UNIVERSITY OF NOTRE DAME

ELECTRICAL SAFETY

1.0 PURPOSE

This program has been established to ensure:

- The safety of employees who may work on or near electrical systems.
- That departments understand and comply with safety standards related to electrical work.
- That departments follow uniform practices during the completion of electrical work.

2.0 SCOPE

This program contains requirements pertaining to the safeguarding of employees against the hazards associated with electrical energy during activities involving work on electrical systems/equipment over 50 volts.

This program applies to all work performed by Notre Dame employees including electrical work on laboratory space infrastructure (panels, circuits, connecting to buses, etc.). It does not pertain to electrical work conducted by laboratory/research personnel for the purpose of research.

3.0 DEFINITIONS

Accessible (equipment) - Admitting close approach; not guarded by locked doors, elevation, or other effective methods.

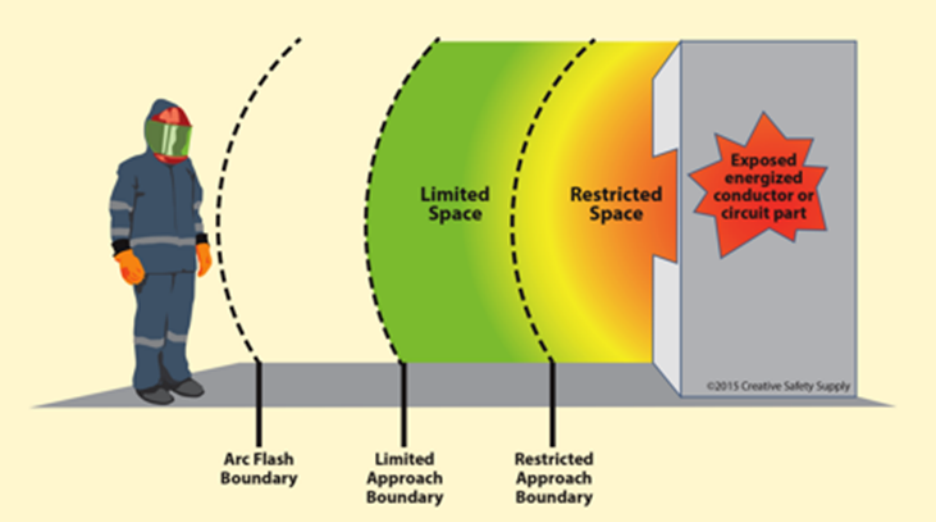
Approach Boundaries – A system of identifying critical distances from energized conductors or parts for the purpose of controlling exposure to electrical shock, flash, and blast hazards. Boundaries are in units of feet or meters from the point of the hazard (see Figure 1).

Arc Flash Boundary – When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm2.

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

Restricted Approach Boundary – An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased likelihood of electric shock, due to electrical arc-over combined with inadvertent movement.

Figure 1:



Arc Flash Hazard – A source of possible injury or damage to health associated with the release of energy caused by an electric arc.

Arc Flash Suit – A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet. (Such a suit may include pants or overalls, a jacket or a coverall, and a beekeeper-type hood fitted with a face shield).

Arc Rating – The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to break-open or at the onset of a second-degree skin burn. Arc rating is usually expressed in cal/cm^2.

Barricade – A physical obstruction such as tape, cones, or A-frame type wood or metal structures intended to provide a warning and to limit access.

Barrier – A physical obstruction that is intended to prevent contact with equipment or live parts or to prevent unauthorized access to a work area.

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

Electrical Hazard – A dangerous condition such that contact or equipment failure can result in electric shock, arc flash burn, thermal burn, or arc blast injury.

Electrically Safe Work Condition – A state in which the conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with University procedure, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

Energized – Electrically connected to, or is, a source of voltage.

Exposed (as applied to live parts) – Capable of being inadvertently touched or approached from closer than a safe distance by a person. It is applied to parts that are not suitably guarded, isolated, or insulated.

Exposed Unqualified Personnel – Personnel who in the performance of their job may be required to enter a room or area containing exposed energized conductors or components, who may approach exposed conductors or who are required to operate or use a machine or equipment on which electrical servicing or maintenance may be performed under one of the Safe Electrical Permit

Fault Current – The amount of current delivered at a point on the system during a short-circuit condition.

Fault Current, Available – The largest amount of current capable of being delivered at a point on the system during a short-circuit condition.

Grounded – Connected to earth or to some conducting body that serves in place of the earth.

Ground-Fault Circuit Interrupter (GFCI) – A device intended for the protection of personnel that functions to de-energize a circuit or portion of a circuit within an established period of time when a current to ground exceeds the values for a Class “A” device.

Incident Energy – The amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. Incident energy is typically expressed in calories per square centimeter (cal/cm^2).

Maintenance, Condition of – The state of the electrical equipment considering the manufacturers’ instructions, manufacturers’ recommendations, and applicable industry codes, standards, and recommended practices.

Nominal Voltage – A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class.

Overcurrent – Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

Overload – Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time it could cause damage or dangerous overheating.

Qualified Person – One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.

Risk Assessment – An overall process that identifies hazards, estimates the likelihood of occurrence of injury or damage to health, estimates the potential severity of injury or damage to health, and determines if protective measures are required.

Shock Hazard – A source of possible injury or damage to health associated with current through the body caused by contact or approach to energized electrical conductors or circuit parts.

Testing – A procedure or methodology for determining or evaluating a characteristic of some process, equipment, or person. For electrical equipment, this typically involves an evaluation of various forms or combinations of voltage, current, impedance, resistance, or capacitance.

Troubleshooting – A procedure or methodology for evaluating the condition of some process, equipment, or person with the intent of determining a deficiency and some means of corrective action to resolve that deficiency. For electrical equipment, this typically involves performing some type of testing of various forms or combinations of voltage, current, impedance, resistance, or capacitance.

Unqualified Person – A person who is not a qualified person. Personnel who face a risk of electrical shock which has not been reduced to a safe level (less than 50 volts) and has had applicable electrical safety awareness training per Section 16.2. Also includes employees who have had little or no training as far as recognizing and avoiding the hazards of working on, near, or with exposed electrical parts and are not designated by the facility as qualified.

Voltage Testing – A procedure for determining or evaluating the voltage potential between two electrical parts. This activity is typically performed with the use of a voltage meter.

Working Distance – The distance between a person's face and chest area and a prospective arc source.

Working near (live parts) – Any activity within a Limited Approach Boundary.

Working on (live parts) – Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the PPE a person is wearing. There are two categories of "working on": *Diagnostic* (testing) is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment; *repair* is any physical alteration of electrical equipment (such as making or tightening connections, removing or replacing components, etc.)

4.0 RESPONSIBILITIES

4.1 The Risk Management & Safety Department (RMS) shall:

- 4.1.1 Annually review, and, if necessary, revise the Electrical Safety Program.
- 4.1.2 Ensure training and retraining is made available to qualified and unqualified employees.
- 4.1.3 Act as a technical resource for this procedure.

4.2 Utilities Department shall:

- 4.2.1 Issue Live Electrical Work Permits and approvals.
- 4.2.2 Provide line wire diagrams.
- 4.2.3 Ensure all electrical panels, disconnects, etc. are marked with the circuit's function and voltage.
- 4.2.4 Maintain copies of all live electrical work permits for a minimum of the current plus one year.
- 4.2.5 Conduct and document pre-job meetings with contractors prior to any live work, excluding testing and troubleshooting, beginning. The meeting shall be conducted by the project manager, project coordinator, or electrical engineer (see Appendix I).

