

# UNIVERSITY OF TOLEDO

SUBJECT: CONTROL OF HAZARDOUS ENERGY SOURCES                      Procedure No: S-08-014  
(LOCK-OUT / TAGOUT) AND ELECTRICAL SAFE WORK PRACTICES

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## PROCEDURE STATEMENT

This program applies to all employees completing tasks in which the unexpected energizing or start-up of machines or equipment or the release of stored energy could cause injury. This procedure covers activities including new equipment installation, systems troubleshooting, lockout tagout, and working on energized electrical systems.

## PURPOSE OF PROCEDURE

To ensure the development of procedures to adequately prevent against employee injury resulting from activities listed above and to assure compliance with NFPA 70 E and the Occupational Safety and Health Administration regulations 29 CFR 1910 Subpart J and Subpart S which includes Standards 1910.147 and 1910.331 through 1910.335. This procedure is designed to protect all employees from hazardous energy sources through proper use of procedures, tools, and personal protective equipment.

## PROCEDURE

It is the responsibility of Department Managers, in those departments where employees are required to provide servicing and maintenance of machines and equipment in which the unexpected energizing or start-up of the machines or equipment or the release of stored energy could cause injury, to assure the following is provided:

- All required tools, personal protective equipment and laundering services (i.e. electrically rated gloves, arc flash rated clothing, insulated tools, and lockout tagout equipment such as locks, tags and isolation devices).
- Whenever a new piece of equipment is purchased or an existing piece of equipment is being overhauled, isolation points must be put in place to accommodate locks.
- Identification and implementation of specific energy control procedures (in writing) for the control of hazardous energy which will include preparation for shutdown, equipment isolation, verification of isolation, lockout/tagout application and finally the release of stored energy (**Appendix A**).
- Inspections of this energy control procedure on an annual basis to ensure employee understanding and competency. This inspection will be completed through an annual P.M. through the Work Order system.

## LOCKOUT/TAGOUT

Lockout tagout procedures (**Appendix A**) must be instituted prior to maintenance or servicing of all machinery and equipment where the unexpected energization, start-up or release of energy could cause injury. Exemptions include the following:

- Lockout tagout procedures do not need to be implemented if an electrical plug powers the piece of equipment and if the plug is removed from the outlet and remains within arms reach of the authorized employee while servicing the equipment.
- Lockout tagout procedures are not intended to apply as long as guards are not removed or bypassed and are effective in preventing worker exposure to hazards created by the unexpected energization or start up of machines or equipment, or the release of energy.

- Workers should be cautious when adding energy to an otherwise deenergized system (hand spinning a fan/motor) or when environmental energy can cause unexpected movement of equipment (airflow through a fan causing the assembly to rotate). If hand spinning a fan motor is necessary, it's recommended that the worker use a tool (a pair of pliers, or similar) to rotate the equipment. If environmental energy can be imparted on the equipment which would cause equipment movement, workers should fix the equipment in place before beginning work to prevent unanticipated movement.
- There are only a few instances that an employee can work on or near energized equipment without implementing the lockout/tagout procedures (See Electrical Safe Work Practices):

Lockout will be accomplished using a lock and key and a multiple lock hasp and/or other approved lockout devices. An approved warning tag will accompany all lockouts. The warning tag will be attached directly to the lockout device or by a nylon tie. Chains or other hardware may also be used in conjunction with locks and lockout devices to isolate energy sources. One key will be issued to the authorized employee applying the lock.

### **Locks and Tags**

- Locks and tags shall be standardized with at least one of these criteria: color, shape or size. In regards to tagging devices, the print and format must be standardized.
- Locks and tags must be of substantial quality and durability to prevent deterioration in extreme environments and maintain their effectiveness. They must be substantial enough to prevent inadvertent or accidental removal.
- A variety of devices will be provided for the placement of locks on a variety of energized equipment (i.e., fuses, breaker switches).
- All tagout devices must include a legend such as Do Not Start, Do Not Open, Do Not Close, Do Not Energize, etc.
- Information placed on the tag must include the name of the authorized employee who locked out the equipment; the authorized employees radio number or phone number, including outside contractors; the date and time of the lockout and; a brief description of the work being done.

### **Procedure Involving More Than One Shift**

When the original authorized employee working on the piece of equipment is replaced by another authorized employee, the original employee will remove his/her lock and the incoming employee will insert his/her lock onto the energy-isolating device. If the first employee leaves the area before the incoming employee arrives, an authorized supervisor can place his/her lock on the system to ensure the system remains safe until the second employee arrives. The incoming employee must then place his/her lock on the energy-isolating device and verify that all other energy sources are locked out before beginning work.

### **Procedure Involving Multiple Locks**

For situations requiring multiple lockout points, multiple locks and other lockout devices must be made available. These locks are intended to supplement the existing lockout tagout equipment, and not replace it.

### **Abandoned Lock Procedure**

Any lockout or tagout devices that are in service must only be removed by the employee who applied the devices or by a supervisor (or designee) if the original employee is not present to remove the device(s).

It is the responsibility of the authorized employee to remove his/her lock at the end of the workday. If an authorized employee forgets to remove his/her lock before leaving the worksite, the immediate supervisor must:

- Call the authorized employee to verify the employee has left the worksite and inform him/her that their lock is being removed.
- Lockout tagout devices may not be removed unless the responsible supervisor is present and authorizes removal.
- The supervisor must make all reasonable attempts to contact the employee and inform him/her that their lock has been removed. If the authorized employee cannot be contacted, and the supervisor has verified that the employee who applied the device is not at the facility, the energy to the equipment may be restored after performing an inspection of the equipment that has been locked out.

- The supervisor must then ensure that the authorized employee is made aware of the removal before he/she resumes works.

### **Contractors**

Whenever contractors and other outside servicing personnel perform tasks covered by the lockout/tagout standard, they must adhere to the standard's requirements. The contractor or outside employer and UT must inform each other of their respective lockout tagout procedures. This also applies to electrical work activity and will be completed during the pre-construction meetings.

### **Training**

Training is required for all employees who work in or around an area where energy control procedures will be utilized. Each affected employee shall be instructed on the purpose and use of the energy control procedures with training reminders as part of the annual inspections by the department supervisors.

## **ELECTRICAL SAFE WORK PRACTICES**

This section is designed to ensure compliance with OSHA 29 CFR 1910 Subpart S which includes standards 1910.331 through 1910.335.

This section applies to the electrical safety work practices for work operations involving all electrical systems where employees may be exposed to live parts over 50 volts and/or those parts that have been de-energized.

The program applies to both qualified personnel (those who have training in avoiding the electrical hazards of working on or near exposed energized parts) and unqualified personnel (those with little or no such training) working on, near, or with the following installations: premises wiring, wiring for connection to supply, other wiring, and optical fiber cable. Only qualified employees may work on open energized electrical equipment.

### **Training**

All employees who face a risk of electrical hazard that is not reduced to a safe level shall be trained. Training shall be performed before an employee is assigned duties involving work around or on electric systems.

The level of electrical safety training provided is dependent on whether the employee is classified as a "qualified person" or "unqualified person" as it relates to work involving exposure to live parts over 50 volts.

A person can be considered qualified with respect to certain equipment and methods but unqualified for others. Group A is considered "unqualified" and will not work on live parts over 50 volts. Group B is considered "qualified" and will work on live parts over 50 volts as permitted by their training.

#### *Group A (Unqualified Persons)*

- Plumbers
- Building/Environmental Services
- Life Safety Technicians
- Roofer
- Auto Mechanics
- Painter

#### *Group B (Qualified Persons)*

- Building Automation
- Electricians
- Air Quality Technicians
- Building Operators
- Maintenance Repair Workers (HSC only)
- Main Campus Data Tech

### **Content of Training**

#### *Unqualified (Group A)*

An "unqualified person" shall, at a minimum, be trained in and familiar with the following:

- Basic electrical hazards.

- Identification of electrical hazards.
- How each hazard (shock, arc flash, arc blast) affects body tissue.
- How to determine the degree of each hazard, Hazard classification 0 through 4 on the arc flash hazard label.
- How to avoid exposure to each hazard. What a flash boundary is and how to identify it.
- Awareness of the importance of electrical safety alerting techniques such as signs, barricades and attendants.
- Safe practices and policies regarding the qualified personnel.

#### *Qualified (Group B)*

A “qualified person” shall, at a minimum, be trained in and familiar with the following:

- All training required for Group A employees.
- The skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment.
- The skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts.
- The approach distances specified on the arc flash hazard label and the corresponding voltages.
- Sufficient illumination is needed in the work area
- Additional precautions are required if work is to take place in a confined space (S-08-019).
- Knowledge of the construction and operation of equipment or a specific work method and to recognize and avoid the electrical hazards that might be present with the respect to that equipment or work method.
- The importance to follow each step in a work plan that has been established for work on or near exposed live parts and to cease should that plan not be followed.
- The proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools and test equipment.
- The skills and techniques necessary to distinguish risk of arc flash from electrical equipment.
- The skills and techniques necessary to determine the nominal voltage of exposed live parts.
- The clearance distances specified in 29 CFR 1910.333(c), NFPA 70-E, and arc flash analysis, and the corresponding voltages to which the qualified person will be exposed.
- Specific on-the-job task training inherent to their jobs which are necessary for their safety.
- Methods of release of victims from contact with exposed energized electrical conductors or circuit parts.
- Personal Protective Equipment Training.

