to perform work on or near electrical equipment or components with exposed energized parts.
- Only authorized employees may perform de-energization of electrical equipment.

- All electrical equipment shall be assumed to be energized until verified as absence of voltage by a qualified employee.
- Do not overload electrical outlets or circuits.
- Electrical panels and outlets must have all covers and enclosures securely in place when not being serviced.
- Electrical panels shall maintain 36 inches of clearance in all directions.
- Storage is prohibited in any rooms designated for electrical equipment.
- Use only grounded (3-prong) electrical outlets.
- Do not remove the grounding prong to make the plug fit into a two-prong socket.
- Remove cords from outlets by pulling the plug, do not pull by the cord.
- Do not carry tools or equipment by their cords.
- Inspect electrical cords regularly for fraying, degradation or damage.
- Cord and plug electrical equipment must be double insulated or grounded.
- Keep electrical cords away from heat, oil, and sharp objects.
- Space heaters are not permitted at UMBC unless issued by the University during temporary heating system outages.
- Extension cords may not serve as a substitute for permanent wiring and may not be run through walls or ceilings.
- Do not splice or daisy-chain extension cords.
- Do not remove or tamper with any guard or enclosure of a tool, machine, or appliance, unless specifically qualified to do so. Improper removal or tampering creates a risk of fire, shock, or electrocution.
- In wet or moisture-prone areas, electrical equipment may only be plugged into a GFCI (Ground Fault Circuit Interrupter) outlet. Extension cords with a GFCI built-in are also acceptable.
- Use only non-conductive (i.e. wood or fiberglass) ladders when working near electrical equipment.

Hazard Identification

- General Requirements
 - Departments with authority over electrical equipment or components of the UMBC electrical system shall be responsible for performing inspections and assessments to identify and eliminate, or mitigate hazards from such equipment. This shall include assessments to determine the presence and the level of shock and arc flash hazard based on nominal voltage and incident energy levels.

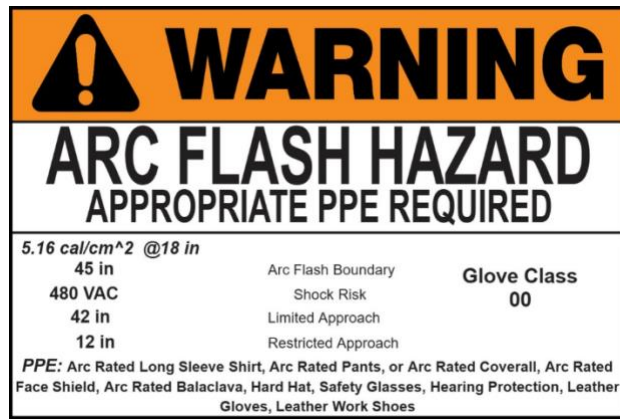
- Condition of Electrical Equipment

- Faulty, damaged, defective, or deficient electrical equipment can pose a high risk of shock, fire, electrocution, and burns. To protect employees, faculty, students, and the campus community, electrical equipment and components of the UMBC electrical system shall be inspected, serviced, and maintained by qualified persons at the schedule necessary to maintain the equipment in good operating condition.
- Electrical equipment shall not be allowed to fall into disrepair or be allowed to operate with faulty, damaged, or deficient components.

- Arc Flash Study

- An arc flash study is a study that identifies arc flash hazards, estimates the likelihood of severe injury, and helps determine the additional protections needed for a given electrical system or installation. Simply put, an arc flash study provides information regarding the incident energy available at the electrical components/devices that personnel would be exposed to while maintaining or otherwise interacting with that equipment and helps determine safe approach distances and PPE for conducting maintenance work.
- NFPA 70E requires that an arc flash study be conducted and then periodically reviewed at periods not to exceed five (5) years for all equipment operating at greater than 50 volts, in addition to whenever a major change or upgrade is made to the campus electrical system, such as a building renovation or new construction.
- All equipment that is likely to require examination, adjustment, servicing, or maintenance while energized (including testing or troubleshooting) shall be marked with a label containing the following information:
 - Nominal system voltage
 - Arc flash boundary
 - And at least one of the following:
 - Available incident energy at working distance, or required PPE Level
 - Minimum arc rating of clothing
 - Level of PPE required (must be equal to or greater than incident energy)

An example of an appropriate equipment label is pictured below:



Requirements for Contractor Work

The department with authority over equipment or components being serviced, maintained or repaired by outside contractors shall be responsible for communicating any hazards associated with the equipment to the contractor personnel.