4.3 Departments shall:

- 4.3.1 Identify and maintain a list of qualified persons within their department.
- 4.3.2 Provide Qualified Employees appropriate personal protective equipment (PPE) (Section 7) and tools (Section 8) to perform their work safely at no cost. Departments are not responsible for providing non-Arc Rated under-layers to employees.
- 4.3.3 Ensure that PPE is appropriately tested and maintained.
- 4.3.4 Document the PPE requirements for electrical tasks using Appendix E (Electrical Tasks and PPE Requirements).

4.4 Supervisors shall:

4.4.1 Ensure employees comply with this program's provisions.
4.4.2 Develop Electrical Safe Work Practices / Work Instructions.
4.4.3 Conduct an annual documented evaluation of each qualified person to ensure adherence to the electrical safety procedures described in this document (see Appendix H).

4.5 Qualified Employees shall:
4.4.1 Use appropriate tools and equipment for the scope of work.
4.4.2 Follow Safe Work Practices / Work Instructions.
4.4.3 Recognize, understand, and communicate identified electrical hazards.
4.4.4 Care for, use, maintain, inspect, and store PPE as appropriate.
4.4.5 Attend training.
4.4.6 Report all identified problems or deficiencies associated with electrical equipment & wiring (such as tripped circuit breakers, blown fuses, damaged equipment, missing ground pins, damaged cords, etc.) to their supervisor immediately.

4.6 Unqualified Employees shall:
4.6.1 Attend general awareness training.
4.6.2 Stay away from live electrical equipment and approach boundaries.
4.6.3 Report all problems or deficiencies associated with electrical equipment & wiring (such as tripped circuit breakers, blown fuses, damaged equipment, missing ground pins, damaged cords, etc.) to their supervisor immediately.

4.7 Contractors shall:
4.7.1 Ensure their personnel are properly trained for the scope of work that they are to perform.
4.7.2 Know and understand the potential electrical hazards associated with their work.
4.7.3 Notify the Notre Dame project manager of changing work conditions that relate to potential electrical hazards.
4.7.4 Provide the appropriate level of PPE and insulated tools.

5.0 ESTABLISHING AN ELECTRICALLY SAFE WORK CONDITION

5.1 Employees who will be exposed to live parts shall de-energize these parts before working on or near these parts unless it can be demonstrated that de-energizing this equipment or circuit will create additional or increased hazards or is infeasible due to equipment design or operational limitations. The required method is to lock and tag out the appropriate equipment or circuit whenever possible (see Section 6.0 and the RMS Lock, Tag, and Try Zero Energy Procedure).

5.2 These safe work practices apply to work on exposed energized parts or close enough to them to potentially expose the employee to any electrical

hazard. Conductors and parts of the electrical equipment that have not been locked or tagged out shall be treated as energized parts and requirements related to working on energized systems shall apply. This shall be in accordance with Section 6.0 of this procedure.

5.3 Safe work practices for de-energizing electrical circuits and equipment shall be determined for each circuit or equipment before these devices are to be de-energized. For each piece of equipment or circuit, all electrical sources shall be identified and appropriate lockout/tagout procedures shall be developed in accordance with the RMS Lock, Tag, and Try Zero Energy Procedure. The following procedures are applicable for electrical hazards:

5.3.1 The equipment or circuit to be worked on shall be disconnected from all electrical energy sources. Control circuit devices such as push buttons, selector switches, and interlocks may not be used as the only means for de-energizing equipment or circuits. An adequately rated volt meter (See Section 13) shall be used to verify that all energy has been removed (See Section 5.4.6).

5.3.2 All stored electrical energy sources which may endanger personnel shall be released. Capacitors shall be discharged and high capacitance items shall be short circuited and grounded if an electrical hazard exists. If capacitors are handled during this process, they shall be treated as energized until they are confirmed as de-energized and grounded and/or shorted.

5.3.3 Stored non-electrical energy that might reenergize electrical circuit parts shall be blocked or relieved to eliminate the potential for this re-energization to occur.

5.3.4 Each disconnect used to de-energize circuits and equipment on which work is to be performed, shall be locked and tagged out by each authorized employee.

5.3.5 Equipment that is not able to accept a lock shall be modified according to manufacturer's specifications, replaced, or isolated using an upstream lockout point.

5.4 An electrically safe work condition shall be achieved and verified by the following process:

5.4.1 Establish a work zone.

5.4.1.1 Work zones are established to prevent unqualified persons from approaching energized parts that would otherwise have been protected by the installations. In addition, work zones provide protection for the person performing the electrical work, so that they are not accidentally bumped or pushed into energized parts.

5.4.1.2 A work zone shall be established whenever unqualified persons could be exposed to energized parts during zero energy verification, diagnostic work, maintenance,

construction and similar activities by appropriately barricading or otherwise identifying the work area.

5.4.1.3 The work zone shall provide a boundary for shock and flash protection in accordance with Tables 1 and 2 below (Note: All dimensions are distance from fixed live part to employee).

Table 1: Alternating Current (AC) Shock Protection Boundaries

Nominal System Voltage	Limited Approach Boundary	Restricted Approach Boundary
Less than 50 V	Not Specified	Not Specified
50 V to 150 V	3 feet, 6 inches	Avoid Contact
151 V to 750 V	3 feet, 6 inches	1 foot
751 V to 15 kV	5 feet	2 feet, 2 inches
Over 15 kV or a movable conductor (a condition in which the distance between the conductor and a person is not under the control of the person) See NFPA 70 E Table 130.4 (D)(a)		

Table 2: Direct Current (DC) Shock Protection Boundaries

Nominal Potential Difference	Limited Approach Boundary	Restricted Approach Boundary
Less than 50 V	Not specified	Not specified
50 V - 300 V	3 feet, 6 inches	Avoid Contact
301 V - 1 kV	3 feet, 6 inches	1 foot
Over 1 kV or a movable conductor (a condition in which the distance between the conductor and a person is not under the control of the person) See NFPA 70 E Table 130.4 (D)(b)		

5.4.1.4 Appropriate warning signs, barricades, or an attendant shall be established to restrict personnel from entering the arc flash protection boundary, and prevent accidental contact with exposed, energized parts.

5.4.2 Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

5.4.3 After properly interrupting the load current, open the disconnecting device(s) for each source. The following steps shall be followed when operating disconnect switches and circuit breakers:
- 5.4.3.1 Where possible, turn all loads OFF.
- 5.4.3.2 Stand to the left or right of the device, if possible, so there is minimum direct body exposure in the event of an electrical explosion.
- 5.4.3.3 The face should be turned to the right or left, away from the device.
- 5.4.3.4 Hold the breath and use a quick, unhesitating motion to open or close the device.