Additional training is provided on the lighting ballast replacement procedures (**Appendix E**).

#### *Retraining*

Retraining will be performed whenever there is an indication that an employee does not have the necessary knowledge or skills to safely work on or around electrical systems and/or not less than 3 year intervals. Retraining shall also be performed when policies or procedures change and/or new equipment or systems are introduced into the work area. Employees are required to attend refresher training offered through the Environmental Health and Radiation Safety Safety (EHRS) Department.

### **Selection and Use of Work Practices**

#### *General*

Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.

#### *De-energized parts*

Live parts to which an employee may be exposed **shall be de-energized** before the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Refer to the UT lockout tagout procedures to de-energize live parts and establish an electrically safe working condition (**Appendix A**).

**The following are the only examples in which work on energized electrical equipment may be acceptable;**

- Examples of increased or additional hazards include interruption of life support equipment, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment, or removal of illumination for an area.
- Examples of work that may be performed on or near energized circuit parts because of infeasibility due to equipment design or operational limitations include testing of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous industrial process in a chemical plant that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

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.

### **Task Identification**

The Job Briefing and Planning Checklist (**Appendix B**) shall be completed prior to beginning work on energized or **potentially** energized electrical equipment for any non-routine work.

The checklist is designed to address appropriate safety measures when performing this type of work. Job briefing checklist should be turned into EHRS with the Energized electrical work permit if applicable.

Task A: De-energizing Electrical Equipment (General)

Task B: Equipment, Diagnostic Testing & Programming (General)

Task C: Energized Electrical Equipment (Repair) (General)

It is the responsibility of the Supervisor to identify any job task conditions which are not covered under general task training and provide training specific to task those conditions.

For routine 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 either of the following apply:

1. The work is complicated or particularly hazardous
2. The employee cannot be expected to recognize and avoid the hazards involved in the job.

### **Working on Energized Equipment Procedures**

**Every effort shall be made to ensure live parts are de-energized before beginning work.** Working on or near live parts shall be a last resort in the workplace, after all other opportunities for establishing an electrically safe condition have been exhausted. The overall goal is to work on everything de-energized. If this is not possible, a live work permit shall be filled out and approved in order to work on the system live (exemptions, testing, diagnostic testing, and voltage measuring).

**No work above a Category 2 shall ever be performed on live equipment by any trade with the exception of the Electricians.** Refer to NFPA Table 130.7(C)(15)(a) and (b), for those tasks or the provided chart.

### **Electrical Equipment is Considered Energized Until:**

- It has been isolated from all sources of supply by opening the properly rated disconnect switches, circuit breakers, cutouts, or contactors;
- A properly rated and operable sensing device has been brought into close proximity to, or touched to, a bare component to confirm that it is de-energized; and
- A properly rated temporary ground connection has been applied or the company lockout tagout policy has been complied with.

### **Energized Electrical Work Permit**

Any work on energized equipment, other than testing and troubleshooting shall have an Energized Work Permit. (**Appendix B , Task C**). All work on or near energized conductors requires a permit. The Energized Electrical Work Permit form will be signed and approved by the Job Supervisor after the task and procedure is discussed with the worker.

If the exposed live parts are not de-energized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved. Such work practices shall protect employees against contact with energized circuit parts directly with any part of their 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 exposed electric conductors or circuit parts. In addition to the policy listed below, every attempt will be made to adhere to best practices specified in NFPA 70E.

Guidelines have been established by which the hazard classification of electrical energized work may be determined and Approach Boundaries around the energized electrical equipment defined. It is based on the Occupational Safety and Health Act (OSHA) *Regulation for Industrial Establishments*, Federal Register 29 CFR Part 1910 Subpart S; the *National Electrical Code (NEC)*, ANSI/NFPA 70, *Electrical Equipment Maintenance*, ANSI/NFPA 70E; *Electrical Safety Requirements for Employee*.

Any person within the hazard label noted arc flash boundary and exposed to potentially energized components shall be qualified. An unqualified person is prohibited within this boundary.

Electrical panels may only be opened by qualified personnel. This includes, but is not limited to, control panels, local disconnects, MCC buckets, and junction boxes.

Electrical panels shall be kept closed unless a qualified person is within reasonable working distance of the panel. Should the panel door need to be left open and unattended, a yellow caution tape barrier or chain barricade shall be erected with a ten foot minimum radius. The barrier shall be tagged with the name, department, and extension of the person responsible for erecting the barrier. The date erected and the date to be removed shall also be included on the tag.

The hazard label noted arc flash boundary shall be enforced by electrically qualified personnel when executing the energized work. If the nature of the work is such that the individual cannot reasonably enforce the barrier boundary, a caution tape barricade or chain barrier shall be erected or a stand-by watch person shall be employed.

All exposed conductors are to be considered energized until de-energized, isolated, and verified. Qualified personnel shall be aware of remotely powered circuits. **(Appendix B, Task A)**

All electrical field equipment shall be identified with its line source of power disconnect location. This includes MCC's, panel-boards, remote mounted transformers, and power distribution panels.

Appropriate PPE shall be worn, when working on energized or potentially energize electrical equipment.

Qualified employees shall determine when it is necessary to test or troubleshoot equipment without the application of an energized electrical work permit.

No person shall attempt to use any type of test equipment unless they are trained, qualified, and deemed competent, on the proper use and limitations of the equipment.

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

When servicing electrical storage batteries, all employees shall wear protective clothing to guard against chemical splashes and burns rubber boots, a rubber apron, chemical goggles, a face shield and rubber gloves in addition to any required PPE related to Arc Flash.

Electrical box and cabinet covers must be replaced when work is completed or when it is to be left for a long period of time. The established Arc Flash boundary notification materials must remain while covers are off at all times.

*Any permit required electrical work on or near exposed live parts shall only be completed if all the following requirements are met. Additional requirements may also apply:*

- The need for energized electrical work shall be clearly communicated to the appropriate supervisor for approval.
- All training requirements for a Qualified Person have been met.

- Written approval on a job briefing work plan has been approved and documented.
- Appropriate PPE is available based on the arc flash hazard label.
- At least one additional qualified person is present.
- Test equipment is ready.
- Hazard boundaries are identified and established.
- The area is dry and well lighted to 5 ft/cd minimum.
- Applicable electrical diagrams have been reviewed and the job briefing checklist has been reviewed, approved, and documented.

#### *Qualified Employee Duties/Functions*

The following duties/functions may only be performed by Qualified Employee:

- Operate any circuit switching device 120 to 480 volts and above.
- Test or troubleshoot electrical equipment.
- Repair or alter electrical equipment.
- Testing, removal or installing fuses.
- Perform work on non-insulated energized circuits and apparatus over 50 volts.
- Perform work within 10 feet of non-insulated energized circuits and apparatus that are not barricaded or covered or otherwise guarded to prevent electrical shock hazards and contact by tools, equipment, or personnel.
- Only qualified employees may enter energized electrical substations and motor control centers. Unauthorized employees shall not be approved to enter these listed areas.

#### **Alerting Techniques**

The following alerting techniques shall be used to warn and protect employees from arc flash hazards, which could cause injury due to electric shock, non contact electric arc burns, or failure of electric equipment parts:

- Safety signs and tags: Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about arc flash hazards which may endanger them, as required by NFPA 70-E.
- Barricades: Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas exposing employees to the flash protection boundary from arc flash hazards. Conductive barricades may not be used where they might cause an electrical contact hazard.
- 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, students and visitors from entering the flash boundary area.

#### **Live/Dead/Live Testing Procedure**

All testing equipment shall be tested as follows:

*(Live-Dead-Live)*

- Test the equipment on a known appropriate voltage source to assure the testing equipment is operating properly,
- Test the field device or equipment for the required voltage energized or de-energized.
- Retest the testing equipment on the same known appropriate voltage to assure the meter is still operating. This procedure is to be used for all voltages over 50 volts each time a voltage testing is required.

Work on energized or potentially energized electrical equipment 480 volts or above shall not be done unless the following conditions are met:

1. All work shall be performed in accordance with the provisions set forth in this procedure and in compliance with all other applicable safety requirements.
2. A designated Electrical Standby Person shall be present and equipped with a level of protection equal to that of the qualified employee performing the work. Electrical Standby Persons shall be trained in energized electrical procedures and how to contact emergency rescue for electrical shock victims. They shall standby outside of the designated Arc Flash Boundary and only enter in the event of an event which would require assistance for the qualified worker. They shall, at a minimum, wear high voltage protective gloves and remain at the site of the work at all times while the work is in progress.