Contractors shall be responsible for ensuring their employees adhere to safe work practices in alignment with this procedure and any associated regulations, standards, or codes, and ensuring contractor personnel have the appropriate training and equipment to perform work in a safe and compliant manner.

Selection of Work Practices

- **De-energization/Electrically Safe Work Condition**
 - Equipment and components of the campus electrical system shall be de-energized and placed into an electrically safe work condition when employees are performing tasks on or near electrical equipment at such a distance where the employees would be exposed to a risk of harm, including shock, arc flash, or electrocution, if the equipment is not de-energized.
 - Departments with authority over electrical equipment or electrical components shall be responsible for developing and maintaining safe work procedures as it pertains to the troubleshooting, inspections, or repairs of such equipment (refer to UMBC Lockout Tagout Program).
- **Energized (Live) Electrical Work**
 - Energized electrical work, including testing and troubleshooting, may only be performed by qualified persons. There are three scenarios in which energized electrical work is considered to be justifiable.
 - The voltage of the equipment is less than 50 volts to ground.
 - De-energizing creates additional or increased hazards, such as

- Interruption of life supporting equipment.
- Deactivation of emergency alarm systems
- Shutdown of ventilation for hazardous locations.
- Substantial loss of lighting that would impede the ability of personnel to safely perform work.
- De-energizing would be considered infeasible due to equipment design or operational limitations, such as:
 - Testing or troubleshooting that can only be performed with the circuit energized
 - Work on equipment that forms an integral part of a continuous process that would require the entire system to be shut down to permit work on one piece of equipment, and shutting down would create additional or increased hazards as noted above.
- Testing instruments, equipment, and accessories must be designed and rated for the circuits and equipment to which they will be connected.
- Energized Electrical Work Permit (Appendix E)
 - Energized electrical work shall require the completion and approval of an Energized Electrical Work Permit (EEWP). The EEWP requires the employee(s) performing the work to ensure that the reasons for performing energized work are justified and ensure that required safety precautions are in place.
 - The EEWP shall be reviewed and approved by the manager or supervisor of the employees to be performing the requested tasks prior to energized electrical work taking place.
 - Testing and troubleshooting generally does not require an EEWP if all other applicable safety practices and procedures are followed.
 - Qualified persons shall utilize the Decision Making Flowchart - Appendix A to determine if an EEWP is required prior to performing any energized electrical task, including testing or troubleshooting.
- At least two qualified persons shall be present during any energized electrical task.
- Qualified persons shall maintain current CPR certification.

- Areas where energized work will be performed must be sufficiently illuminated and free of obstructions and hazardous, conductive, or combustible materials.
- Safe Approach Distances
 - Safe approach distances shall be adhered to when performing work on or near any exposed energized electrical components. The greater the distance, the less likely an injury could be received from the energized equipment.
 - The NFPA specifies three classes of safe approach distances:
 - *Limited Approach Boundary*: Distance from an exposed live part within which a shock hazard exists. An unqualified employee may not cross this boundary unless they are continuously escorted by a qualified employee.
 - *Restricted Approach Boundary*: Distance from an exposed live part within which there is an increased risk of shock (due to electrical arc-over combined with inadvertent movement) for personnel working in close proximity to the live part. This boundary may only be crossed by a qualified person who is safely insulated or guarded from the live parts.
 - *Arc Flash Boundary*: The distance at which a worker would receive second degree burns in the event of an arc flash incident when appropriate arc-rated personal protective equipment is not being worn. This boundary may only be crossed by a qualified person wearing the appropriate PPE.
 - For systems that are 600 volts or less, the Flash Protection Boundary shall be a minimum of four feet. An engineering analysis must be performed to determine the Flash Protection Boundary for systems that are above 600 volts.
 - Refer to Appendix B, C, and D for more information on shock and arc flash approach distances.