5.4.4 Where it is possible, visually verify that all the blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.

5.4.5 Apply lockout/tagout devices in accordance with the **RMS Lock, Tag, and Try Zero Energy Procedure**.

5.4.6 Verification of De-energized State: Before any electrical equipment can be worked as de-energized, a qualified employee shall operate the equipment operating controls or otherwise verify that the equipment cannot be reenergized. In addition, the qualified employee shall verify the electrically safe work condition through the following steps:
- 5.4.6.1 Use an adequately rated volt meter (See Section 13) to test each phase conductor or circuit part to verify that they are de-energized.
  - Phase-to-Phase
  - Phase-to-Ground
- 5.4.6.2 Appropriately rated rubber insulating gloves (at a minimum Class 0) and flash protection PPE shall be worn to perform this task until it is verified that the equipment is de-energized.
- 5.4.6.3 Determine if external auxiliary voltages may be present and verify that they are also de-energized
- 5.4.6.4 Determine that the volt meter is operating satisfactorily before and after the tests (See Section 13).

5.4.7 Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them.

5.4.8 Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground-connecting devices rated for the available fault duty.

5.4.9 When determining if there is a possibility of induced voltages on long feeders or branch circuits, confirm that there are no adjacent feeder or branch circuit conductors that could later be energized resulting in induced voltages.

5.5 The following procedure shall be followed before re-energizing electrical equipment or circuits:

5.5.1 A qualified individual shall conduct tests and visual inspections as necessary to ensure that the electrical equipment or circuit can be safely energized.

5.5.2 Remove all tools, spare parts, keys, wires, etc. from within the equipment or enclosure.

5.5.3 All protective grounds shall be removed. Grounding devices should first be removed from the equipment or circuit, then from the ground connection.

5.5.4 Tests should be conducted to check for ground-faults, short-circuits, damaged equipment, and similar conditions.

5.5.4.1 Simple installations and repairs, such as outlet installations, may only require a simple continuity test.

5.5.4.2 More complicated systems may have written procedures such as point-to-point continuity tests, hi-pot testing, and similar tasks.

5.5.5 Close and secure all equipment or enclosure(s).

5.5.6 Each lock and tag shall be removed by the employee who applied it unless the necessary provisions covered in the **RMS Lock, Tag, and Try Zero Energy Procedure** have been implemented.

5.5.7 Prior to re-energizing the equipment or circuit(s), all employees shall be removed from the area.

5.5.8 Equipment or devices shall be tested for proper operation and installation before being used with appropriate electrical voltage meters and/or equipment.

5.6 Restore area to its original condition.

6.0 WORKING ON OR NEAR ENERGIZED PARTS

6.1 Energized Electrical Work Permit:

6.1.1 If live parts are not placed in an electrically safe condition, work shall be considered energized electrical work.

6.1.2 All live electrical work, with the exception of testing and troubleshooting, shall be referred to the Utilities Department.

6.1.3 Live work shall be performed by written permit only (Appendix A). Examples of such work include:

6.1.3.1 Working within the restricted approach boundary.

6.1.3.2 Interacting with equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists.

6.1.3.3 Modifying electrical installations (e.g. removing face plates, connecting to bus heads, rewiring electrical boxes).

6.1.4 The permit shall be originated by the individual requesting that the energized work be completed.

6.1.5 The Assistant Vice President for Utilities & Maintenance, Assistant Director for Utilities & Maintenance, or the Vice President for Facilities Design and Operations shall approve the permit prior to commencing work.

6.1.6 The permit shall be present in the area where the energized work is taking place for the duration of the task.

6.1.7 At least two qualified employees shall be present for all energized work requiring a permit.

6.1.8 If both qualified employees are working on the circuit, an attendant is required to prevent any unqualified person from entering the limited approach boundary and to summon emergency response personnel if needed. The attendant can be an unqualified person as long as they remain outside the arc flash boundary.

6.1.9 A method of contacting emergency personnel shall be present on all live work job sites.

6.1.10 Energized electrical work permits shall be issued prior to the work and shall be good for a maximum of one shift.

6.1.11 Copies of all energized electrical work permits shall be retained by the Utilities Department for a minimum of the current plus one year and available for review.

6.2 Pre-Job Briefings:

6.2.1 Pre-job briefings associated with work requiring completion of an energized electrical work permit shall be conducted and documented on the Pre-Job Checklist for Live Electrical Work (Appendix B) or similar form. The briefing shall include, but not be limited to, the following topics:

6.2.1.1 Electrical hazards associated with the work tasks.

6.2.1.2 Procedures that shall be followed.

6.2.1.3 Special precautions required by working conditions.

6.2.1.4 Energy source controls.

6.2.1.5 Required PPE.

6.2.2 Additional job briefings shall be held if significant changes occur that might affect the safety of the employees such as:

6.2.2.1 The work is complicated or particularly hazardous or,

6.2.2.2 The employee cannot be expected to recognize and avoid the hazards involved in the job.

6.2.3 The Pre-Job Briefing shall allow the involved employees to provide feedback as appropriate.

6.3 Approach Boundaries to Live Parts:

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

6.3.2 Safe approach distances to fixed live parts can be determined by referring to NFPA 70E Tables 130.4(D)(a) and 130.4(D)(b). These tables can be used to identify the Limited and Restricted Approach Boundaries associated with various system voltages.

6.3.3 Unqualified persons may only cross the Limited Approach Boundary when they are under the direct supervision of a qualified person. **Note:** Arc-rated PPE is required for any employee crossing the arc flash boundary.

6.3.4 Qualified persons may not cross or take any conductive object closer than the Restricted Approach Boundary unless one of the following conditions applies:

6.3.4.1 The qualified person is insulated or guarded from energized electrical conductors or circuit parts operating at 50 volts or more.

6.3.4.2 The energized electrical conductors or circuit parts are insulated from the qualified person and from any other conductive object.

6.3.5 Crossing the Restricted Approach Boundary is considered the same as making contact with energized parts. Qualified persons may only cross this boundary to perform work on energized parts when all of the following precautions have been taken:

6.3.5.1 The qualified person has specific training to work on energized parts.

6.3.5.2 The qualified person has obtained an approved Energized Electrical Work Permit.

6.3.5.3 The qualified person uses PPE appropriate for working on energized parts.

6.3.6 Arc Flash Boundary

6.3.6.1 If the equipment has an NFPA 70E label attached, its stated arc flash boundary shall be used.

6.3.6.2 For unlabeled equipment/systems, individuals shall refer to NFPA 70E Table 130.7(C)(15)(a) and (b) (Appendix C). If the tables cannot be accessed, the arc flash boundary shall be a minimum of 14 feet. If the 14 foot boundary cannot be obtained due to the room size, the entire room shall be considered a restricted area.

6.4 Additional Precautions for Personnel Activities:

6.4.1 Employees shall ensure that the rated test instrument is operating properly through verifying on a known voltage.

6.4.2 Employees shall not reach blindly into areas that might contain exposed live parts.

6.4.3 Employees shall not enter spaces containing live parts unless illumination is provided that allows the work to be performed safely. Additional illumination may be needed when using arc rated face shields/hoods during electrical work.

6.4.4 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.

6.4.5 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.

6.4.6 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. Employees shall also adhere to the requirements of the University's Confined Space Entry Procedure.

6.4.7 A permit is not required if the qualified person is provided with and uses appropriate safe work practices and PPE under the following conditions:

6.4.7.1 Testing, troubleshooting, or voltage measuring.

6.4.7.2 Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed.

6.4.7.3 Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed.

6.4.7.4 General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed.

7.0 PERSONAL PROTECTIVE EQUIPMENT

7.1 General Requirements

7.1.1 Employees working in areas where electrical hazards are present shall use appropriate protective equipment.

7.1.2 Employees shall wear hand and arm protection as follows:

7.1.2.1 Rubber insulating gloves and heavy duty leather protectors where there is danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts.