3. The supervisor of the Qualified employee performing the work shall be notified that such work shall be done, the exact location of the work, and when the work will begin. Once the work is complete, the supervisor shall also be notified.

#### **Use of Ground Fault Circuit Interrupters**

Employees shall use ground-fault circuit interrupter (GFCI) devices to protect against 120 volt electrical hazards. Requirements for and use of GFCI devices.

- GFCI devices will be handled carefully to avoid damage
- A GFCI device will be located at the end of in-use extension cords and the load will be plugged directly into the GFCI
- The GFCI will be tested before the first use each shift.
- Defective GFCIs will not be used

#### **Procedures for Diagnostic Testing of Energized Equipment**

Qualified employees shall determine when it is necessary to test, position, or troubleshoot equipment without safeguards being in place.

Only qualified employees may perform tests on energized or potentially energized electrical circuits or equipment 50 volts and above.

Diagnostic testing on live, energized parts is allowed, however if a problem is discovered during diagnostic testing and a component be removed or rework shall be performed, this is no longer diagnostic testing. At this time, the circuit shall be de-energized and lock/tagged out.

Test instruments, equipment rated for the proper voltage, and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that could expose someone to injury, the defective or damaged item shall be properly tagged out and removed from service. It may not be used again until repairs and tests to assure the equipment is safe to use have been made.

When performing tests, these requirements shall be followed:

- The test equipment shall be evaluated for proper operation immediately before and after the test.
- Test instruments, equipment, and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that could expose someone to injury, the defective or damaged item shall be properly tagged out and removed from service. It may not be used again until repairs and tests to assure the equipment is safe to use have been made.

Note: The following measurement equipment shall be used in all industrial applications:

- CAT III Distribution wiring, including "Mains" Bus, feeders, and branch circuits: permanently installed loads.
- CAT IV Origin of installation utility level and outside cable run.



**Electrical Work Guidelines Table 1**

**NFPA 70E Table 130.7(C)(15)(a)**

***Arc-Flash PPE Categories for Alternating Current (ac) Systems***

<b>Equipment</b>	<b>Arc Flash PPE Category</b>	<b>Arc-flash boundary</b>
Panelboards or other equipment rated 240 volts and below Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18in.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards Parameters: Maximum of 35 kA available fault current; maximum of 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18in.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)

Phasing sticks shall be used when verifying that circuits 1,000 volts or greater are de-energized. Phasing sticks shall be tested prior to and after each use.

**NFPA 70E Table 130.7(C)(15)(b)**  
**Arc-Flash PPE Categories for Direct Current (dc) Systems**

<b>Equipment</b>	<b>Arc flash PPE Category</b>	<b>Arc-flash boundary</b>
Storage batteries, dc switch- boards, and other dc supply sources Parameters: Greater than or equal to 100 V and less than or equal to 250 V Maximum arc duration and mini- mum workind distance: 2 sec @ 455 mm (18 in.)		
Available fault current less than 4 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 4 kA and less than 7 kA	2	1.2 m (4 ft)
Available fault current greater than or equal to 7 kA and less than 15 kA	3	1.8 m (6 ft)

### **Overhead Power Lines**

When working in the vicinity of overhead power lines, Qualified employees shall not approach nor carry conductive objects any closer than outlined in the following table:

Approach Distances for Overhead Power Lines – Refer to NESC Section 23

Approach Distance exceptions:

- The conductive object has an approved insulating handle.
- The person is insulated from the energized part by the appropriate personal protective equipment rated for the expected voltage.
- The energized part is insulated from the person and all other conductive objects in the area.
- The person is insulated from all conductive objects in the area.

### **Racking/Stabbing/Working Electrical Equipment**

When racking or stabbing or performing any other work activity on energized or potentially energized electrical equipment 480 volts or above, the following procedures shall apply:

1. Every effort shall be made to de-energize the equipment, and any other electrical circuits or equipment in the area that might affect the work. De-energization of the equipment shall be verified through proper testing procedures.
2. If the equipment cannot be de-energized, approval shall be obtained from the Project Manager, Supervisor, Owner, and/or Owners Representative prior to the work proceeding.
3. If circuits or equipment in the area that might affect the work cannot be de-energized, they shall be isolated with insulating blankets, or otherwise rendered harmless.

The job briefing checklist shall be completed and signed by the Supervisor responsible for the work ( **Appendix B**).

The following protective equipment shall be used when the equipment cannot be de-energized:

- Approved and tested high voltage rubber gloves of the proper voltage rating, with leather protectors.
- Approved PPE clothing based arc flash PPE categories
- Approved face shield/hood.
- Approved protective balaclava
- Dielectric switchboard matting or dielectric boots of the proper rating, if required.
- Hearing protection

When racking/stabbing in or out electrical equipment, remote racking systems should be used whenever possible. When not possible, stand to one side of the cabinet and turn your face away from the work.

Replacement of fuses may only be done using exact duplicates of the same rating.

### **Conduit and Cable Dismantling**

Prior to the dismantling of conduit or electrical cable begins, the following procedures shall be implemented:

- The electrical circuit(s) to be dismantled shall be de-energized, locked and tagged out by a Qualified Employee in accordance with the University of Toledo's lockout/tagout procedure.
- All disconnects, identification and verification of conduits shall be performed by a Qualified Employee.
- All affected conductors shall be checked with an appropriate voltage tester by a Qualified Employee to assure that the conductors to be dismantled have been de-energized and are out of service.
- Approved PPE clothing shall be used based on an arc flash hazard assessment when possible.
- The voltage tester and all other electrical safety equipment (e.g. gloves, mats, etc.) shall have current inspection stickers and be in good condition and shall be tested daily for any damage.
- After determining that all electrical circuits are de-energized, locked and tagged out, the conductors shall be disconnected by a Qualified Employee at all points of termination (energy source and equipment being served).
- Conduit and/or cables to be dismantled shall be tagged by a Qualified Employee at each end, each intersection, and at intervals not to exceed fifty feet in any direction along the entire length of the conduit and/or cable. Demolition tags should be used for this purpose.

- Each identification tag should clearly specify the name of the Qualified Employee who performed the work, the date and the Supervisor's name.
- All electrical cable and/or conduit dismantled should be removed in a safe manner and placed where it will not cause a tripping hazard.
- Every effort should be made to ensure that the Qualified Employee who began the dismantling work continues with the work until completion. If, for any reason, the Qualified Employee performing the work should be absent or unavailable, a second Qualified Employee may assume the task; however, the status and energy state of the work shall be verified prior to commencing work.

### **Electrical Guarding and Working Space**

Suitable access and working space shall be provided and maintained around all electrical equipment to permit ready operation and maintenance. The working space is defined as the direction to access of energized parts in switchboards, control panels, fused switches, circuit breakers, panel boards and similar equipment that requires examination, adjustment, servicing or maintenance while energized.

The dimensions of the working space shall not be less than three-feet in depth and 30-inch in width or the width of the equipment which ever is greater.

The working space shall be kept clear of stored items, installed piping, ducts or foreign equipment except:

- Control equipment that by its nature or because of other requirements, may be in the working space
- Structures that provide adequate mechanical protection against vehicular traffic impact for the electrical equipment and do not interfere with the operation of the equipment may be located in the working space. Panel doors shall always be able to be opened 90-degrees.

Energized parts of electrical equipment operating at 50 volts or more shall be guarded against accidental contact by use of cabinets or enclosures.

Entrances to rooms or other guarded locations containing exposed energized parts shall be marked with conspicuous warning signs prohibiting unauthorized entrance.

All openings in boxes enclosures and fittings shall be effectively guarded or closed to afford protection.

### **De-Energized Equipment and Marking Circuits**

A test shall be performed by a qualified person to verify that the equipment or circuit is de-energized. (**Appendix B, Task A**).

Electrical control panels, switch gears, circuit breakers, panel boards, and similar equipment shall be clearly marked as to what equipment or circuit is controlled.

### **Electrical Equipment Grounding**

The practice of grounding electrical conductors is intended to prevent an individual from receiving an electrical shock due to inadvertent energization of the equipment. This safety precaution is executed in addition to normal lockout and tagout isolation when required.

The following 13kV and 480V equipment shall be properly grounded before work may begin on the equipment: (Per ASTM F 855)

- Main isolation switches
- 13kV Busses and isolation switches
- Substation busses and breakers
- Substation transformers (primary and secondary)
- Primary disconnects
- Medium Voltage MCC bus

Ground clusters shall be manufactured and listed for that purpose.

Application of ground clusters may only be executed by qualified individuals.

Two individuals shall be present for the application of ground clusters. One may be outside the flash hazard boundary.

Ground clusters shall be kept in good repair. Full inspection of each cluster is required prior to use and annually.