Personal Protective Equipment

- General Requirements
 - Inspect all PPE prior to use. Remove from service and report any damaged, degraded, or malfunctioning PPE to supervision.
 - Clothing made of non-synthetic (such as 100 percent cotton or wool) or flame-resistant material shall be worn when performing any task where there is likelihood of an arc flash, including in underlayers.

- Only insulated tools and equipment shall be used within the Limited Approach Boundary of exposed energized parts.
- Insulated tools shall be rated for the voltages on which they are used and shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- Fuse and fuse holder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.
- Ropes and hand lines used near exposed live parts operating at 50 volts or more or where an electrical hazard exists, shall be nonconductive.
- Clothing should be comfortable, not too loose or too snug. Secure any zippers, shirt cuffs, or collars to prevent any skin exposure.
- Gloves should be worn in conformance with ASTM standards based on voltage protection requirements.
- Face shields with appropriate arc rating shall be worn.
- Safety glasses or goggles shall be worn under face shields and hoods.
- Conductive clothing or jewelry (watches, keychains, necklaces, etc.) may not be worn.
- Wear appropriately insulated shoes or boots.
- Long hair must be tied back to prevent impaired vision or inadvertent contact or entanglement with equipment.
- Use only non-conductive ladders (i.e., fiberglass).
- Shock Hazard PPE Requirements
 - Employees working within the Restricted Approach Boundary shall be provided with and utilize voltage rated PPE, tools, barriers, and other related equipment, and shall be selected based on the nominal voltage (refer to Appendix B).
- Arc Flash PPE Requirements:
 - The appropriate clothing and PPE shall be worn when performing any task where there is a risk of an arc flash event, based on the incident energy level and subsequent hazards and risks identified.
 - There are two acceptable methods of assessing arc flash risk to determine PPE selection, described below. Only one method can be used when assessing arc flash risk and may not be combined.

- Incident Energy Analysis Method

- This method involves using incident energy to determine the risk of an arc flash and the distance of the arc flash boundary. NFPA 70E defines incident energy as “The amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. Incident energy is typically expressed in calories per square centimeter (cal/cm²).”
 - An arc flash study of the electrical distribution system is used to calculate the incident energy and determine the arc flash boundary. Both values can be found on the arc flash labels that are applied to the equipment during the assessment. PPE is selected that is rated equal to or greater than the incident energy value.
 - Refer to the table in Appendix C for PPE selection based on this method.
- PPE Category (Table) Method
 - This method uses NFPA tables to estimate the risk based on maximum available fault currents, clearing times of overcurrent protective devices such as breakers and fuses, and working distances. If known, the fault currents at the equipment and clearing times are cross-referenced with the tables to determine the arc flash PPE category and arc flash boundary. Using this method, the arc flash labels will identify the PPE Category rather than the incident energy.
 - If no arc flash label exists on the equipment, the PPE Category method must be used. Employees must know the available fault current and clearing times and use the tables in Appendix D to determine the arc flash category, estimate arc flash boundary, and select PPE.
 - It is important to note that this method cannot be used if the fault current and clearing times of the equipment are not known, or if the values fall outside of the parameters specified in the tables in Appendix D.

Alerting Methods

- Alerting methods shall be used as necessary to warn and protect employees from injury due to shock, burn, or failure of electrical parts.
 - Methods include:
 - *Safety signs and tags* - to be used where necessary to warn employees about electrical hazards which may endanger them. Electrical equipment shall be marked with descriptive markings, including the equipment’s voltage, current, wattage, or other ratings necessary.