7.1.2.2 Employees shall wear rubber insulating gloves with heavy duty leather protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts.

7.1.2.3 Rubber insulating gloves shall be permitted to be used without heavy duty leather protectors, under the following conditions:

- There shall be no activity performed that risks cutting or damaging the gloves.
- The rubber insulating gloves shall be electrically retested before reuse.
- The voltage rating of the rubber insulating gloves shall be reduced by 50% for class 00 and by one whole class for classes 0 through 4.

The following ratings can be found on voltage rated gloves:

- Class 00 = Protect up to 500v (ac) / 750v (dc) volts
- Class 0 = Protect up to 1,000v (ac) / 1500v (dc)
- Class 1 = Protect up to 7,500v (ac) / 11,250v (dc)
- Class 2 = Protect up to 17,000v (ac) / 25,500v (dc)
- Class 3 = Protect up to 26,500v (ac) / 39,750v (dc)
- Class 4 = Protect up to 36,000v (ac) / 54,000v (dc)

Note: heavy duty leather gloves are made entirely of leather with minimum thickness of 0.03 in. (0.7 mm) and are unlined or lined with nonflammable, non-melting fabrics.

7.1.3 Where insulated footwear is necessary as protection against step and touch potential, dielectric footwear shall be required.

7.1.3.1 Insulated soles shall not be used as the primary electrical protection. *The integrity of the insulating quality of footwear with insulated soles cannot be easily determined after they have been worn in a work environment. EH (Electrical Hazard) rated footwear meeting ASTM F 2413 can provide*

a secondary source of electric shock protection under dry conditions.

7.2 Arc Flash PPE. Arc flash PPE shall be used when working inside the arc flash boundary. **One** of the following methods shall be used for the selection of arc flash PPE:

7.2.1 If the equipment is labeled, the stated PPE category shall be used. Table 3 of Appendix C lists the equipment contained in the PPE categories.

7.2.2 If the equipment is not labeled:

7.2.2.1 Complete a detailed flash risk assessment under engineering supervision to determine the incident exposure energy of each employee. Select appropriate protective clothing based on the calculated exposure level in accordance with Table 130.5(G) located in Appendix D **or**,

7.2.2.2 Calculate the arc flash PPE category in accordance with NFPA 70E Table 130.7(C)(15)(a) and (b) located in Appendix C. Once complete, refer to Table 130.7(C)(15)(c) for the PPE items required.

7.3 Arc Rated Clothing General Requirements

7.3.1 Arc rated apparel shall be visually inspected before each use. Arc rated apparel that is damaged or becomes contaminated with grease, oil, flammable liquids, or combustible liquids shall not be used.

7.3.2 The garment manufacturer's instructions for care, maintenance and cleaning of arc rated apparel shall be followed.

7.3.3 When arc rated apparel is worn to protect an employee, it shall cover all ignitable clothing and allow for movement and visibility.

7.3.4 Arc rated apparel shall cover potentially exposed areas as completely as possible. Shirt and coverall sleeves shall be fastened at the wrists, shirts shall be tucked into pants, and shirts, coveralls, and jackets shall be closed at the neck.

7.3.5 Garments that are not arc rated shall not be permitted to be used to increase the arc rating of a garment or of a clothing system.

7.3.6 Apparel made from materials that are not arc rated shall not be worn. Example: hair nets, ear warmers, or head covers could melt onto an employee's hair and head unless properly rated.

7.3.7 Non-melting, flammable fiber garments (i.e. cotton, wool, rayon, silk, or blends of these materials) may be used as under-layers beneath arc rated apparel.

7.3.7.1 Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric

under-layers (an incidental amount of elastic used on non-melting fabric underwear or socks shall be permitted).

7.3.8 Garments worn as outer layers over arc rated apparel (i.e. jackets or rainwear) shall be made from arc rated material.

7.3.9 Flash suits shall permit easy and rapid removal by the user.

7.4 Care for Rubber Insulating Equipment

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

7.4.2 Insulating equipment shall be inspected for damage before each day's use and immediately following any incident that could have caused damage.

7.4.3 An air test shall be performed on rubber insulating gloves before each use. To complete an air test, manually fill the glove with air. Fold over the cuff to seal the air inside the glove. Detect any leaking air by either listening for escaping air or feeling the escaping air by holding the glove near the face.

7.4.4 Insulating equipment found to have defects that might affect its insulating properties shall either be replaced or removed from service until testing indicates that it is acceptable for continued use.

7.4.5 Where the insulating capability of protective equipment is subject to damage during use, the insulating material shall be protected by an outer covering of leather or other appropriate material.

7.4.6 Rubber insulating equipment shall be tested according to the schedule in Appendix F.

7.4.7 Rubber insulating equipment shall be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that may cause damage.

7.4.8 No repairs to rubber insulating equipment shall be attempted.

8.0 INSULATED TOOLS & EQUIPMENT

8.1 Employees shall use insulated tools or handling equipment, or both, when working inside the restricted approach boundary of exposed energized electrical conductors or circuit parts where tools or handling equipment might make unintentional contact. The following requirements apply:

8.1.1 Insulated tools shall be rated for the voltages on which they are used.

8.1.2 Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.

8.1.3 Insulated tools and equipment shall be inspected prior to each use. The inspection shall look for damage to the insulation or damage that can limit the tool from performing its intended function or could

increase the potential for an incident (e.g., damaged tip on a screwdriver).

8.2 Employees shall only use fiberglass portable ladders within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts.

9.0 ELECTRICAL INSTALLATION REQUIREMENTS

9.1 Free from Recognized Hazards

9.1.1 Equipment shall be suitable for the installation and use, be free from recognized hazards and shall be installed and maintained in accordance with the manufacturer's instructions, OSHA, and applicable sections of the National Electrical Code (NEC).

9.1.2 "Suitable" means that the equipment is listed or labeled for the intended use by a nationally recognized testing laboratory such as Factory Mutual (FM) or Underwriters Laboratory (UL).

9.2 Labeling

9.2.1 Each disconnecting means - the switch, device or circuit breaker used to disconnect the circuit from the power source - shall be clearly labeled to indicate the circuit's function and voltage. See Appendix G for acceptable example labels.

9.2.2 Identification should be specific rather than general; i.e., a branch circuit serving receptacles in a main office should be labeled as such, not simply labeled "receptacles".

9.2.3 All labels and marking shall be durable enough to withstand the environment to which they may be exposed.

9.2.4 Labels shall be replaced when they are no longer legible.

9.2.5 Pull boxes, junction boxes, and switch gears over 600 volts, nominal, shall be permanently marked with their voltage.

9.3 Guarding of Live Parts

9.3.1 Live parts of electric equipment operating at 50 volts or more shall be guarded against accidental or incidental contact.

9.3.2 Proper guarding can be achieved by use of an approved cabinet or other approved enclosure, by location in a room or vault that is accessible to qualified persons only, or by elevating the equipment or controlling the arrangement of the space to prevent contact by unqualified persons.

9.3.3 Where electric equipment is located in an area that is potentially exposed to physical damage, the enclosure or guard shall be of sufficient strength to prevent such damage. As an example, for traffic exposure, a system of bollards or barricades could be used to protect the installation.