The following procedure shall be used when grounding a system:

- Wear appropriate flash and shock hazard PPE while conducting this procedure. Assume PPE Class IV is required unless otherwise indicated.
- Ensure proper approach boundaries have been enforced.
- Connect one end of the grounding cluster to an effective ground.
- Touch each phase with the ground cluster to discharge any stored line potential.
- Connect the individual phases to the ground cluster.
- When removing the ground cluster, disconnect the phase conductors first and the ground connection last.

### **New Equipment Installation Requirements**

All new equipment shall be inspected for the following:

- Single phase equipment shall utilize a 3-wire hook-up for power connection.
- Three phase equipment shall utilize a 4 or 5-wire hook-up for power connection.

Hook-up cables shall match equipment connections. Hook-up cables with more conductors than termination points shall not be utilized.

It is an acceptable termination practice to have spare signal and sensor wires simply straight cut and taped, as long as they are inside the electrical cabinet enclosure. Wires should be labeled as spares.

### **Spare power wires or wires that could be used for power**

Terminate power wires to a dummy terminal strip/block inside the electrical cabinet enclosure. Spare power wires terminated on a non-dummy terminal strip/block should have a suitable closed plug on the opposite cable end.

Shall be labeled as spare conductor with information on the conductors source locations.

### **Panel device**

All panel devices shall be labeled or have the label close to the device on the panel or strip.

### **Procedures for Diagnostic Testing of Energized Equipment**

Electrical Maintenance Lockout/Tagout Requirements

Prior to beginning work on electrical equipment, every effort shall be made to de-energize the equipment and other electrical equipment in the area that might affect the work. In order to accomplish this task, the UT lockout/tagout procedures shall be strictly followed (**Appendix A**).

Follow all safe work practices when working near energized or potentially energized electrical parts:

- Only trained and qualified employees may perform work on electrical equipment.
- Only qualified employees may enter energized electrical substations and motor control centers. Unqualified employees are not approved.
- Never assume that electrical insulation is intact; take the necessary precautions prior to contacting insulated conductors
- Appropriate PPE shall be worn, when working on energized electrical equipment.
- Do not wear jewelry.
- Secure metal framed eyeglasses with a safety cord made for that purpose.
- Never reach blindly into electrical cabinets or enclosed areas.
- Make sure work areas are well lighted.
- Secure electrical cabinet doors to prevent them from closing.
- Keep the work area clear of non-essential tools and equipment,
- Handle conductive objects carefully when in the area of electrical equipment.
- Identify all sources of electricity and take the appropriate safety measures before proceeding with the work.

## **Approach Boundaries to Live Parts**

Observing a safe approach distance from exposed energized parts is an effective means of maintaining electrical safety. As the distance between an individual and the live parts increase, the potential for an electrical injury decreases.

### *Shock Hazard Analysis*

A shock hazard analysis shall be conducted to determine the voltage to which employees will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electric shock to employees.

### *Shock Protection Boundaries*

Limited, Restricted, and Prohibited Approach Boundaries are applicable to the situation in which approaching employees are exposed to live parts. Safe approach distances to live parts can be determined by referring to **Appendix C**, "Approach Boundaries to Live Parts for Shock Protection".

### *Approach to Exposed Live Parts Operating at 50 Volts or More*

Qualified persons shall not approach or take any conductive object closer to exposed live parts operating at 50 volts or more than the Restricted Approach Boundary set forth in **Appendix C** unless on the following conditions apply;

- The qualified person is insulated or guarded from the live parts, and no uninsulated part of the qualified person's body crosses the Prohibited Approach Boundary set forth in **Appendix C**.
- The live part operating at 50 volts or more is insulated from the qualified person and from any other conductive object at a different potential.

### *Approach by Unqualified Persons*

An unqualified person shall not be permitted to enter spaces that are to be accessible to qualified employees only, unless the electric conductors and equipment involved are in an electrically safe work condition.

### *Entering the Limited Approach Boundary*

Where there is a need for unqualified person(s) to cross the Limited Approach Boundary, a qualified person shall advise the unqualified person of the possible hazards and continuously escort the unqualified person(s) while inside the Limited Approach Boundary.

***Under no circumstances shall the escorted unqualified person(s) be permitted to cross the Restricted Approach Boundary.***

### *Entering Prohibited Approach Boundary*

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:

- The qualified person has specific training to work on energized parts;
- The qualified person has obtained an approved Energized Electrical Work Permit; and
- The qualified person uses personal protective equipment (PPE) appropriate for working on energized parts which are rated for the voltage and energy level involved.

## **Flash Hazard Analysis**

A flash hazard analysis shall be done in order to protect employees from the possibility of being injured by an arch flash. This analysis shall determine the Flash Protection Boundary and the personal protective equipment that employees within the Flash Protection Boundary shall use. UT is in the process of completing the flash hazard analysis. NFPA table 130.7 C (15) (a) and (b) will be used to determine PPE when the analysis is unavailable.

### *Flash Protection Boundaries*

The flash boundaries are listed in NFPA table 130.7 C (15) (a) and (b).

## **Other Precautions for Personnel Activities**

### *Alertness*

Employees shall be instructed to be alert at all times when they are working near live parts operating at 50 volts or more in work situations where unexpected electrical hazards might exist.

Employees shall not knowingly be permitted to work in areas containing live parts operating at 50 volts or more or other electrical hazards while their alertness is recognizably impaired due to illness, fatigue, or other reasons.

Employees shall not be instructed to reach blindly into areas that might contain exposed live parts where an electrical hazard exists.

### *Illumination*

Employees shall not enter spaces containing live parts unless illumination is provided that allows work to be performed safely.

### *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 live parts.

### *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 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.

### *Confined or Enclosed Work Spaces*

When an employee works in a confined space or enclosed space (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.

### *Portable Ladders*

Portable ladders shall have nonconductive siderails if they are used where the employee or the ladder could contact exposed energized parts.

### *Housekeeping*

Where live parts present an electrical contact hazard, employees may not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.

### *Interlocks*

Only a qualified person may defeat an electrical safety interlock, and then only temporarily while he or she is working on the equipment. The interlock system shall be returned to its operable condition when this work is completed.

## **Equipment Procedures**

The following procedures shall be followed regarding equipment procedures:

- Test equipment that has been exposed to excessive moisture shall be immediately removed from service and may not be returned to service until repairs and tests are performed to assure its safe operation.
- All electrical test equipment shall be stored in a clean, dry location, kept clean and in good operating condition.
- Voltmeters shall be daily if in use by a designated Competent Person. The inspection results are to be documented and kept on file. Any equipment that is, or is suspected to be defective shall be tagged and removed from service until proper repairs are made and tests verify that the equipment is accurate and safe to use.

- Electrical test equipment that is rated for use on 2300 volts or higher shall be electrically tested and calibrated by an approved testing facility at intervals not to exceed twelve months. If the integrity of such equipment is suspect, it shall be taken out of service until it is tested at an approved testing facility and deemed accurate and safe for use. Records of all tests and repairs are to be maintained on file.
- Voltage tester leads shall be kept in a separate dedicated pouch to prevent damage by other objects.

#### *Inspection and Storage*

##### Inspection of Electrical Testing Equipment

- Test equipment shall be evaluated for proper operation immediately before and after the test.
- Test instruments, equipment and all associated leads, cables, power cords, probes, connectors, etc. shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that could expose someone to injury, the defective or damaged item shall be removed from service. It shall not be used again until repairs and tests to assure the equipment is safe to use have been made.
- Voltmeters shall be inspected monthly by a designated Competent Person. The inspection results are to be documented and kept on file. Any equipment that is, or is suspected to be defective shall be tagged out and removed from service until proper repairs are made and tests verify that the equipment is accurate and safe to use.

##### Electric Tools and Visual Inspection

- Single phase electric hand tools and other single phased portable electrical equipment (small appliances) shall bear the original mark of or be approved by a nationally recognized testing laboratory such as (United Laboratories Inc.)
- All exposed non-current carrying metal parts shall be grounded or double insulated.
- Before each use, portable electric tools and equipment shall be visually examined for deficiencies in the appliance and cord. Verify the following:
  - No breaks, damage, or cracks that would expose live parts
  - No missing cover plates
  - No missing or damaged pins or blades on the plug
  - No stray electrical wire strands show
  - If applicable, you plug the wider blade into the correct side of the receptacle
- When visual deficiencies are noted:
  - The appliance or tool shall not be used
  - The appliance or tool shall be tagged as “DANGER – DO NOT USE”
  - Plant supervision shall be notified

#### **Portable Electric Equipment (Cord and Plug Connected Equipment)**

##### *Handling*

Portable equipment shall be handled in a manner which will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment. Flexible cords may not be fastened with staples or otherwise hung in such a fashion as could damage the outer jacket or insulation.

##### *Visual Inspection*

Portable cord and plug connected equipment and flexible cord sets (extension cords) shall be visually inspected before use on any shift for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket). Cord and plug connected equipment and flexible cord sets (extension cords) which remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated.

If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.