- *Barricades* - to be used in conjunction with safety signs where necessary to prevent or limit employee access to work areas exposing employees to uninsulated energized conductors or circuit parts. Conductive barricades may not be used where there may be an electrical contact hazard.
- *Attendants* - shall be stationed to warn and protect employees if signs and barricades are not sufficient.

Additional Electrical Safety Requirements

- Overhead Lines
 - Work being conducted near overhead lines shall require either the de-energizing and grounding of the lines, or other appropriate protective measures to be taken before such work takes place.
 - Protective measures, such as guarding, isolating, or insulating, shall prevent the qualified person from contacting the lines with their body or through conductive material, tools, or equipment.
 - Unqualified persons working on the ground, or on an elevated platform such as a scaffold or aerial lift are not allowed to bring any conductive object, or any insulated object that does not have the proper insulating rating (including vehicles and mechanical equipment), closer to unguarded, energized overhead lines than the distances allowed below:
 - 50kV or Below - 10 feet
 - Over 50kV - 10 feet plus 4 inches for each 10kV over 50 kV
 - Qualified persons working in the vicinity of overhead lines, whether in an elevated position or on the ground, are not allowed to approach or take any conductive object without an approved insulating handle closer to exposed energized parts than allowed in the aforementioned approach boundaries tables (Appendix B), unless:
 - The person is insulated from the energized part by using appropriate voltage-rated gloves, with voltage-rated sleeves if necessary, or
 - The energized part is insulated from all other conductive objects at a different potential and from the person, or
 - The person is insulated from all conductive objects at a potential different from the energized part.
 - The clearance requirement for scaffolds, vehicles, and mechanical equipment may be reduced if:
 - The vehicle is in transit with its structure lowered. The clearance may be reduced to 4 feet when near energized lines operating at less than 50 kV, or 4 feet plus 4 inches for every 10 kV over 50 kV.

- Insulating barriers (not a part of the vehicle attachment or its raised structure) are installed to prevent contact with the lines and the barriers are rated for the voltage of the line being guarded. The clearance may be reduced to the distance allowed by the design of the insulating barrier.
 - The equipment is an aerial lift insulated for the voltage involved and the work is performed by a qualified person. The clearance between the uninsulated portion of the lift and the power line may be reduced to the distance specified for qualified persons.
 - Persons working on the ground are not allowed to contact the vehicle or mechanical equipment (ex. boom trucks) or any of its attachments unless:
 - The person uses protective equipment rated for the voltage, or
 - The equipment is located so that no uninsulated part of its structure can provide a conductive path to persons on the ground. Equipment shall not approach closer to the line than 10 feet for voltages less than 50 kV, or 10 feet plus 4 inches for every 10 kV over 50 kV.
 - When any vehicle or mechanical equipment is intentionally grounded, persons may not stand near the point of grounding when there is any possibility of contact with overhead energized lines. Additional precautions (e.g. such as the use of barricades or insulation) must be taken as necessary to protect persons from hazardous ground potentials that can develop within a few feet or more outward from the grounding point.
- Working with High Voltage
 - Work performed on equipment that is greater than 600 volts terminal-to-terminal or 300 volts terminal-to-ground is considered high voltage electrical work.
 - High voltage electrical work presents a considerably higher risk of death or serious harm, and as such, special precautions must be taken in addition to general electrical safety requirements.
 - High Voltage Requirements:
 - Rooms and areas where high voltage electrical equipment is located shall have labels or markings on the doors indicating the area contains high voltage equipment and that access is restricted only to authorized personnel.
 - Switches, circuit breakers, and other control devices for high voltage equipment shall be labeled as such.
 - A minimum of two employees shall be present when working on high-voltage equipment. Both employees shall have current CPR training and understand emergency response procedures.
 - Safety rescue hooks shall be provided and positioned in close proximity to where the work is being performed.