9.3.4 Missing breaker blanks, box covers, bent latches or broken parts shall be repaired immediately upon being identified.

9.3.5 Covers shall not be left off energized electrical equipment unless the area is secured against unauthorized entry and proper warning signs are installed.

9.4 General Wiring Design and Protection. New electrical wiring and the modification, extension or replacement of existing wiring shall conform to OSHA, the applicable requirements of the NEC, the facility's state and local building codes, and the following:

9.4.1 Grounded conductors (neutral) may not be attached to any terminal or lead so as to reverse designated polarity.

9.4.2 The grounding terminal or grounding-type device on receptacles, cord connector, or attachment plug may not be used for any purpose other than grounding.

9.4.3 Conductors and equipment shall be protected from overcurrent above their safe current carrying capacity.

9.4.4 All AC systems of 50 to 1,000 volts shall be grounded as required by the NEC and OSHA. The path to ground from circuits, equipment and enclosures shall be permanent, continuous and effective.

9.4.5 Conductors entering boxes, cabinets or fittings shall be protected from abrasion, and openings through which conductors enter shall be effectively closed. Unused openings in cabinets, boxes and fixtures shall also be effectively closed with devices approved for electrical service.

9.4.6 All pull boxes, junction boxes and fittings shall be provided with covers approved for the purpose. In completed installations, each outlet box shall have a cover, faceplate or fixture canopy. Pull boxes and junction boxes for systems over 600 volts, nominal, shall provide complete enclosure, and the boxes shall be closed by suitable covers securely fastened in place.

9.4.7 Electrical equipment shall not be used for storage in or on top of loose parts such as bolts, all-thread, nuts, washers, fuses, excess wire, etc., that could roll into or come in contact with live parts.

9.4.8 Switchboards and panel boards that have exposed live parts shall be located in permanently dry locations and accessible to qualified persons only. Panel-boards shall be mounted in cabinets, cutout boxes or other approved enclosures, and shall be dead front unless accessible to qualified persons only. Exposed blades of knife switches shall be de-energized when open.

9.4.9 Cabinets, cutout boxes, fittings, receptacles, boxes and panel-board enclosures in damp or wet locations shall be installed so as to prevent moisture or water from entering and accumulating

within the enclosure. In wet locations the enclosures shall be weatherproof.

9.4.10 Fixtures, lamp holders, lamps, and receptacles shall have no live parts exposed to employee contact.

9.4.11 Multi-plug receptacle adapters may not maintain ground continuity or may overload circuits and shall not be used. If additional receptacles are needed in a work location, additional circuits and/or receptacles shall be installed. Multi-plug power strips with over-current protection are acceptable for use with electronic equipment if the total wattage of the equipment does not exceed the capacity of the power strip.

9.4.12 Power strips shall be directly connected to a receptacle.

9.4.13 Power strips shall not be plugged into another power strip (piggy-backed / daisy chained).

9.4.14 Adaptors for a 3-prong plug going to a 2-prong receptacle shall not be used.

9.4.15 Electrical equipment, wiring methods and installations of equipment in hazardous classified locations shall be intrinsically safe, approved for the location, or safe for the location. Hazardous classified locations are areas where flammable liquids, gases, vapors, or combustible dusts or fibers exist or could exist in sufficient quantities to produce an explosion or fire. Refer to 29 CFR 1910.307 for information regarding rated class and division wiring / installation requirements.

10.0 OVERHEAD WIRES

NOTE OF CLARIFICATION – THE UNIVERSITY NEITHER OWNS NOR OPERATES ANY PERMANENTLY INSTALLED OVERHEAD LINES ON CAMPUS, AS SUCH ANY THAT EXIST BELONG TO PUBLIC UTILITIES.

If working on, near, or with overhead wires, the following safe work practices, and the separation distances discussed below, shall be followed:

10.1 If work is performed on or near overhead wires, such wires shall be de-energized and grounded or appropriate protective measures shall be taken to prevent operator contact with the overhead lines. These protective devices shall prevent employees from contacting such lines directly or indirectly with any part of their body or through contact with conductive materials, tools, or equipment.

10.2 If an unqualified employee is working in an elevated position near overhead lines, the location shall be such that the person and the longest conductive object cannot come closer to any unguarded, energized overhead line than the following distances:

10.2.1 For voltages to ground 50kV or below: 10 feet.

10.2.2 For voltages to ground over 50kV: 10 feet + 4 inches for every 10kV over 50kV.

10.2.3 **Note:** Any object not specifically rated for voltage level found in the overhead line is considered a conductive object.

10.3 If a qualified employee is working in the vicinity of an energized overhead line, the individual shall not approach or take any conductive device closer than the minimum approach distances cited in NFPA 70E Table 130.4(D)(a) and 130.4(D)(b), unless:

10.3.1 The person is insulated from the energized part (gloves, with sleeves if necessary, rated for voltages involved are appropriate); or,

10.3.2 The energized part is insulated both from all other conductive objects at a different potential and from the person; or,

10.3.3 The person is insulated from all conductive objects at a potential different from that of the energized part.

10.4 Vehicles Used Near Overhead Lines

10.4.1 Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 feet minimum is maintained. If the voltage of the overhead line is greater than 50 kV, the distance shall be increased by 4 inches for every 10 kV over 50kV. Only under the following conditions may the clearance be reduced:

10.4.1.1 If the vehicle is in transit with its structure lowered, clearance may be reduced to 4 feet. If the voltage is greater than 50kV, the clearance shall be increased 4 inches for every 10 kV over 50kV.

10.4.1.2 If appropriately rated insulation barriers have been installed to prevent contact with lines and are not part of the raised structure or a part of or an attachment to the vehicle, the clearance may be reduced to the designed working dimensions of the insulating barrier.

10.4.1.3 If the equipment is an aerial lift insulated for the voltage involved, and the work is performed by a qualified person, the clearance may be reduced to that identified in Tables 130.4(D)(a) and (b).

10.4.2 Employees standing on the ground shall not contact the vehicle or its attachments unless the individual is wearing appropriate insulating materials or the vehicle and its attachments are located such that no uninsulated portion can come any closer than the safe distance identified.

11.0 PORTABLE ELECTRICAL EQUIPMENT

11.1 Pre-Use Visual Inspection

11.1.1 Employees using portable electrical or test equipment shall perform a visual pre-use inspection of cord and plug devices before equipment is used on any shift to ensure that the equipment is safe to operate. This includes inspecting for items such as missing ground poles on plugs, damage to cord insulation, and/or crushed or broken plug jackets.

11.1.2 Defective materials shall be removed from use and not placed back into service until repairs have been completed by a person qualified and authorized to perform the repairs.

11.2 Use of Ground-Fault Circuit-Interrupters (GFCIs)

11.2.1 GFCI protection shall be used for personnel in damp areas or where employees are likely to contact water or conductive liquids.

11.2.2 Extension cords shall be of the grounded type and shall be equipped with a GFCI (i.e. use of a pigtail GFCI). **NOTE:** When using pigtail GFCIs, they shall be plugged in at the outlet.

11.3 Extension Cords and Multi-Plug Adapters

11.3.1 Extension cords and flexible cords shall be designed for hard or extra hard usage (for example, types S, ST, and SO). The rating or approval shall be visible.