When an attachment plug is to be connected to a receptacle (including an on a cord set), the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of proper mating configurations.

#### *Grounding Type Equipment*

A flexible cord used with grounding type equipment shall contain an equipment grounding conductor.

Attachment plugs and receptacles may not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. Additionally, these devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current-carrying conductors.

Adapters which interrupt the continuity of the equipment grounding connection may not be used.

#### *Conductive Work Locations*

Portable electric equipment and flexible cords 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.

#### *Connecting Attachment Plugs*

Employees' hands may not be wet when plugging and unplugging flexible cords and cord and plug connected equipment, if energized equipment is involved.

Energized plug and receptacle connections may be handled only with insulating protective equipment if the condition of the connection could provide a conducting path to the employee's hand (if, for example, a cord connector is wet from being immersed in water).

Locking type connectors shall be properly secured after connection.

#### *Electric Power and Lighting Circuits*

##### *Routine Opening and Closing of Circuits*

Load rated switches, circuit breakers, or other devices specifically designed as disconnecting means shall be used for the opening, reversing, or closing of circuits under load conditions. Cable connectors not of the load break type, fuses, terminal lugs, and cable splice connections may not be used for such purposes, except in an emergency.

##### *Reclosing Circuits After Protective Device Operation*

After a circuit is de-energized by a circuit protective device, the circuit may not be manually reenergized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses is prohibited.

Note: When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is reenergized.

##### *Overcurrent Protection Modification*

Overcurrent protection of circuits and conductors may not be modified, even on a temporary basis, beyond that allowed by 1910.304(e), the installation safety requirements for overcurrent protection.

##### *Test Instruments and Equipment*

Only qualified persons may perform testing work on electric circuits or equipment.

##### *Visual Inspection*

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 the equipment is used. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

##### *Rating of Equipment*

Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.

### *Occasional Use of Flammable or Ignitable Materials*

Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be used, unless measures are taken to prevent hazardous conditions from developing. Such materials include, but are not limited to: flammable gases, vapors, or liquids; combustible dust; and ignitable fibers or flyings.

### **Personal Protective Equipment**

Employees working in areas within the flash protection boundary shall be provided with, and shall use, personal protective equipment and AR clothing that is appropriate for the specific parts of the body to be protected and for the work to be performed.

NOTE: Personal protective equipment requirements will be located on the arc flash hazard warning label on the equipment.

- Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested, as required by 29 CFR 1910.137.
- If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected. (For example, an outer covering of leather is sometimes used for the protection of rubber insulating material.)
- Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to arc flash hazards.
- Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.
- Employees shall wear hearing protection whenever working within the arc flash boundary.
- Heavy duty leather protectors shall be worn where required for arc flash protection.

When working near equipment labeled with an arc flash hazard, each employee shall use insulated tools or handling equipment if the tools or handling equipment might be used within the arc flash protection boundary. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.

Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install fuses when the fuse terminals are energized.

Ropes and handlines used near or within the flash protection boundary shall be nonconductive.

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

### *Labels*

Labels will be placed on all electrical equipment with an arc flash hazard.

The label will be placed in a conspicuous location that will be seen by any individual, and will contain:

- At least one of the following:
  - Available incident energy and the corresponding working distance
  - Minimum arc rating of clothing
  - Required level of PPE
  - Highest Arc Flash PPE Category for the equipment
- Nominal system voltage
- Arc Flash boundary

Note: Labels prior to September 30, 2011 are acceptable if they contain the available incident energy or required level of PPE.

Employees working in areas where there are potential electrical hazards shall be provided with and use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

Protective equipment shall be maintained in a safe, reliable condition and shall be visually inspected before each use.

#### *Personal Protective Equipment for Live Electrical Work*

- Hand wrist, and arm jewelry is expressly forbidden within the energized electrical work boundary.
- Polyester, nylon, rayon, silk, or other flammable materials shall not be worn within the energized electrical work boundary.
- Electrically insulated gloves shall be field tested daily and tested by an approved lab every six months.
- All personal protective equipment, including insulated tools shall be carefully inspected before each use. The PPE shall be free of holes, tears, grease, dirt, and other contamination.
- Electrical PPE shall only be used for the purpose for which it is designed, insulated rubber gloves are to be used only for electrical work.
- When panels at or below 240V are fed from transformers smaller than 125 kVA, no arc flash clothing is necessary (no arc flash risk).
- When testing or trouble shooting electrical systems over 50V and below 240V, Class 2 PPE is the required minimum (If a detailed Arc Flash analysis has not been performed). Approved proper voltage rated insulated gloves are required if the individual will be within the restricted exposed electrical boundary.
- After a panel has been verified to be de-energized and has been locked out according to electrical lockout tagout procedures the required PPE may be removed. Insulated gloves are not required following the verification procedure.

#### *Inspection of Protective Equipment*

All personal protective equipment required by this Program, including gloves, mats, boots, clothing, faceshields, hoods, etc. shall be inspected and maintained in compliance with this Program and the manufacturer's guidelines. Any defective personal protective equipment shall be immediately removed from service and properly repaired or replaced.

All inspections, repairs and tests done on protective equipment shall be documented by the Competent Person or approved outside testing facility performing the inspection, repair and/or test. All such documentation is to be maintained by the Safety Director and available for review.

#### **Use of Protective Equipment During Testing**

When using a voltage meter to check any energized or potentially energized source that is above 50 volts and when troubleshooting any energized or potentially energized source that is above 50 volts, the following protective equipment, as applicable to the Arc Flash Hazard Risk Assessment and equipment Arc Flash Label shall be worn:

- Approved and tested high voltage rubber gloves of the proper voltage rating, with leather protectors.
- Approved PPE clothing based on a Hazard Risk Assessment
- Approved face shield/hood or equivalent.
- Approved balaclava
- Dielectric switchboard matting or dielectric boots of the proper rating.
- Ear Plugs.

#### **Selection of Personal Protective Equipment**

Employees working within the Flash Protection Boundary shall wear protective clothing and other personal protective equipment identified by the flash hazard analysis and the incident energy exposure of the employee. The specific protection to be worn within the Flash Protection Boundary can be determined by one of the following two methods:

- Complete a detailed flash hazard analysis under Electrical Engineering supervision that determines the incident exposure energy of each employee. Appropriate protective clothing can then be selected based on the calculated exposure level; or
- Determine the hazard level of the task by referring to NFPA 70E Table 130.7(C)(15)(a) and (b), "Arc Flash PPE Categories for Alternating Current (ac) and Direct Current (dc) systems".

### **Apparel and Underlayers/Arc Rated (AR) Clothing**

(AR) clothing shall consist of materials, such as flame-retardant treated cotton, meta-aramid, para-aramid, and poly-benzimidazole (PBI) fibers. These materials can ignite but will not continue to burn after the ignition source is removed.

(AR) clothing made from flammable synthetic materials that melt at temperatures below 315 degrees celcius such as acetate, nylon, polyester, polypropylene, and spandex, either alone or in blends, shall NOT be used. Clothing made from non-melting flammable natural materials, such as cotton, wool, rayon, or silk may be used as underlayers beneath (AR) apparel. (AR) clothing without an arc rating has not been tested for exposure for an electrical arc.

(AR) apparel is used to describe a fabric made up of a flammable fabric treated in such a way that will provide arc flash protection. (AR) clothing or equipment has been tested to an exposure for an electrical arc.

Follow all manufacturers' instructions for care and maintenance of apparel shall be followed. Apparel shall be visually inspected before each use. Apparel that is contaminated or damaged shall not be used.

### **Insulated Tools and Equipment**

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 or fuse holder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.

Ropes and handlines used near exposed live parts operating at 50 volts or more or where an electrical hazard exists, shall be nonconductive.

Portable ladders shall have nonconductive side rails and shall meet the requirements of ANSI standards for ladders.

### **Rubber Insulating Equipment**

Rubber insulating equipment includes protective devices such as gloves, sleeves, blankets, and matting.

All electrical protective equipment shall be subjected to periodic electrical tests conducted in accordance with appropriate voltages identified by ASTM standards to reliably indicate whether the insulating equipment can withstand the voltage involved. Insulating equipment failing to pass inspections or electrical tests shall NOT be used by employees.

Rubber insulating equipment test intervals shall occur as follows:

- Rubber insulating line hoses shall be tested upon indication that the insulating valve is suspect;
- Rubber insulating covers shall be tested upon indication that the insulating valve is suspect;
- Rubber insulating blankets shall be tested before first issue and every twelve months thereafter;
- Rubber insulating gloves shall be tested before first issue and every six months thereafter; and
- Rubber insulating sleeves shall be tested before first issue and every twelve months thereafter.

*Note:* If the insulating equipment has been electrically tested but not issued for service, it shall not be placed into service unless it has been electrically tested within the previous twelve months.

All departments using rubber insulating equipment shall make the appropriate arrangements for testing of such equipment.