- Employees shall wear the appropriate high-voltage PPE rated to the voltage of the equipment being serviced, to include:
 - Arc-rated clothing/coverall
 - Arc-rated flash suit (when CAT 4 incident energy levels are present)
 - Hard hat
 - Non-conductive safety glasses
 - Insulated rated gloves
 - Protective face shield
 - Hearing protection
 - Non-conductive reinforced toe footwear

Training Requirements

- Unqualified persons who work on or near electrical equipment shall be provided with awareness-level training that provides a foundational knowledge of electrical safety rules, regulations, and best practices to avoid exposure to electrical hazards. Training shall be provided at least annually.
- Qualified persons shall receive continuing safety training at least every three years in accordance with OSHA and NFPA 70E requirements, that covers at a minimum the following subjects:
 - CPR and emergency response procedures.
 - PPE selection and use.
 - Ability to distinguish exposed live parts from other parts of electrical equipment.
 - Skills necessary to determine nominal voltage of exposed live parts.
 - Required clearance and approach distances and the corresponding voltages to which the qualified person will be exposed.
 - Measures and equipment necessary for protection when direct contact or contact with tools must be made to energized equipment.
- Retraining shall also be required in the following circumstances:
 - Following any accident or near-miss, regardless of whether an injury occurred.
 - When the employee demonstrates an insufficient knowledge of, or deviates from the training received.
 - The employee no longer demonstrates that they are able to perform the tasks assigned in a safe manner.

Recordkeeping Requirements

Departments shall be responsible for maintaining the following records, as applicable:

- A record of electrically qualified employees under their supervision.
- Current records of electrical equipment testing, inspections, servicing, and repairs .
- Records of hazard and risk surveys and assessments of electrical system equipment and components under their authority.
- Records of employee electrical safety training.

Unless otherwise specified, all records shall be maintained for a period of at least three (3) years.

V. ROLES AND RESPONSIBILITIES

Department Heads, Managers, Deans, Supervisors, Administrators

- Ensure employees comply with all provisions of this program.
- Develop and maintain a list of qualified electrical workers under their supervision.
- Ensure that employees complete necessary training pertaining to electrical safety.
- Ensure that the electrical equipment under their authority is appropriately serviced, maintained, and inspected to ensure good working condition.
- Ensure that energized electrical work permits are submitted and utilized when necessary.
- Ensure that appropriate hazard controls and personal protective equipment are provided and utilized by employees when necessary.
- Report and assist in the investigation of all injuries and incidents involving electrical work.

Environmental Safety and Health

- Provide technical support, guidance, and consultation to affected departments and employees on matters pertaining to electrical safety.
- Periodically review and evaluate the effectiveness of this procedure and modify or revise as necessary to ensure continued effectiveness.
- Investigate and follow up on any reported safety concerns, accidents, or near misses pertaining to electrical safety.
- Assist with referring affected departments to qualified training providers.

Employees

- Follow all necessary safety precautions and requirements of this procedure, as well as all other applicable safety policies and procedures, when working on or around electrical equipment or components of an electrical system.

- Handle and operate all electrically-powered equipment, tools, appliances, or devices in the manner and purpose for which they are intended.
- Complete all required training prior to performing any work on or around electrical equipment or components of an electrical system.
- Wear all necessary personal protective equipment and use only the appropriate tools and equipment necessary to safely perform tasks involving electrical equipment.
- Report all safety concerns, incidents, and near-misses to supervision and Environmental Safety and Health.

VI. APPENDICES

- Appendix A: Energized Electrical Work Permit Decision Making Flow Chart
- Appendix B: Approach Boundaries for Shock Protection from Live Parts
- Appendix C: Arc Flash PPE Selection Guide Using the Incident Energy Method
- Appendix D: Arc Flash PPE Selection Guide Using the Category/Table Method
- Appendix E: Energized Electrical Work Permit

VII. ADDITIONAL REFERENCES

- UMBC Policy VI-13.00.01 - Environmental Safety and Health Management and Enforcement
- UMBC ESH Procedure - General Safety Rules for UMBC Employees
- UMBC Lockout Tagout Program