11.3.2 Extension cords shall be the appropriate size for the length of cord and rated load.

11.3.3 Extension cords shall be protected from damage. Flexible cords may not be run through windows or doors unless protected from damage. Flexible cords may not be run above ceilings or inside or through walls, ceilings or floors, and may not be fastened with staples or otherwise hung in such a fashion as to damage the outer jacket or insulation.

11.3.4 Extension cords shall only be used on a temporary basis not to exceed 90 days.

11.3.5 Damaged extension cords shall be disposed of.

11.3.6 Cords shall be covered by a cord protector or other means when they extend into a walkway or other path of travel to avoid creating a trip hazard. Likewise, cords in the path of travel of mobile equipment shall be protected to avoid damage.

11.3.7 Attachment plugs and receptacles may not be connected or altered in any way that would interrupt the continuity of the equipment grounding conductor. Additionally, these devices may not be altered to allow the grounding pole to be inserted into current connector slots. Clipping or bypassing the grounding prong from an electrical plug is prohibited.

11.3.8 Flexible cords may only be plugged into grounded receptacles. Adapters that interrupt the continuity of the equipment grounding connection shall not be used.

11.3.9 Attachment plugs and connector bodies shall be dead front construction and have no exposed metal parts.

11.3.10 Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.

11.3.11 Employees' hands shall not be wet when plugging and unplugging flexible cords and connected equipment if energized equipment is involved.

11.3.11.1 If the connection could provide a conducting path to employee's hands (for example, if a cord connector is wet from being immersed in water), the energized plug and receptacle connections shall be handled only with insulating protective equipment rated for voltage involved.

11.3.12 Locking-type connectors shall be properly locked into the connector.

11.3.13 When not in use extension cord sets shall be properly coiled and stored in locations where they will not be damaged.

11.4 Portable Corded Electric Tools & Lighting

11.4.1 Portable equipment shall be handled in a manner that will not cause damage.

11.4.2 All portable corded electric tools shall be double insulated or have a three-prong connection and be used with a GFCI when doing maintenance or construction work or when working in damp or conductive locations.

11.4.3 Lamps for general illumination shall be protected from breakage and metal shell sockets shall be grounded.

11.4.4 Temporary lights shall not be suspended by their cords unless they have been designed for this purpose.

11.4.5 Portable lighting used in wet or conductive locations shall be operated at no more than 12 volts or shall be protected by GFCI's.

12.0 ELECTRIC POWER AND LIGHTING CIRCUITS

This primarily refers to circuit breakers which provide over-current protection and test equipment used on these circuits.

12.1 Load Rated Equipment

12.1.1 Electric power and lighting circuits shall use only load rated equipment for purposes of opening, reversing, or closing circuits.

12.1.2 A circuit shall not be reenergized until it is determined that the equipment can be reenergized safely.

12.1.3 Over-current protection may not be modified, even on a temporary basis, beyond that allowed by 1910.304(f) which contains the installation safety requirements for over-current protection.

12.2 Testing Equipment or Circuits

12.2.1 Only qualified employees shall conduct testing work on equipment or circuits.

12.2.2 Testing equipment shall have a pre-use inspection to ensure that it is fit for usage. Defective materials shall be removed from service until the defect is corrected.

13.0 TESTING INSTRUMENTS AND EQUIPMENT

13.1 Only UL listed test equipment shall be used.

13.2 Departments shall maintain an inventory of approved testing instruments and equipment.

13.3 Test instruments, equipment, and their accessories shall be designed for the environment to which they will be exposed, and for the manner in which they will be used.

13.4 Test instruments shall be checked on a known source prior to each use to ensure accuracy and functionality.

13.5 Noncontact Voltage Sensors suitable for use below 1000VAC (tick tracers) shall only be used for diagnostic purposes. These sensors shall NOT be used in place of approved voltage meters for verification of de-energized circuits during Lockout/Tagout procedures. **CAUTION:** The AC sensor **DOES NOT** sense DC voltages and typically reliable for sensing AC voltages between 50 - 600 VAC.

13.6 Noncontact test instruments designed for use above 1000V shall be permitted to be used to detect voltage on systems rated 1000V or greater.

13.7 Visual Inspection

13.7.1 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.

13.7.2 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.

13.8 Each department shall develop a process for conducting and documenting inspections.

14.0 SIGNS AND LABELING

14.1 Safety signs and symbols shall be used to warn employees of electrical hazards which may endanger them.

14.2 Label all disconnecting switches and circuit breakers to indicate their use and / or equipment served and the associated voltage.

14.3 Barricades may be used in conjunction with safety signs when necessary to prevent access to work areas. Conductive barriers shall not be used if they present an electrical hazard.

14.4 If signs and barricades are not sufficient or provided, an attendant shall be posted to warn employees of the danger.

15.0 PROGRAM EVALUATION

15.1 RMS shall review this procedure annually. At a minimum, the evaluation shall review:

15.1.1 The University's Electrical Safety Procedure to determine if it is complete and current;

15.1.2 Training records to determine if all required training was appropriately conducted and attended.

15.1.3 The availability of all records required to be maintained by this procedure. This includes a review/audit of:

15.1.3.1 List of "Qualified" Electrical employees.

15.1.3.2 An annual documented evaluation of each qualified person shall be conducted to ensure adherence to the electrical safety procedures described in this document. See Appendix H.

15.1.3.3 Completed Pre-Job Briefing Forms and Energized Live Electrical Permits.

15.1.3.4 Tool and tester inventory used for live electrical work to ensure the list is accurate and the tools and testers are available and in good condition.

15.1.3.5 Records showing that electrical testers are inspected.

15.1.3.6 Records showing that gloves and insulating blankets/mats are inspected and voltage tested as required or replaced by the required test date.

15.2 The evaluation shall be documented and communicated to appropriate management levels and a process developed to bring any identified deficiencies to closure.

16.0 TRAINING

16.1 Qualified Personnel

16.1.1 All Qualified Electrical Personnel who are required to perform work on University electrical devices and systems shall be trained and competent in all safety related work practices, procedures, and requirements that pertain to their respective work assignments. These practices shall include, but not be limited to the following:

16.1.1.1 Inherent hazards of electricity such as high voltages, electric current, arcing, grounding, and lack of guarding.
16.1.1.2 Methods of safe release of victims from contact with exposed energized conductors or circuit parts.
16.1.1.3 Skills and techniques necessary to distinguish exposed energized components from the other components of electric equipment.
16.1.1.4 Skills and techniques necessary to determine the nominal voltage of exposed energized components.
16.1.1.5 Lock, Tag & Try, which includes written procedures, de-energizing equipment, application of locks and tags, and reenergizing equipment.
16.1.1.6 Work planning, Electrical Work Permit System, and work authorization procedures.
16.1.1.7 Knowledge and understanding of the clearance distances corresponding to voltages which employees may be exposed to.
16.1.1.8 Proper use of special precautionary techniques, personal protective equipment (PPE), insulating and shielding materials, and insulated tools associated with working on or near exposed components of electrical equipment -- based on the voltage levels.
16.1.1.9 Medical response to include: first aid, cardiopulmonary resuscitation (CPR), and the use of an AED.

16.1.2 Training shall be conducted annually. First aid training shall be conducted at a frequency that satisfies the certifying organization's requirements.