Gloves shall be electrically tested by an approved outside testing facility at intervals not to exceed six months. The type, size, class, and latest test date shall be clearly marked on each glove. Any glove that fails the electrical test shall be immediately removed from service.

Gloves shall be stored in a manner to prevent physical damage. Do not store them folded, creased, or compressed. The storage location should be free from chemicals, solvents, sunlight, heat, moisture, ozone, or any objects that could cause damage.

Gloves shall be inspected by the wearer for defects before each use and at any time if there is cause to suspect damage. They shall be inspected over the entire surface and be gently rolled between the hands to expose any defects. If any of the following defects are found, the gloves shall be repaired and retested before they are put back into service:

Holes, tears, punctures, or cuts

- Ozone cutting or checking
- Imbedded foreign objects
- Texture changes such as softening, hardening, becoming sticky or inelastic

Gloves shall be given an air test before each use and any time there is reason to suspect damage. The test is performed by rolling the cuff tightly toward the palm in such a manner that air is trapped inside the glove. Once this is accomplished, look, listen, and feel for air leaks throughout the glove. If no leaks are detected, the glove may be used. No part of the glove is to be stretched more than 1.25 times its normal size. This test can also be performed using a commercial glove pump designed for the function.

Gloves shall be worn with leather protector gloves to prevent damage. If the protectors have been used for any other purpose, they cannot be used to protect insulating gloves. Protectors with holes, tears, cuts, chemical or oil contamination, holes, or any other defects that diminish their capacity to provide protection shall not be used.

Gloves shall be free of any marking, labels or adhesive tape other than those applied by the manufacturer or testing facility.

Gloves shall be cleaned of any grease, perspiration, etc. after each use. Use only a mild, non-bleaching soap, and rinse with clean water.

#### *Rubber Insulating Blankets*

Rubber insulating blankets shall be electrically tested by an approved outside testing facility at intervals not to exceed twelve months. Defective or suspect defective blankets cannot be used until they have been tested and approved.

Rubber insulating blankets shall be visually inspected by the user before each use and at any other time if there is cause to suspect any defect or damage. They shall be inspected on both sides over the entire blanket surface for defects and embedded materials. Blankets with any of the following defects shall be returned to an approved electrical testing facility for inspection and retesting:

- Holes, tears, punctures, or cuts
- Severe corona cutting or ozone checking
- Imbedded foreign objects
- Texture changes such as softening, hardening, becoming sticky or inelastic

Rubber insulating blankets shall be cleaned as necessary to remove foreign substances or chemicals. They shall be cleaned with a mild, non-bleaching detergent and water and then be rinsed thoroughly with clear water to remove all of the detergent. If washed, the blanket shall be air dried. The cleaning agent used shall not degrade the insulating or physical properties of the blanket.

Rubber insulating blankets shall be stored in a cool, dark, dry location that is free of chemicals, solvents, ozone, vapors, fumes, electrical discharges and sunlight. They shall be stored in a container, bag, box, or compartment designed for and used exclusively for this purpose. They shall not be stored folded, creased or compressed in any manner that could cause stretching compression, or abrasion.

Rubber insulating blankets shall be free from any adhesives, tape, labels, or other markings, other than those placed by the manufacturer or testing facility. Tape cannot be used to secure blankets for shipment or storage.

Rubber insulating blankets shall be visually inspected in the field by a designated Competent Person to determine that such equipment is being maintained in a satisfactory condition by the users. This field inspection shall be done at intervals not to exceed every six months.

Rubber insulating blankets shall be of the proper class, type, and voltage rating for the task being performed. Rubber insulating blankets are to be repaired only by an approved facility. Blankets shall be retested after any repair.

Any rubber insulating blanket not suitable for electrical service shall be destroyed.

Source: Safety & Health Committee

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11/29/10  
12/29/11  
12/29/14  
12/18/17  
12/15/21  
9/30/22

## ENERGY CONTROL PROCEDURE

The following procedure will establish the guidelines to be followed by any personnel working on electrical/mechanical equipment or systems.

1. Prior to securing any equipment or system, notify Central Control (on Health Science Campus only). The Central Control operator will make a log entry noting who is working on what equipments. If there is automation of this equipment, the Central Control operator will place the equipment or system in an appropriate non-operating condition.
2. Notify all affected employees that a lockout/tag out system is going to be utilized on the equipment and the reason why it will be locked out.
3. Survey and identify energy sources and their associated hazards, obtain lockout equipment and review the equipment specific lockout/tag out procedures if needed. Any concerns should be directed to the immediate supervisor.
4. The equipment or system will be physically checked to ensure that it has been placed in an appropriate non-operating condition. All electrical/mechanical devices or sources of power will be placed in the appropriate non-operating position, and all sources of potential energy secured.
  - a. Workers should consider if energy from the environment can cause equipment to move or rotate (eg airflow in an air handler) without the equipment being energized. In those instances, the equipment should be mechanically prevented from moving during the repairs.
  - b. If a worker needs to introduce mechanical energy into a system which is safely shutdown and locked out (eg hand-spinning a fan and motor) the worker should use tools to grip and spin the equipment, as opposed to using hands which could become entangled in the equipment.
5. Lockout and tag out the energy isolating sources with assigned locks and tags. This usually requires locking out the electrical disconnects. Use valve covers, plug locks, etc., on equipment that cannot be locked out directly. Tag out alone is not acceptable at any time unless the equipment is not capable of being locked out. The tag has to be located in the same place the lockout device would have been attached. Also, added measures need to be taken to ensure the level of safety is equal to that obtained by using a lock.
6. A lockout tag will be placed on each electrical/mechanical device. This lockout tag will indicate the name of the person responsible for securing the equipment or system, the reason for the lockout/tag out, the time and the date.
7. Once locked/tagged out, be sure to dissipate any stored energy (hydraulic systems, air, springs, water pressure or steam).
8. After ensuring that no other personnel are exposed, attempt to turn on the equipment using the push button, toggle switch, etc., to confirm that the lockout was effective. After it is determined that lockout was effective, return equipment to the off position.
9. Equipment is now locked out and ready to be serviced.

### RESTORING EQUIPMENT TO USE

1. When the equipment is ready to be restored to service, all lockout tags and locking means will be removed by the person who placed them on the equipment/system. The machine or equipment that had been isolated shall be inspected to ensure that nonessential items have been removed and to ensure that the machine or equipment components are operationally intact prior to start up. This person will also ensure that all personnel involved in the work are clear of the equipment.
2. After all locks and tags have been removed, the electrical/mechanical device and/or source of power can be placed in an appropriate operating condition/re-energized.
3. Central Control will then be notified that the equipment/system is ready to be restored to service. The Central Control operator will place the equipment or system in service or into the appropriate condition that is required. The Central Control operator will make a log entry indicating that the equipment or system has been restored to service.

**Job Briefing and Planning Checklist**  
**Task A: De-energizing Electrical Equipment**

Work location	_____
Requested work date and time	_____
Department or person requesting work	_____
Qualified person/persons doing the work	_____

Description of work:
----------------------

	Yes	No
Are there any unusual work conditions? If yes describe:	<input type="checkbox"/>	<input type="checkbox"/>
Is an Energized Electrical Work Permit required?	<input type="checkbox"/>	<input type="checkbox"/>
Is emergency equipment available, fire extinguisher, phone, etc?	<input type="checkbox"/>	<input type="checkbox"/>
Is a Safety retrieval standby person required?	<input type="checkbox"/>	<input type="checkbox"/>

<u>You will be required to perform the following task steps. Please read and check off items.</u>	
1. Determine all power sources and nominal voltages, delivered to the electrical equipment.	<input type="checkbox"/>
2. Power down any loads fed from the electrical equipment.	<input type="checkbox"/>
3. Open all disconnect switches/circuit breakers that feed the electrical equipment.	<input type="checkbox"/>
4. Lockout/tagout all feed sources to the electrical equipment.	<input type="checkbox"/>
5. Locate and reference the tables for the proper Arc Flash Boundary, Voltage, and PPE.	<input type="checkbox"/>
6. Establish the Arc Flash Boundary around the electrical equipment.	<input type="checkbox"/>
7. Use an approved voltage rated Cat III voltmeter, inspect the meter leads and probe covers for any damage.	<input type="checkbox"/>
8. <u>Live Test</u> : Verify the voltmeter function with a known energized voltage source; 120V outlet.	<input type="checkbox"/>
9. Inspect all PPE and insulated tools.	<input type="checkbox"/>
10. Wear the appropriate PPE.	<input type="checkbox"/>
11. Open the electrical equipment door or remove covers of the equipment being evaluated.	<input type="checkbox"/>
12. Where induced voltages or stored energy exist, apply grounding device per company procedures.	<input type="checkbox"/>
13. <u>Dead Test</u> : Measure for any voltages present in the equipment.	<input type="checkbox"/>
14. If no voltage was detected, continue to the next step, if voltage detected, repeat procedures 2-5.	<input type="checkbox"/>
15. <u>List Test</u> : Repeat	<input type="checkbox"/>
16. After "no voltage present" is verified the PPE can be removed and work can be performed.	<input type="checkbox"/>
17. After work has been performed, close the electrical enclosure on equipment being evaluated.	<input type="checkbox"/>
18. Remove the established Arc Flash Boundary notification material.	<input type="checkbox"/>

\*Return completed permit to Environmental Health and Radiation Safety.



**Job Briefing and Planning Checklist**  
**Task B: Equipment, Diagnostic Testing & Programming**

Work location	_____
Requested work date and time	_____
Department or person requesting work	_____
Qualified person/persons doing the work	_____

<u>Description of work:</u>		
	Yes	No
Are there any unusual work conditions? If yes describe:	<input type="checkbox"/>	<input type="checkbox"/>
Is an Energized Electrical Work Permit required?	<input type="checkbox"/>	<input type="checkbox"/>
Is emergency equipment available, fire extinguisher, phone, etc?	<input type="checkbox"/>	<input type="checkbox"/>
Is a Safety retrieval standby person required?	<input type="checkbox"/>	<input type="checkbox"/>

<u>You will be required to perform the following task steps. Please read and check off items.</u>	
1. Determine all power sources and nominal voltages, delivered to the electrical equipment.	<input type="checkbox"/>
2. Locate and reference the tables for the proper Arc Flash Boundary, Voltage, and PPE.	<input type="checkbox"/>
3. Establish the Arc Flash Boundary around the electrical equipment per the company's procedures.	<input type="checkbox"/>
4. Locate an approved Cat III voltmeter, rated for the appropriate voltage level, inspect meter leads and probe covers for any damage.	<input type="checkbox"/>
5. <u>Live Test</u> : Verify the voltmeter function with a known energized voltage source; 120V outlet.	<input type="checkbox"/>
6. Inspect all PPE and insulated tools.	<input type="checkbox"/>
7. Wear the appropriate PPE.	<input type="checkbox"/>
8. Open the electrical equipment door or remove covers of the equipment being evaluated.	<input type="checkbox"/>
9. <u>Energized Work</u> : Perform the Diagnostic Testing or Programming for the required task in the equipment.	<input type="checkbox"/>
10. After Testing or Programming has been performed, shut the electrical equipment being evaluated.	<input type="checkbox"/>
11. Remove the established Arc Flash Boundary notification material	<input type="checkbox"/>
12. Remove required PPE.	<input type="checkbox"/>

\*Return completed permit to Environmental Health and Radiation Safety.

**Job Briefing and Planning Checklist**  
**Task C: Energized Electrical Equipment (Repair)**

Work location	_____
Requested work date and time	_____
Department or person requesting work	_____
Qualified person/persons doing the work	_____

<u>Description of work:</u>		
Are there any unusual work conditions? If yes describe:	Yes	No
	<input type="checkbox"/>	<input type="checkbox"/>
Is an Energized Electrical Work Permit required?	<input type="checkbox"/>	<input type="checkbox"/>
Is emergency equipment available, fire extinguisher, phone, etc?	<input type="checkbox"/>	<input type="checkbox"/>
Is a Safety retrieval standby person required?	<input type="checkbox"/>	<input type="checkbox"/>

<u>You will be required to perform the following task steps. Please read and check off items.</u>	
1. Determine if this work can be done de-energized. If yes refer to Task A; if no, continue.	<input type="checkbox"/>
2. Fill out and have signed an Energized Electrical Work Permit.	<input type="checkbox"/>
3. Locate and reference the tables for the proper Arc Flash Boundary, Voltage, and PPE.	<input type="checkbox"/>
4. Establish the Arc Flash Boundary around the electrical equipment.	<input type="checkbox"/>
5. Locate an approved Cat III voltmeter rated for the appropriate voltage level, inspect meter leads and probe covers for any damage.	<input type="checkbox"/>
6. <u>Live Test</u> : Verify the voltmeter function with a known energized voltage source; 120V outlet.	<input type="checkbox"/>
7. Have available, properly voltage rated insulated tools	<input type="checkbox"/>
8. Inspect all PPE and insulated tools.	<input type="checkbox"/>
9. Wear the appropriate PPE.	<input type="checkbox"/>
10. Have Qualified stand-by person with insulated retrieval device available during work.	<input type="checkbox"/>
11. Open the electrical equipment door or remove covers of the equipment being repaired.	<input type="checkbox"/>
12. <u>Energized Work</u> : Perform equipment repair or installation for the required task in the equipment..	<input type="checkbox"/>
13. After the repair has been performed, close the electrical equipment being repaired.	<input type="checkbox"/>
14. Remove the established Arc Flash Boundary notification material.	<input type="checkbox"/>
15. Remove required PPE.	<input type="checkbox"/>

\*Return completed permit to Environmental Health and Radiation Safety.

**Energized Electrical Work Permit (General)**

**Part I: (Completed by the person requesting permit)**

Job Site	_____	Work Order #	_____
Start Date	_____	Time/Duration	_____
Requested by	_____	Date	_____
Title	_____	Signature	_____

Description of circuit/equipment/job location:

Description of work to be done:

**Part II: (Completed by electrically qualified people doing the work)**

- |   | Check on completion      |
|---|--------------------------|
| 1. Detailed job description procedure to be used in performing the above described work. (Describe below or see attached sheet) | <input type="checkbox"/> |
| 2. Description of the safe work practices to be employed.   | <input type="checkbox"/> |
| 3. What is the Hazard Risk Classification (see tables and circle one)?  | 0 1 2 3 4                |
| 4. Determine required PPE based on Hazard Risk Classification (see tables).   | <input type="checkbox"/> |
| 5. Determination of the flash protection boundary (see tables).   | <input type="checkbox"/> |
| 6. Determination of shock protection boundaries (see approach boundary table).  | <input type="checkbox"/> |
| 7. Means employed to restrict the access of unqualified persons from the work area.   | <input type="checkbox"/> |
| 8. Completion of a job briefing, including discussion of any job-related hazards for non-routine work.                          | <input type="checkbox"/> |

Electrically Qualified Person(s) \_\_\_\_\_ Date \_\_\_\_\_

Electrically Qualified Person(s) \_\_\_\_\_ Date \_\_\_\_\_

**Part III: Approval to Perform Electrically Energized Work (Completed by Supervisor)**

- Reason(s) why the circuit/equipment cannot be de-energized or work deferred until next scheduled outage:
- I authorize the work described above to be done in an energized state.

Foreman/Supervisor: \_\_\_\_\_ Date \_\_\_\_\_

Signature: \_\_\_\_\_ Date \_\_\_\_\_

**Energized Electrical Work Permit**  
**(Ballast Replacement)**

**Part I: (Completed by the person requesting permit)**

Job Site	_____	Work Order #	_____
Start Date	_____	Time/Duration	_____
Requested by	_____	Date	_____
Title	_____	Signature	_____

Description of circuit/equipment/job location:

Description of work to be done:

**Part II: (Completed by electrically qualified people doing the work)**

- |  | Check on<br>completion   |
|--|--------------------------|
| 1. Obtain voltage rated ladder and voltage rated insulation wire strippers/cutters.  | <input type="checkbox"/> |
| 2. Obtain voltage rated gloves and safety glasses.                                   | <input type="checkbox"/> |
| 3. Determine means to restrict the access of unqualified persons from the work area. | <input type="checkbox"/> |

Electrically Qualified Person(s) \_\_\_\_\_ Date \_\_\_\_\_

Electrically Qualified Person(s) \_\_\_\_\_ Date \_\_\_\_\_

**Part III: Approval to Perform Electrically Energized Work (Completed by Supervisor)**

- Reason(s) why the circuit/equipment cannot be de-energized or work deferred until next scheduled outage:
- I authorize the work described above to be done in an energized state.

Foreman/Supervisor: \_\_\_\_\_ Date \_\_\_\_\_

Signature: \_\_\_\_\_ Date \_\_\_\_\_

\*Return completed permit to Environmental Health and Radiation Safety.