16.2 Exposed Unqualified Personnel shall be trained on the following:

16.2.1 Inherent hazards of electricity such as high voltages, electric current, arcing, grounding, and lack of guarding.
16.2.2 The ability to recognize potentially hazardous energy and its potential impact on workplace conditions.
16.2.3 Proper handling and use of portable electrical equipment.

16.3 Retraining shall occur if:

16.3.1 Annual evaluations indicate that the employee is not complying with safety-related work practices.
16.3.2 New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from those that the employee would normally use.
16.3.3 The employee's job duties change.

17.0 **RECORDKEEPING**

17.1 Training records shall be maintained for the duration of employment.
17.2 Each department shall maintain a list of all employees classified as qualified persons.
17.3 Documentation of the annual Electrical Work Evaluation Checklist (Appendix H) shall be maintained by the department for the duration of employment.

18.0 REFERENCES

18.1 NFPA 70E, “Standard for Electrical Safety in the Workplace”, 2018 edition.
18.2 OSHA 29 CFR 1910 Subpart S – Electrical.

19.0 REVISION LOG

History	Effective Date
Electrical Safety procedure developed	February 2020

UNIVERSITY OF NOTRE DAME

Appendix A: Energized Electrical Work Permit

This authorization must be available at the work location. This permit is valid for one shift

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

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

3. Safety Precautions *(Completed by the qualified person doing the work)*
Enter the details for each step

Shock Risk Assessment	Voltage personnel will be exposed to:	
	Limited Approach Boundary (70E Table 130.4(D(a))	
	Restricted Approach Boundary (70E Table 130.4(D(a))	
Arc Flash Risk Assessment	Arc Flash PPE Category (From equipment label or 70E Table 130.7(C)15(a) or (b).	
	Arc Flash Boundary (From equipment label or 70E Table 130.7(C)15(a) or (b).)	
Safe Work Practices to be used		
Other Hazards Present (e.g. working at height)		

Additional Permits (check as appropriate)
Hot Work Permit-required Confined Space Other (describe)___

Required PPE
Hearing protection F/R clothing Safety glasses with side shields Hard hat
Voltage-rated gloves Arc-rated face shield Other (as required by NFPA 70E) Class E Class G
Class _____

How are unqualified persons restricted from the work area?	

4. Approvals *Senior Director of Utilities & Maintenance or designee*

Print Name	**Signature**	**Date**	**Approval**
			Approved Disapproved

5. Pre-Job Coordination

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

Do you agree the above described work can be done safely? Yes No (if no, do not perform the work)
Name of person(s) doing the work:_____ Signature_____
Signature_____

6. Notification

Personnel who may be in or near the area, and may be impacted, have been informed.

Yes No	**Name(s)**

7.Work Completion

Electrical Work Complete: Date: Time:

Copies shall be provided to the Utilities Department and the contractor completing work

Appendix B: Pre-job Briefing Checklist for Live Electrical Work

	Name	Title
Person Authorizing Work		
Qualified Employee(s)		

Date:_____

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

1.) Description of Task to be performed:

2.) Electrical hazards associated with the work tasks:

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

4.) Any special precautions required by working conditions:

5.) Energy sources to be controlled:

6.) PPE required for the Job:

PRE-JOB BRIEFING SIGN OFF – INVOLVED EMPLOYEES

JOB POSITION	PRINT	SIGN

By: _____ Date / Time:_____

Appendix C: Arc Flash PPE Category Method

Use to:

- **Determine Arc Flash Boundary when not marked & not using incident energy analysis**
- **Determine Arc Flash PPE category based on boundary**
- **List of needed items (Table 3)**

Table 1: For use with Alternating Current Systems (NFPA 70E Table 130.7(C)(15)(a))

Equipment	Arc Flash PPE Category	Arc-flash boundary
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)

Table 2: For use with Direct Current Systems (NFPA 70E Table 130.7(C)(15)(b))

Equipment	Arc flash PPE category	Arc-flash boundary
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)

Table 3: Personal Protective Equipment *(NFPA 130.7(C)(15)(c))*

PPE CATEGORY 1

Minimum Arc Rating of
4 cal/cm²

Arc Rated Clothing:

- AR long-sleeve shirt and pants, or AR coverall
- AR face shield, or AR flash suit hood
- AR jacket, parka, rainwear, or hard hat liner (as needed)

Protective Equipment:

- Hard hat
- Safety glasses or safety goggles
- Hearing protection (with inserts)
- Heavy-duty leather gloves
- Leather footwear (as needed)

PPE CATEGORY 2

Minimum Arc Rating of
8 cal/cm²

Arc Rated Clothing:

- AR long-sleeve shirt and pants, or AR coverall
- AR flash suit hood, or AR face shield and AR balaclava
- AR jacket, parka, rainwear, or hard hat liner (as needed)

Protective Equipment:

- Hard hat
- Safety glasses or safety goggles
- Hearing protection (with inserts)
- Heavy-duty leather gloves
- Leather footwear

PPE CATEGORY 3

Minimum Arc Rating of
25 cal/cm²

Arc Rated Clothing:

- As required: AR long-sleeve shirt, AR pants, AR coverall, AR flash suit jacket, and/or AR flash suit pants
- AR flash suit hood
- AR gloves
- AR jacket, parka, rainwear, or hard hat liner (as needed)

Protective Equipment:

- Hard hat
- Safety glasses or safety goggles
- Hearing protection (with inserts)
- Leather footwear (as needed)

PPE CATEGORY 4

Minimum Arc Rating of
40 cal/cm²

Arc Rated Clothing:

- As required: AR long-sleeve shirt, AR pants, AR coverall, AR flash suit jacket, and/or AR flash suit pants
- AR flash suit hood
- AR gloves
- AR jacket, parka, rainwear, or hard hat liner (as needed)

Protective Equipment:

- Hard hat
- Safety glasses or safety goggles
- Hearing protection (with inserts)
- Leather footwear (as needed)

Appendix D: Personal Protective Equipment When Using the Incident Energy Analysis Method *(NFPA Table 130.5(G))*

Incident energy exposure equal to 1.2 cal/cm^2 up to 12 cal/cm^2

1. Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
2. Long sleeve shirt and pants or coverall or arc flash suit (SR)
3. Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR)[b]
4. Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) (AN)
5. Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)[c]
6. Hard hat
7. Safety glasses or safety goggles (SR)
8. Hearing protection
9. Leather footwear

Incident energy exposures greater than 12 cal/cm^2

1. Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy[a]
2. Long sleeve shirt and pants or coverall or arc flash suit (SR)
3. Arc flash suit hood
4. Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) (AN)
5. Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR)[c]
6. Hard hat
7. Safety glasses or safety goggles (SR)
8. Hearing protection
9. Leather footwear

SR: Selection of one group is required.
AN: As needed.

[a]Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for a flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.

[b]Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.

[c]Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.

Appendix E: Electrical Tasks & PPE Requirements

This appendix, or equivalent, is mandatory and shall be completed for each electrical task that is conducted within the department. Job safety planning and risk assessments are important components to ensuring safety of workers and personnel in the area where the work is being performed.

This document shall be reviewed with all qualified workers (those conducting the task) and made available to them.