## APPROACH BOUNDARIES TO LIVE PARTS FOR SHOCK PROTECTION

### APPROACH BOUNDARIES TO LIVE PARTS FOR SHOCK PROTECTION (Alternating Current Systems)

Nominal System Voltage (Phase to Phase)	Limited Approach Boundary <i>Exposed Movable Conductor</i>	Limited Approach Boundary <i>Exposed Fixed Circuit Part</i>	Restricted approach	Prohibited Approach Boundary
Less than 50 volts	Not specified	Not specified	Not specified	Not specified
50 volts to 300 volts	10 feet	3 feet 6 inches	Avoid contact	Avoid contact
301 volts to 750 volts	10 feet	3 feet 6 inches	1 foot	1 inch
751 volts to 15 kilovolts	10 feet	5 feet	2 feet 2 inches	7 inches
15.1 kilovolts to 36 kilovolts	10 feet	6 feet	2 feet 7 inches	10 inches
36.1 kilovolts to 46 kilovolts	10 feet	8 feet	2 ft 9 inches	1 ft 5 inches
46.1 kilovolts to 72.5 kilovolts	10 feet	8 feet	3 ft 3 inches	2 ft 2 inches
72.6 kilovolts to 121 kilovolts	10 feet 8 inches	8 feet	3 ft 4 inches	2 ft 9 inches
138 kilovolts to 145 kilovolts	11 feet	10 feet	3 ft 10 inches	3 ft 4 inches

### APPROACH BOUNDARIES TO LIVE PARTS FOR SHOCK PROTECTION (Direct Current Systems)

Nominal System Voltage	Limited Approach Boundary <i>Exposed Movable Conductor</i>	Limited Approach Boundary <i>Exposed Fixed Circuit Part</i>	Restricted approach	Prohibited Approach Boundary
Less than 100 volts	Not specified	Not specified	Not specified	Not specified
100 volts to 300 volts	10 feet	3 feet 6 inches	Avoid Contact	Avoid Contact
301 volts to 1kilovolts	10 feet	3 feet 6 inches	1 foot	1 inch
1.1 kilovolts to 5 kilovolts	10 feet	5 feet	1 feet 5 inches	4 inches
5 kilovolts to 15 kilovolts	10 feet	5 feet	2 feet 2 inches	7 inches
15.1 kilovolts to 45 kilovolts	10 feet	8 feet	2 feet 9 inches	1 foot 5 inches
45.1 kilovolts to 75 kilovolts	10 feet	8 feet	3 feet 2 inches	2 feet 1 inch
75.1 kilovolts to 150 kilovolts	10 feet 8 inch	10 feet	4 feet	3 feet 2 inches

- **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.
- **Prohibited Approach Boundary:** Distance from an exposed live part within which work is considered the same as making contact with the live part. This boundary may only be crossed by a qualified person who has specific training to work on energized parts; has obtained an approved Energized Electrical Work Permit; and uses PPE appropriate for working on energized parts which are rated for the voltage and energy level involved. (Note: A permit is not required for work related to testing, troubleshooting, and voltage measuring).
- **Flash Protection Boundary (not listed in table):** Distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur. 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.

## UNIVERSITY OF TOLEDO LIGHTING BALLAST REPLACEMENT PROCEDURE

To change lighting ballast with the lighting circuit **de-energized**:

Procedure (per UT written procedures)

1. Receive ballast replacement work request.
2. Use voltage rated insulated ladder.
3. Wear safety glasses.
4. De-energize the local lighting circuit by performing the required LOTO procedure.
5. If lighting circuit breaker or lighting switching device cannot be determined, contact a UT electrician for assistance.
6. Open the lighting fixture to expose the ballast housing compartment.
7. Open the ballast housing compartment.
8. Determine the fixture circuit is deenergized with an approved voltage tester.
  - Test the voltage tester on a known voltage source (i.e. 120 outlet)—Live Test
  - Test the fixture line side conductors to determine the circuit is deenergized with the approved tester—Dead test
  - Retest the voltage tester on a known voltage source (i.e. 120 outlet)—Live Test

\*NOTE: The neutral may be hot when three wires are inside the fixture under the line side wire nut because it may feed somewhere else. All fixture could also have multiple circuits. Check all wiring to ensure it is de-energized.

9. Determine the correct ballast replacement voltage and starting type.
10. Acquire new ballast.
11. Review new ballast wiring diagram and compare it to the existing ballast conductor colors. (Be sure of all new connections combinations as required.)
12. Expose circuit conductors withing fixture (de-energized work).
13. Disconnect into (2) parts the PowerPlug luminaire device (½ orange; ½ white).
  - **(De-energized work)** Leave the fixture line side power conductor wrenut connection together in the fixture. The fixture line side power conductor could be (Black, Red, Blue 120V) (Brown, Orange or Yellow 277V) colored.
  - **(De-energized work)** With wire strippers cut the ballast solid line side, wire (Black) conductor. This cut will be between the existing wrenut connector and the ballast.
  - **(De-energized work)** With wire strippers, strip the ballast solid line side existing black conductor to expose the bare copper wire to the correct length and install the PowePlug luminaire device (Orange ½; Black Hole) on to the black solid conductor.
  - **(De-energized work)** Leave the fixture line side common conductor wrenut connection to the fixture together. The fixture common side conductor could be (White 120V) (Gray 277V)
  - **(De-energized work)** With wire strippers cut the ballast solid common line side, (White) conductor. This cut will be between the existing wrenut connector and the ballast.
  - **(De-energized work)** With wire strippers, strip the white conductor to expose the bare copper wire, to the correct length and install the PowerPlug luminaire device (Orange ½; Orange Hole) on to the conductor.

- Connect the ballast green ground wire (if supplied) to the fixture grounding screw.
  - Connect the existing lamp pin striped wires together the new ballast load conductors (with proper sized wire nut connectors) per the ballast wiring diagram instructions.
  - Connect the new line side ballast conductor (Black) into the (White ½ ; Black Hole) of the PowerPlug luminaire device.
  - Connect the new line side ballast conductor (White) into the (White ½ ; White Hole) of the PowerPlug luminaire device.
  - Connect the (2) ½ of the PowerPlug luminaire device together.
  - Reinstall the ballast housing compartment cover.
- 
- 14. Replace lamps as required.
  - 15. Close up the lighting fixture lamp cover.
  - 16. Energize the local lighting circuit by removing LOTO devices.
  - 17. Test the local lighting, by using the fixture switching or circuit to confirm the ballast and luminaire disconnect replacement has been successful.



## UNIVERSITY OF TOLEDO LIGHTING BALLAST REPLACEMENT PROCEDURE

To change lighting ballast with the lighting circuit **energized**:

Procedure (per UT written policies)

1. Receive ballast replacement work request.
2. Acquire and process energized electrical Hot Work Permit (Ballast Hot Work).
3. Use voltage rated insulated ladder.
4. Use voltage rated insulated wire strippers/cutters. Inspect tools for damage.
5. Use voltage rated gloves. Air test gloves.
6. Use approved safety glasses.
7. Inspect and wear all required PPE.
8. Open the lighting fixture to expose the ballast housing compartment.
9. Open the ballast housing compartment.
10. Determine the correct ballast replacement voltage and starting type.
11. Acquire new ballast.
12. Review new ballast wiring diagram and compare it to the existing ballast conductor colors. (Be sure of all new connections combinations as required.)
13. Expose live circuit conductors within fixture (120 or 277 volt)
14. Disconnect into (2) parts the PowerPlug luminaire device (½ orange; ½ white).
  - **(Energized work)** Leave the fixture line side power conductor wrenut connection to the fixture together. The fixture line side power conductor could be (Black, Red, Blue 120V) (Brown, Orange or Yellow 277V) colored.
  - **(Energized work)** With electrical insulated gloves, and insulated wire strippers, cut the ballast solid line side hot wire (Black) conductor. This cut will be between the existing wrenut connector and the ballast.
  - **(Energized work)** With electrical insulated gloves on, and insulated wire strippers, strip the remaining black conductor to expose the bare copper wire to the correct length and install the PowerPlug luminaire device (Orange ½; Black Hole) on to the black solid conductor. **(Do not allow any part of this energized uninsulated conductor to touch any part of the fixture at any time.)**
  - **(Energized work)** Leave the fixture line side common conductor wrenut connection to the fixture together. The fixture common side conductor could be (White 120V) (Gray 277V).
  - **(Energized work)** With electrical insulated gloves and wire strippers cut the ballast solid common line side, (White) conductor. This cut will be between the existing wrenut connector and the ballast.
  - **(Energized work)** With electrical insulated gloves, strip the white conductor to expose the bare copper wire, to the correct length and install the PowerPlug luminaire device (Orange ½; Orange Hole) on to the conductor. **(Do not allow the any part of this uninsulated conductor to touch any part of the fixture at any time.)**
  - Connect the ballast green ground wire (if supplied) to the fixture grounding screw.
  - (De-energized work) Cut and strip the existing lamp pin existing wires, to be reused. Remove the old ballast from the ballast compartment.
  - (De-energized work) Install the new ballast to the ballast housing compartment.

- (De-energized work) Connect the existing lamp pin striped wires together the new ballast load conductors (with proper sized wire nut connectors) per the ballast wiring diagram instructions.
  - (De-energized work) Connect the new line side ballast conductor (Black) into the (White ½ ; Black Hole) of the PowerPlug luminaire device.
  - (De-energized work) Connect the new line side ballast conductor (White) into the (White ½ ; White Hole) of the PowerPlug luminaire device.
  - (De-energized work) Connect the (2) ½ of the PowePlug luminaire device together (Ballast is now energized).
  - (De-energized work) Reinstall the ballast housing compartment cover.
15. Replace lamps as required.
16. Close up the lighting fixture lamp cover.
17. Observe new ballast and lamps are working.