Description of Task	Equipment	Voltage	PPE Category	Specific PPE To Be Worn

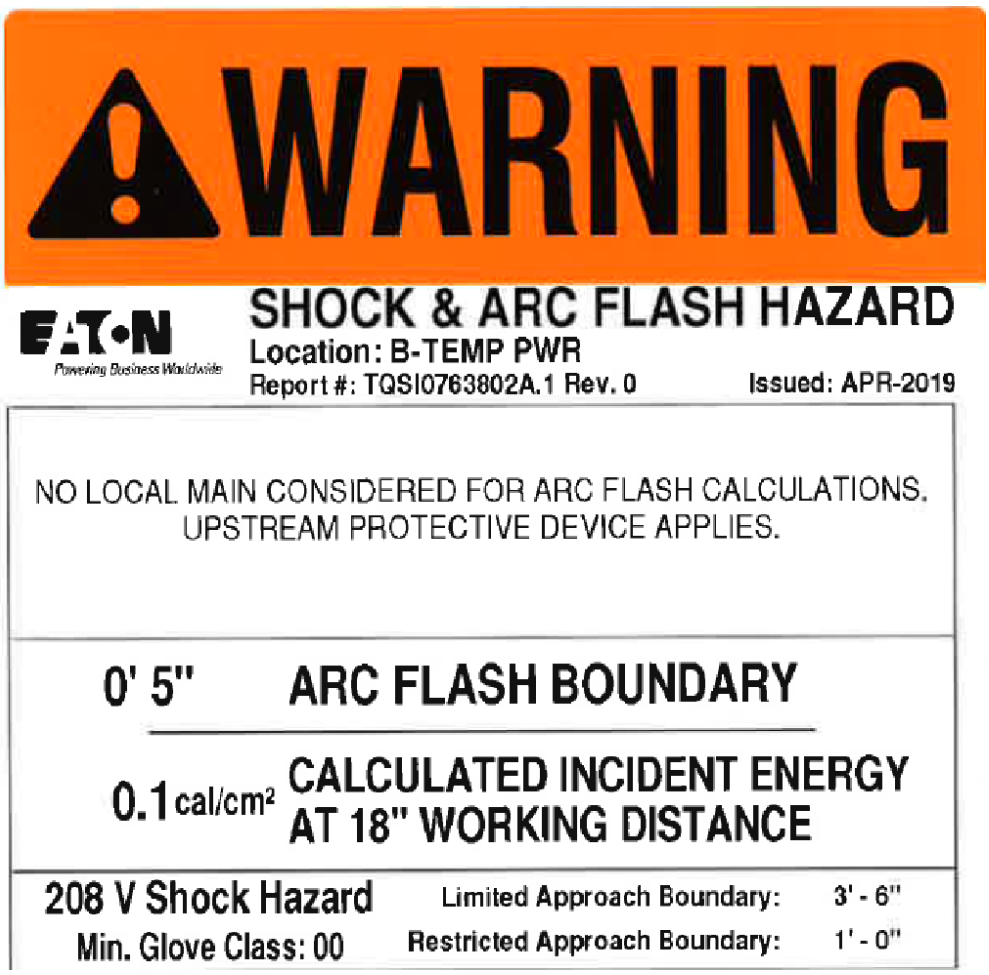
Use additional pages if necessary……..

Appendix F: Inspection Schedule for Rubber Insulating Equipment

Rubber Insulating Equipment	When to Test
Line hose	If insulating value is suspect
Covers	If insulating value is suspect
Blankets	Before first issue; and every 12 months thereafter (*)
Gloves	Before first issue; and every 6 months thereafter (*)
Sleeves	Before first issue; and every 12 months thereafter (*)

(*) – New insulating equipment is not permitted to be placed into service unless it has been electrically tested within the previous 12 months. Insulating equipment that has been issued for service is not new and is required to be retested in accordance with the intervals in this table.

Appendix G: Label (Example)



UNIVERSITY OF NOTRE DAME

Appendix H: Workplace Electrical Safety Observation Form

Evaluator Name:_____ Date : _____Time:_____ AM/PM

Worker 1 Observed:_____

Worker 2 Observed:_____

Please check the boxes below including a brief description of the discrepancy related to each "No" checked. In the comment section or back side of form.

Job & Location: _____

I. PERSONAL SAFETY

	Worker 1				Worker 2			
	Yes	*No*	*N/A*		*Yes*	*No*	*N/A*	Comments
Arc Rated Clothing On								_____ Cal/cm^2 or PPE Level _____
Face and Eye Protection Used								
Rubber Gloves: in Tolerance, Tested, Used								
Leather Protector Gloves Used								
Insulated Tools Used								
GFCI Portable Device Used								

II. PROPER WORK METHODS

	Yes	*No*	*N/A*
Can Identify Potentially Energized Parts Y/N_____, Nominal Voltage:_____volts			
Can State Approach Boundaries: Limited:_____Restricted:_____Arc Flash:_____			
Accurately Determined Arc Flash Hazard at 18" Working Distance			
Lockout/Tagout Equipment and Procedures Used Properly			
Sufficiently Illuminated			
Testing properly with Appropriate Meter to Determine all Parts are De-energized			
Housekeeping Clean and Neat on Job Site			
Visually Inspect Equipment, PPE, Meters, Cords and Test Leads			
Equipment is Properly Grounded			
Demonstrate Knowledge of Construction and Operation of Equipment			

III. COMMENTS

Please explain any "NO" answers and note any other deficiencies that are not specifically covered by a checklist item:

Employee Signature		**Date**	
Employee Signature		**Date**	
Evaluator Signature		**Date**	

Appendix I: Contractor / Host Employer Meeting (Page 1 of 2)

The Notre Dame (ND) Electrical Safety Program requires that each department contracting electrical work meet to discuss information related to electrical safety procedures with the contract employer. This form is used to notify both parties that they must comply with the applicable procedure requirements It shall be completed by the primary university contact in conjunction with the contract employer's representative. The exchange of information shall occur once for each job and be completed before electrical work begins.

Identification of Contractor & Host Employer:	
Contractor Company Name:	Contractor Employer Representative:
ND Representative: *(The meeting shall be conducted by the project manager, project coordinator, electrical engineer, or other ND employee with knowledge of the electrical system)*	Project Name/Equipment/Building:

ND Responsibilities:	
Identify any known electrical hazards that are related to the contract employer's work that might not be recognized by the contractor or its employees.	Comments: ☐ *(Check when complete)*
Note that ND will report any observed contract employer related violations concerning electrical work to the contract employer	Comment: ☐ *(Check when complete)*

Contractor Responsibilities:	
Communicate hazards to their employees as communicated to the contractor by ND.	Comments: ☐ *(Check when complete)*
Follow the safe work practices required by OSHA & NFPA 70E and any required by ND.	Comments: ☐ *(Check when complete)*
Inform ND of any unique hazards presented by the contractors work and any unanticipated hazards found during the contractor's work that were not communicated by ND.	Comment: ☐ *(Check when complete)*
Communicate to ND the measures taken to correct any violations reported by ND and to	Comment:

prevent such violation from recurring in the future.	☐ (*(Check when complete)*

Appendix I: Contractor / Host Employer Meeting (Page 2 of 2)

Lockout / Tagout (LTT) Exchange of Procedures:
Comments: ☐ Check here to confirm that LTT programs have been exchanged.
After comparing the two LTT programs, note any additional restrictions or prohibitions that either party needs to comply with:

Acknowledgements:	
Signature of Contract Employer Representative:	Date:
Signature of Notre Dame Representative:	Date: