ENVIRONMENTAL HEALTH & SAFETY

UNIVERSITY *of* WASHINGTON

ELECTRICAL SAFETY MANUAL

AUGUST 2024

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PURPOSE

This document serves as the University of Washington (UW) Electrical Safety Program manual. The purpose of this manual is to establish requirements to protect personnel and students from potential harm and prevent fires/explosions that could result during the use of electrical systems (e.g., electrical equipment, circuits, wiring, and components) greater than 50 and less than 600 volts (V) with alternating current (AC) or direct current (DC) power. The requirements in this manual meet the requirements of the Washington Administrative Code (WAC) Section 296-24-957 Part L Electrical, National Fire Protection Association (NFPA) National Electrical Code, and NFPA 70E Standard for Electrical Safety in the Workplace (2024).

The intent of this document is to fulfill the following requirements:

- Provide the scope, purpose, employee authorization criteria, requirements, and procedures to ensure safe and compliant handling of electrically energized parts and/or equipment.
- Define a process for evaluating the hazards of potentially energized electrical work tasks and to determine appropriate hazard controls.
- Identify a formal process for controlling energized electrical work through assessment and documented approval processes.
- Identify training requirements for Qualified Personnel who work on, or near, energized electrical circuits and components.
- Provide guidance for UW personnel when managing contractors performing work on or handling energized parts and/or equipment on UW property, owned or leased.

SCOPE

The Electrical Safety Program applies to all University personnel and students who:

1. Are designated to perform work on, or near, energized electrical circuits and components;
2. Operate, maintain, and repair electrical equipment and system; or
3. Design, construct, install, and use electrical equipment or systems in research and development.

This includes all locations that serve as assigned workplaces and educational settings for University personnel, including the Seattle, Bothell and Tacoma campuses, the University of Washington Medical Center, Harborview Medical Center, as well as all other University owned properties, University leased spaces, temporary field locations, and research vessels owned or leased by the UW.

This document does *not* cover electrical transmission operations on energized systems over 600V which are regulated under WAC 296-45 Electrical Power Generation, Transmission, and Distribution. WAC 296-45 includes information on specialized training, personal protective equipment, and work practices for energized systems over 600V. EH&S must be made aware of proposed work on energized systems over 600V prior to work being conducted.

This document does *not* cover work on energized systems less than 50V as there are no specific regulatory requirements for work on these systems. Recommended training for personnel working on or near energized parts less than 50V can be found in the training section of this manual.

Notes:

- *UW departments, units, and organizations can use this UW Electrical Safety Program Manual to meet compliance requirements. Departments/units/organizations may develop and require specific procedures, equipment, and documentation to supplement this manual. The details of the department/unit/organization-specific information may be added to its Supplemental Accident Prevention Plan (SAPP). The requirements must be equal to or more stringent and must not conflict with the information provided in this document.*
- *For the purposes of this document, "employees" refers to University personnel (as defined in Administrative Policy Statement 40.1), faculty and academic personnel, staff, and paid student workers.*

ROLES AND RESPONSIBILITIES

Role	Responsibilities
Departments/Units/ Organizations	Departments/units/organizations that conduct work on energized electrical conductors and circuit parts: **Supervisors are responsible for ensuring items below are completed**.
	• Designate a Research & Development (R&D) Electrical Safety Authority. • Provide necessary resources to implement, maintain, and document department/unit-specific electrical safety procedures. • Designate personnel as a Qualified Person based on their training, knowledge, and experience related to energized parts. • Ensure only Qualified Persons work on exposed energized electrical conductors and circuit parts. • Ensure this manual is reviewed and followed by personnel; record the signatures of personnel to indicate they have read and understood this manual (Appendix H). • Provide documented training to personnel by a person/company qualified to train personnel in working on energized parts. • For work involving electrical hazards, perform arc flash risk assessment as required by NFPA 70E, sec 130.4 and shock hazard risk assessment as required by NFPA 70E, sec 130.5. (Utilize the Risk Assessment Procedure defined in NFPA 70E, sec 110.3 (H)). • Ensure personnel have and use the proper safety equipment and personal protective equipment required for the job. • Ensure workers are trained by a Qualified Person on proper use, operation, and procedures to work on energized equipment. • Ensure contractors are made aware of this manual before beginning work on energized equipment. • Ensure all new electrical installations meet applicable codes and standards. • Ensure any energized work performed as part of this Program meets the exemption criteria noted in NFPA 70E Article 110.2. • Report incidents to Environmental Health & Safety within 24 hours via the UW Online Accident Reporting System (OARS). Some incidents require immediate notification.

Role	Responsibilities
Research & Development (R&D) Electrical Safety Authority	**This role is designated by the unit/department/organization;** allowed to be an electrical safety committee, engineer, or equivalent Qualified individual.
	• Ensure the use of appropriate electrical safety-related work practices and controls. • Allowed to delegate authority to an individual or organization within their control. • Act in a manner similar to an authority having jurisdiction for Research & Development (R&D) electrical systems and electrical safe work practices. • Report all incidents to a supervisor immediately.
Environmental Health & Safety (EH&S)	• Develop, coordinate, and maintain the UW Electrical Safety Program in accordance with NFPA 70E, applicable Labor & Industries regulations, and industry best practices. Perform an annual review of the UW Electrical Safety Program and update as needed. • Assign a UW Electrical Safety Program Administrator to maintain the overall Program. • Provide consultation and assistance to departments/units/organizations to comply with the requirements of this Program. • Audit a representative sample of department/unit/organization procedures to ensure compliance in accordance with this manual. • Provide training to personnel working on or near energized electrical parts.
Qualified Person	An individual who ***has demonstrated*** skills and knowledge related to the construction, and operation, and installations of electrical equipment, and has received safety training to identify the hazards and reduce the associated risk.
	• Ensure required documents are completed prior to conducting any work on energized parts and/or equipment. • Complete all required training(s) to maintain Qualified Worker status. • Perform work using the proper safety equipment and personal protective equipment required for the job. • Report all incidents to a supervisor immediately.
Unqualified Electrical Worker	An individual who ***has not*** been recognized by the department/organization/unit as having sufficient understanding of the equipment, device, system, or facility to effectively control presented hazards. Reports to a Qualified Person.
	• Does not conduct work without a Qualified Person's "eyes on" oversight until determined to be qualified by the department/organization/unit. • Report all incidents to a supervisor immediately.

Role	Responsibilities
Project Managers or Hiring Managers	• Project managers and hiring managers must coordinate and discuss with contractors the scope of work on energized parts and/or equipment. • Ensure any accidents or incidents related to work on energized equipment are reported to the UW Online Accident Reporting System (OARS).

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ELECTRICAL HAZARDS

IDENTIFYING ELECTRICAL HAZARDS

The risk assessment procedure defined in NFPA 70E, sec 110.3 (H) addresses employee exposure to electrical hazards and identifies the process used by the employee before work is started to carry out the following:

- Determine if a task meets exemption criteria for energized work
- Identify hazards
- Assess risks
- Implement risk control(s) according to the Hierarchy of Controls

Electrical hazards include the following:

- Contact with exposed energized conductors and circuit parts
- Short-circuit
- Overloaded current
- Shock
- Arc flash
- Arc blast
- Fire and/or explosion
- Resistive heating

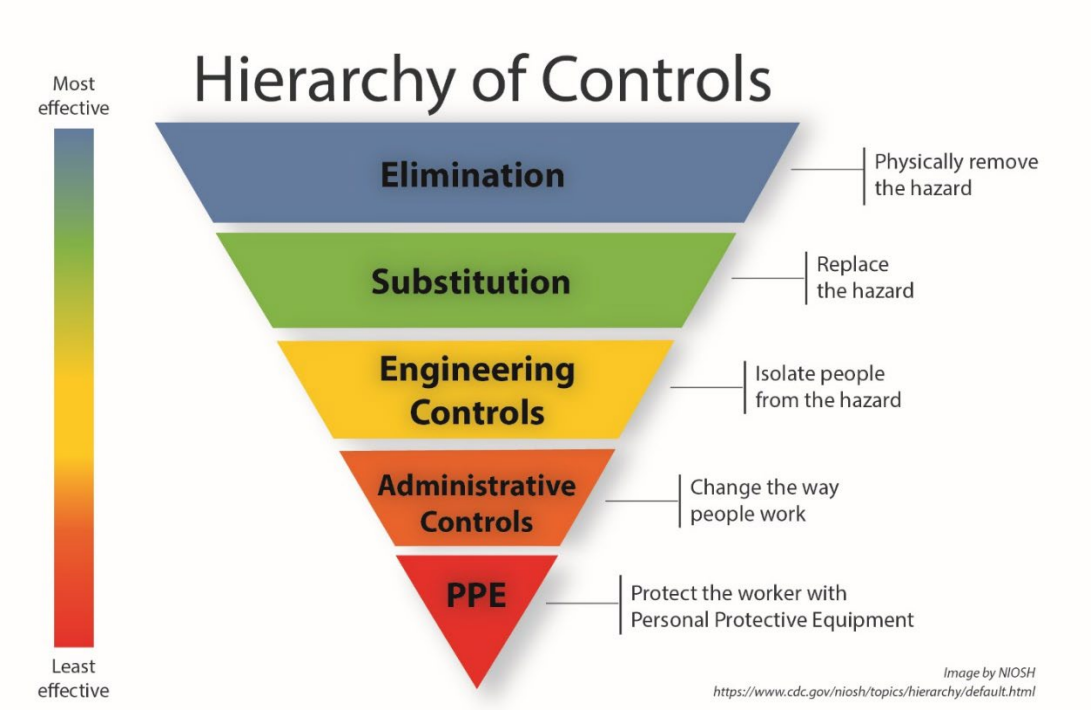
Information on assessing hazards in a specific location while conducting a specific work practice can be found on the UW Job Hazard Analysis (JHA) webpage on the EH&S website.

Supervisors are generally responsible for the identification and correction of hazards their employees face. Unsafe working conditions, practices, or procedures must be corrected in a timely manner based on the severity of the hazards.

Supervisors must ensure that work areas they exercise control over are inspected periodically and/or at least annually.

Hazard Controls

When controlling hazards, personnel must follow the Hierarchy of Controls, starting with the most effective method (hazard elimination), working down to the least effective method (personal protective equipment (PPE)).



Hazard Elimination

Hazard elimination is the most effective method and highest priority in the implementation of safety-related work practices. Once a hazard has been identified, it must be determined whether the hazard can be eliminated. During the electrical system design stage, methods should be employed to eliminate hazards in their entirety.

Hazard Substitution

Hazard substitution is the second most effective and second highest priority in the implementation of safety-related work practices. It involves substituting a hazard for something less hazardous. An example would be to substitute using a tool plugged into a wall socket for a tool that is battery operated.

Engineering Controls

Engineering controls protect personnel by removing hazardous conditions or by placing a barrier between personnel and the hazard. Well-designed engineering controls can be highly effective in protecting personnel and will typically be independent of the personnel interactions. Engineering control requirements include:

- All sources of electrical energy (e.g., distribution panels, breakers, disconnects, switches, junction boxes, etc.) must be completely enclosed.
- A watertight enclosure must be used where there is the possibility of moisture entry either from operations or weather exposure.
- Electrical distribution areas must be guarded against accidental damage by: locating them in specifically designed rooms; using substantial guard posts and rails; and other structural means.

- Electrical distribution rooms, vaults, and spaces must be enclosed within fences, screens, partitions, or walls to minimize the potential of entry by Unqualified Persons.
- Entrances to electrical distribution rooms, vaults, and spaces (that are *not* under the observation of an attendant) must be kept locked.
- Sufficient access and working space must be provided and maintained around electrical equipment to allow for ready access, and safe operation and maintenance of equipment. A clear approach of three (3) feet in front and on all sides must be maintained for all distribution panels, switches, and disconnects.
- All conduits must be fully supported throughout their length; non-electrical attachments to conduits are prohibited.
- All non-rigid cords must be provided strain relief where necessary.

Administrative Controls

Administrative controls are changes to work procedures or behaviors that aim to reduce the frequency, duration, and severity of exposure to hazards. This can include training, policies, procedures, or shift designs that change how people behave, rather than removing the hazard or providing PPE.

- Signs warning Unqualified Persons to keep out of electrical distribution rooms, vaults, and spaces must be displayed at entrances.
- Unqualified Persons may not enter electrical distribution rooms, vaults, and spaces where there are energized, exposed electrical conductors, or circuit parts.
- Access to electrical distribution rooms, vaults, and spaces is limited to those employees who have a need to enter.
- Only Qualified Persons can conduct diagnostics and repairs to electrical equipment.
- Contractors performing electrical work must hold a current license to conduct electrical work.
- Areas under new installation or repair must be sufficiently guarded with physical barriers and warning signs to prevent unauthorized entry.
- All electrical control devices must be properly labeled in accordance with NFPA labeling requirements.
- All Qualified Persons must follow established electrical safety processes and standard operating procedures.
- Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, necklaces, metalized aprons, cloth with conductive thread, or metal headgear) cannot be worn if they could contact exposed energized parts. Articles can be worn if they are rendered nonconductive by covering, wrapping, or other insulating means.

Personnel Protective Equipment (PPE)

Personal protective equipment is considered the least effective safety method as it's focused on controlling the person and not the hazard. It includes items such as face shields, eye protection, arc rated clothing, rubber boots, among others.

Refer to the personal protective equipment section of this manual for specific details.

HAZARDOUS EFFECTS OF ELECTRICITY ON THE HUMAN BODY

Severity of injury from electrical shock to the person depends on the amount of electrcial current and the length of time the current passes through the body. Wet or broken skin can create a pathway for electricity to flow through the chest and can increase the severity of effects from the current. Effects of electric current on the human body includes:

Table 2: Reaction of the Human Body to Electric Current

Effect of AC current (on an individual weighing 115-150 pounds)	**AC current** (in milliampere)
Perception threshold (tingling sensation)	0.7-1
Slight shock – not painful (no loss of muscle control)	1.2-1.8
Shock – painful (no loss of muscle control)	6-9
Shock – severe (muscle control loss, breathing difficulty, onset of "let-go threshold")	15-23
Possible ventricular fibrillation (3-second shock)	100 (0.1 amperes)
Possible ventricular fibrillation (1-second shock)	200 (0.2 amperes)
Heart muscle activity ceases	500 (0.5 amperes)
Tissue and organs burn	1,500 (1.5 amperes)

Source: Mitchell & Lindsey Electrical Safety Specialists

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SAFE WORK PRACTICES

Safe work practices are employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contact when work is performed near or on equipment or circuits that are (or may be) energized.

Specific safe work practices must be consistent with the nature and extent of the associated electrical hazard. These practices must be conducted in combination with appropriate training, regulatory requirements, and risk assessments.

WORKING ON OR NEAR DE-ENERGIZED ELECTRICAL EQUIPMENT

UW Hazardous Energy Control Lockout/Tagout (LOTO) Program

The UW Hazardous Energy Control Lockout/Tagout (LOTO) Program must be followed when working on or near exposed energized electrical equipment.

In the event personnel may be exposed to energized parts, the parts must be put into an electrically safe work condition before personnel are allowed to begin working on or near them, unless work on energized components meets exemption criteria.

- If equipment is believed to be de-energized, but it's *not* locked and tagged out, **and** *not* tested/verified to be de-energized, then it must be considered energized.
- Personnel conducting a lockout/tagout must be familiar with the UW Hazardous Energy Control LOTO Program Manual, and be current on their lockout/tagout training.

Grounding

Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:

- **Placement**: Temporarily protective grounding equipment must be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential) as well as the physical hazard presented by grounding equipment movement in the event it becomes energized. The location, sizing, and application of temporary protective grounding equipment must be identified as part of the job planning process.
- **Capacity**: Temporary protective grounding equipment must be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
- **Impedance**: Temporary protective grounding equipment and connections must have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

Testing

Qualified Persons must use properly rated test equipment to test circuit elements and current-carrying parts to verify all circuits and parts are de-energized.

Testing must also determine if any energized conditions exist as a result of induced voltage or unrelated voltage back feed.

WORKING ON OR NEAR ENERGIZED ELECTRICAL EQUIPMENT

Safe work practices must be used to protect individuals from injury while they are exposed to electrical hazards from electrical conductors or circuit parts that are or can become energized while working on or near energized electrical equipment.

- The specific safety-related work practice must be consistent with the electrical hazards and the associated risk.
- Appropriate safe work practices must be determined before any person is exposed to the electrical hazards involved by conducting risk assessments to identify arc flash and shock hazards.
- Only Qualified Persons are allowed to work on electrical conductors or circuit parts that have *not* been put into an electrically safe work condition.
- There must be a justification for working on energized electrical equipment.
- An Energized Electrical Work Plan and Permit are required under certain conditions.
- A job safety plan and job briefing are required before starting work.

Energized Electrical Work

There must be justification to work on equipment in an energized state (between 50 and 600V) that would pose additional hazards or increased risks, or infeasibility due to equipment design or operational limitation by de-energizing the equipment. This justification must be reviewed and approved by the Qualified Persons' supervisor prior to the beginning of the task or project.

Examples of justifications for performing energized electrical work include, but are not limited to:

- Interruption of life support equipment
- Deactivation of emergency alarm systems
- Shutdown of hazardous location ventilation equipment
- Diagnostics and testing/troubleshooting that can only be performed with the circuit energized
- Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down to allow work on one circuit or piece of equipment

Work performed on energized parts (e.g., testing, troubleshooting, voltage measuring, removal of a panel to observe live equipment, etc.) by properly Qualified Persons is allowed to be performed *without* an Energized Electrical Work Permit under the following conditions:

1. Appropriate training is completed before work begins;
2. Applicable risk assessments are completed before work begins;
3. Safe work practices are followed;
4. Standard operating procedures (SOPs) are followed; and
5. PPE is provided and used appropriately.

While a formal permit is not required, the expectation is the Qualified Person will perform the electrical tasks following all the safe work practices detailed in this chapter, including completing an Energized Work Plan, and Job Safety Plan and Briefing.

Examples of tasks for which a permit is *not* required include, but are not limited to, the following:

- Thermography, ultrasound, and visual inspection up to a restricted approach boundary
- Access/egress with no electrical work performed up to the restricted approach boundary
- General housekeeping and miscellaneous non-electrical tasks up to restricted approach boundary

Powered Electronic Equipment

Individuals working with powered electronic equipment must be aware of the hazardous effects of electricity on the human body and hazards associated with powered electronic equipment, which includes (but is not limited to) the following types of devices:

- Electric arc welding equipment
- High-power radio, radar, and television transmitting towers and antenna
- Industrial dielectric and radio frequency (RF) induction heaters
- Shortwave or RF diathermy devices
- High voltage energy storage capacitors laser system
- Process equipment that includes rectifiers and inverters such as:
    - Motor drives
    - Uninterruptible power supply systems
    - Lighting controllers

Normal operation of powered electronic equipment during electrical work is permitted when all of the following conditions are met:

- The equipment is properly installed per applicable regulations.

- The equipment is properly maintained per applicable regulations.
- The equipment is used in accordance with instructions included in the Nationally Recognized Testing Laboratory (NRTL) listing and labeling and in accordance with the manufacturer's instructions.
- All equipment doors are closed and secured.
- All equipment covers are in place and secured.
- There is no evidence of impending failure.

Energized Work Plan and Permit

When energized electrical work is performed, an Energized Electrical Work Plan and Permit (Appendix C) is required to be documented under the following conditions:

- When energized electrical work will be performed within the restricted approach boundary.
- When personnel may interact with the equipment when conductors or circuit parts are not exposed, but an increased likelihood of injury from exposure to an arc flash exists.
- The following tasks are exempt from signatures in Part III of the Energized Work Plan and Permit, but still must utilize Part II to address arc flash and shock hazards:
    - Testing, troubleshooting, or voltage measuring.
    - Thermography, ultrasound, or visual inspections.
    - Access to, and egress from, an area with energized electrical equipment.
    - General housekeeping and miscellaneous non-electrical tasks.
    - Crossing the limited approach boundary for visual inspections.

The Energized Work Plan and Permit must include the following:

- A description of the circuit and equipment to be worked on and its location
- Description of the work to be performed
- Justification for why the work must be performed in an energized condition
- The voltage to which personnel will be exposed
- Available incident energy at the working distance or arc flash PPE category
- Determination of shock and arc flash protection boundaries
- The necessary PPE required to safely perform the assigned task
- A description of the safe work practices utilized
- The means used to restrict the access of Unqualified Persons from the work area; typically, this will consist of demarcating the electrical safety boundary using Energized Area signs and/or Caution Energized Area tape.

- Evidence of completion of the Job Briefing (Appendix B), including a discussion of any job-specific hazards.
- Energized work approval signatures (not required for tasks that are exempt from a permit, such as testing, troubleshooting, or voltage measuring).

Job Safety Plan and Briefing

Before starting each job that involves exposure to electrical hazards, the Qualified Person on site must complete a Job Safety Plan, which is reviewed by their supervisor, and conduct a Job Safety Briefing with the personnel conducting the work.

The **Job Safety Plan** must be completed by a Qualified Person (and be documented) and include the following information:

- Description of the job and the individual tasks
- Identification of the electrical hazards associated with each task
- A shock risk assessment for tasks involving a shock hazard
- An arc flash risk assessment for tasks involving an arc flash hazard
- Work procedures involved, special precautions, and energy source controls

The **Job Safety Briefing** must cover the job safety plan, the information on the Energized Electrical Work Plan and Permit, and must include the following information:

- Hazards associated with the work being conducted
- Work procedures involved
- Special precautions taken
- Energy source controls in place
- PPE requirements
- Emergency and incident procedures

If the work or operations to be performed during the workday or shift are repetitive and similar, at least one Job Safety Briefing must be conducted before the start of the first job or shift. Additional briefings must be held if significant changes that might affect the safety of the individuals involved occur during the work.

A brief discussion is satisfactory if the work involved is routine and if the individuals involved, by virtue of training and experience, can reasonably be expected to recognize and avoid the hazards involved in the job. A more extensive discussion must be conducted if either the following are true:

- The work is complicated or particularly hazardous.
- Personnel conducting the work cannot be expected to recognize and avoid the hazards involved in the job.

A **Job Safety Plan and Briefing Checklist** can be found in Appendix B of this manual to help with the development of a Job Safety Plan and to ensure all topics are covered during the Job Safety Briefing.

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PERSONAL PROTECTIVE EQUIPMENT (PPE) AND TOOLS

Personnel working in areas where there are potential electrical hazards are required to wear personal protective equipment (PPE) that protects against electrical hazards.

- Personnel must be trained on its selection and use by the department/unit/organization.
- Departments/Units/Organizations as well as personnel must ensure PPE is used properly.
- PPE provided must be appropriate for the specific parts of the body to be protected and for the work to be performed.
- Protective equipment must be maintained in a safe, reliable condition and must be periodically inspected and/or tested according to the manufacturer's requirements.
- If the insulating capacity of the protective equipment may be subject to damage during use personnel must protect the insulating material.
- Personnel must wear nonconductive head protection wherever there is a potential for injury to the head from electrical shock or burns due to contact with exposed energized parts.
- Eye and face protection is required whenever there is risk of injury to the eyes or face from electrical arcs, flashes, or flying objects.
- When arc-rated clothing is worn to protect personnel, it must cover all ignitable clothing and must allow for movement and visibility.
- Personnel must remove all metal objects including rings, watches, necklaces, earrings, etc.

ARC FLASH PPE

When selecting PPE, use either the Incident Energy Analysis Method **or** the Arc Flash PPE Categories Method, but *not* both.

Incident Energy Analysis Method

The incident energy exposure level must be based on the working distance of the employee's face and chest areas from a prospective arc source for the specific task to be performed. Arc-rated clothing and other PPE must be used by the employee based on the incident energy exposure associated with the specific task. Recognizing that incident energy increases as the distance from the arc flash decreases, additional PPE must be used for any parts of the body that are closer than the working distance at which the incident energy was determined.

The Incident Energy Analysis must take into consideration the characteristics of the overcurrent protective device and its fault clearing time, including its condition of maintenance. Some electrical equipment that has had an Incident Energy Analysis

completed will have an arc flash label that lists the incident energy and shock protection information.

The Incident Energy Analysis must be updated when changes occur in the electrical distribution system that could affect the results of the analysis. The incident energy must be reviewed for accuracy at intervals not to exceed five years.

Refer to the UW Facilities design standard for short-circuit and incident energy studies.

Refer to NFPA 70E Table 130.5(G): Selection of Arc-Rated Clothing and Other PPE When the Incident Energy Analysis Method Is Used.

Arc Flash PPE Categories Method

The arc flash PPE categories method uses tables (NFPA 70E Table 130.7(C)(15)(a) for ac systems and 130.7(C)(15)(b) for dc systems) to estimate the risk based on maximum available fault currents, clearing times of overcurrent protective devices such as breakers and fuses, and working distances. If known, the fault currents at the equipment and clearing times are cross-referenced with these tables to determine the arc flash PPE category and arc flash boundary. Using this method, the arc flash labels will identify the PPE Category rather than the incident energy.

If no arc flash label exists, the arc flash PPE categories method must be used. If the available fault current and clearing times are *not* known, an in-depth risk assessment must be conducted by a qualified person to determine these values, which can then be cross-referenced with the tables mentioned above (NFPA 70E Table 130.7(C)(15)(a) for ac systems and 130.7(C)(15)(b) for dc systems) to determine the arc flash PPE category and estimate the arc flash boundary.

Once the arc flash PPE category is determined, personal protective equipment must be selected from the appropriate Arc Flash PPE Category listed in NFPA 70E Table 130.7(C)(15)(c).

HEAD, FACE, NECK, AND CHIN PROTECTION

Personnel must wear nonconductive head protection wherever there is a risk of head injury from electrical shock or burns due to potential contact with energized electrical conductors or circuit parts or from flying objects resulting from arc flash and/or arc blast. Personnel must wear nonconductive protective equipment for the face, neck, and chin whenever there is a risk of injury from exposure to electric arcs or flashes, or from flying objects resulting from electrical explosion. Personnel who wear hairnets or beard nets must ensure they are arc-rated.

EYE PROTECTION

Personnel must wear properly rated eye protection whenever there is risk of injury from electric arcs, flashes, or impact from flying objects resulting from electrical explosion.

HEARING PROTECTION

Personnel inside the arc flash boundary must wear hearing protection (but are *not* required to participate in the Hearing Loss Prevention Program).

BODY PROTECTION

Personnel must wear arc-rated clothing whenever there is potential for exposure to an electric arc flash above the threshold incident energy level for a second-degree burn (1.2 calories per square centimeter (cal/cm^2) or 5 Joules per square centimeter (J/cm^2).

Refer to Appendix D of this manual.

HAND AND ARM PROTECTION

Electric Shock Protection

Personnel must wear **rubber insulating gloves with protectors** when there is a risk of electric shock due to contact with exposed energized electrical conductors or circuit parts.

Personnel must wear **rubber insulating gloves with protectors *and* rubber insulated sleeves** when there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts.

Rubber insulating gloves must be rated for the entire voltage for which the gloves will be exposed. Rubber insulating gloves may be allowed to be used without protectors, under the following conditions:

- No activity will be performed that includes a potential risk of cutting or damaging the glove.
- The rubber insulating gloves are inspected and air tested (filled with air either manually or with a power inflator and checked for leakage) before each day's use.
- The rubber insulating gloves are electrically tested every six (6) months.
- The top of the cuff of the protector glove must be shorter than the rolled top of the cuff of the insulating glove.

The voltage rating of rubber insulating gloves (described below) must be reduced by 50% for class 00 and by one whole class for classes 0 through 4 if used without protectors.

Voltage ratings and classes of rubber insulating gloves

ASTM LABELING CHART FOR RUBBER INSULATING GLOVES

CLASS	TEST AC VOLTS	MAXIMUM USE AC VOLTS	TEST DC VOLTS	MAXIMUM USE DC VOLTS	LABEL COLOR	LABEL IMAGE
00	2,500	500	10,000	750	BEIGE	
0	5,000	1,000	20,000	1,500	RED	
1	10,000	7,500	40,000	11,250	WHITE	
2	20,000	17,000	50,000	25,500	YELLOW	
3	30,000	26,500	60,000	39,750	GREEN	
4	40,000	36,000	70,000	54,000	ORANGE	

Class 00: BEIGE LABEL

- Maximum use voltage of 500 volts AC/proof tested to 2,500 volts AC
- Maximum use voltage of 750 volts DC/proof tested to 10,000 volts DC

- Class 0: RED LABEL
  - Maximum use voltage of 1,000 volts AC/proof tested to 5,000 volts AC
  - Maximum use voltage of 1,500 volts DC/proof tested to 20,000 volts DC
- Class 1: WHITE LABEL
  - Maximum use voltage of 7,500 volts AC/proof tested to 10,000 volts AC
  - Maximum use voltage of 11,250 volts DC/proof tested to 40,000 volts DC
- Class 2: YELLOW LABEL
  - Maximum use voltage of 17,000 volts AC/proof tested to 20,000 volts AC
  - Maximum use voltage of 25,500 volts DC/proof tested to 50,000 volts DC
- Class 3: GREEN LABEL
  - Maximum use voltage of 26,500 volts AC/proof tested to 30,000 volts AC
  - Maximum use voltage of 39,750 volts DC/proof tested to 60,000 volts DC
- Class 4: ORANGE LABEL
  - Maximum use voltage of 36,000 volts AC/proof tested to 40,000 volts AC
  - Maximum use voltage of 54,000 volts DC/proof tested to 70,000 volts DC

Arc Flash Protection

Hand and arm protection must be worn where there is possible exposure to arc flash.

FOOT PROTECTION

Heavy-duty leather work shoes and/or boots must be worn for all tasks where incident energy exposure exceeds 4 cal/cm^2. Toe guards and structural components must be constructed of Structurally Engineered Moldable Composite (SEMC) Certified materials.

LAYERING

Non-melting, flammable fiber garments are allowed to be used as underlayers in conjunction with arc-rated garments in a layered system. Garments made of non-melting, flammable fibers as underlayers requires the system arc rating to be sufficient to prevent breakopen of the innermost arc-rated layer at the expected arc exposure incident energy level. This is to prevent ignition of flammable underlayers. Those that are not arc-rated must not be allowed to be used to increase the arc rating of a garment or of a clothing system.

Meltable fibers, such as acetate, nylon, polyester, polypropylene, and spandex, are ***not*** allowed in clothing underlayers next to the skin. Items with underwire and elastics, such as underwear and bras, must be removed. Specific tasks may require additional arc-rated layers to achieve the required protection level.

PPE CARE AND INSPECTION

PPE must be maintained in a safe, clean, and reliable condition and inspected before each use.

- If PPE is damaged, impaired, or unsuitable for use, personnel must not use the PPE, tag it out of service, and inform their supervisor.
- The out-of-service PPE must be sent back to the manufacture for repair or disposed of properly.
- Arc-rated apparel must be stored in a manner that prevents physical damage; damage from moisture, dust, or other deteriorating agents; or contamination from flammable or combustible materials.
- Manufacturer instructions for care and maintenance of arc-rated apparel must be followed. This includes assuring laundry products do not interfere with or degrade the arc resistance of the fabric. Refer to Appendix F in this document for information about inspection, maintenance, and care of PPE.

INSULATING MATERIALS & TOOLS

Personnel must use insulated tools and handling equipment rated for the voltages encountered when working inside the Limited Approach Boundary and Restricted Approach Boundary near exposed energized circuits, conductors, or parts.

Insulated tools must be designed and constructed to meet the demands of use and the environment to which they are exposed. Insulating equipment made of materials other than rubber must provide electrical and mechanical protection at least equal to that of rubber equipment. If the insulating capability is subject to damage during use, the insulating material must be protected by an outer covering of leather or other appropriate material.

Rubber insulating blankets and mats can be used to help protect the worker against shock hazards and limit accidental contact with energized electrical conductors, surfaces, or circuit parts, and must be rated for the applicable phase-to-phase voltage.

Insulating rubber equipment such as gloves, sleeves, blankets, and matting must be stored in an area protected from light, temperature extremes, excessive humidity, ozone, and other substances and conditions that might cause damage.

Rubber insulating equipment must be:

- Tested according to the schedule supplied by the manufacturer;
- Inspected for damage before each use;
- Inspected immediately following any incident that could have caused damage; and
- Inspected before each use and electrically tested before the first use and at least once every 12 months after being placed in service.
- Complete records must be kept of the date of the test and the results (refer to Appendix F).

Rubber insulated equipment found to have defects that might affect its insulating properties must be removed from service until testing indicates that it is acceptable for continued use. Do not attempt to repair defective rubber insulated equipment.

Fuse handling equipment insulated for the circuit voltage shall be used to remove or install a fuse if the terminals are energized. Ropes and handlines used near exposed energized parts must be nonconductive. Portable ladders used for electrical work must be made of fiberglass. Tools and handling equipment must be replaced if the insulating capability is decreased due to damage.

Testing Insulated Equipment

Rubber insulating equipment that has been placed in service must be subjected to electrical testing by an accredited testing facility at least every six months.

If the insulating equipment has been electrically tested but *not* issued for service, it must *not* be placed into service unless it has been electrically tested within the previous 12 months.

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FLEXIBLE CORDS AND PORTABLE ELECTRICAL EQUIPMENT

SURGE SUPPRESSORS, POWER STRIPS, AND EXTENSION CORDS

Extension cords must be visually inspected before use on any shift for external defects.

Refer to the Extension Cords, Surge Suppressors, and Power Strips guidance document.

PORTABLE CORD AND PLUG DEVICES

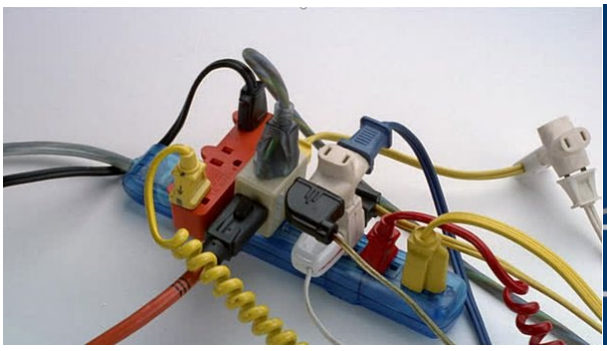
Portable cord and plug-connected devices must be visually inspected before use on any shift for external defects such as loose parts, deformed and missing pins, and damage to outer jacket or insulation. They must also be inspected for possible internal damage from a pinched or crushed outer jacket. Any defective cord or cord-and-plug-connected equipment must be immediately removed from service and no person may use it until it is repaired and tested by a Qualified Person to ensure it is safe for use.

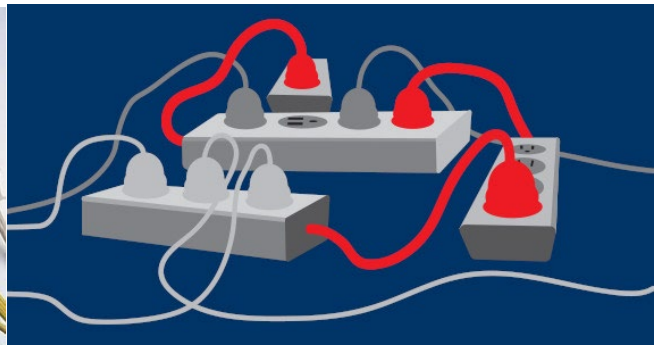
Portable equipment must be handled in a manner that will not cause damage. Do not handle electrical equipment using the cord. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment.

DAISY CHAINING

Daisy chaining (shown below) is the connection of two or more extension cords or power strips in a series with only one connected to a power outlet. This is usually found as a result of inadequate access to power outlets. Daisy chaining can result in an overload to the circuits and can pose a fire risk. Even though power strips are able to power multiple items, when they are connected in this way the strip connected to the outlet provides much more power than the approved amount.

Use a power strip or extension of appropriate length for the use, or change the location of workstations and equipment to be closer to an area with a power outlet.





PENDANT DROPS

Pendant drops are receptacle boxes suspended with a cord from a junction box and are used for portable power sources, such as multiple pieces of equipment. The following must be met for use of pendant drops:

- Only specific types of receptacle boxes are permitted to be hung from a junction box.
    - Receptacle boxes with knockouts that are designed to be mounted to a wall are *not* allowed to be hung from a pendant drop.
    - Boxes must be solid and closed without knockouts on the sides.
- Strain relief must also be present at the point where the wire originates and at the wire's entrance into the receptacle box.
    - Failure to maintain these strain relief points is a fire hazard.
- Tension relief must also be provided where the cable enters the box. In some types of boxes, this is incorporated into the box's design and for others it must be added.
- The cable used must be rated and labeled for use as a pendant drop.
- The circuit must be capable of withstanding the load from the equipment.
- Receptacle boxes must never rest on the floor.

TEMPORARY WIRING AND FLEXIBLE CORDS

Temporary electrical power and lighting installations (600 volts or less) may only be used during and for renovations, maintenance, repair, or experimental work. The following additional requirements apply:

- Ground-fault protection (e.g., ground-fault circuit interrupters or GFCI) must be provided on all temporary-wiring circuits, including extension cords, cord and plug-connected tools used for construction and maintenance activities, or used outdoors or in potentially damp or wet locations, when supplied by 125-volt, and 15, 20, or 30-ampere circuits. GFCI protection must be tested in accordance with the manufacturer's instructions.
- In general, all equipment and tools connected by a cord and plug must be grounded. NRTL listed or labeled double-insulated tools and appliances need not be grounded.
- Feeders must originate in an approved distribution center, such as a panelboard, that is rated for the voltages and currents the system is expected to carry.
- Branch circuits must originate in an approved power outlet or panelboard.

- Neither bare conductors nor earth returns may be used for the wiring of any temporary circuit.
- Receptacles must be of the ground-fault type. Unless installed in a complete metallic raceway, each branch circuit must contain a separate equipment-grounding conductor, and all receptacles must be electrically connected to the grounding conductor.
- Suitable disconnecting switches or plug connects must be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.
- Lamps for general illumination must be protected from accidental contact or damage, either by elevating the fixture eight feet or more above the floor or work surface or by providing a suitable guard. Headlamps supplied by flexible cord must be equipped with a handle of molded composition or other approved material and must be equipped with a substantial bulb guard.
- Flexible cords and cables must be of an approved type and suitable for the location and intended use.

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WORKING SPACE AROUND ELECTRIC EQUIPMENT

Sufficient access and working space must be provided and maintained around all electric equipment to permit ready and safe operating and maintenance of the equipment. Enclosures that house electric apparatus and are controlled by lock and key must be accessible to a Qualified Person.

Working space for equipment operating at 600 volts or less to ground and likely to require examination, adjustment, services, or maintenance while energized must comply with the required dimensions of WAC 296-24-95703 (7)(a). The depth of the working space in the direction of access to live parts may not be less than indicated in WAC 296-24-95703 Table S-1. Distances must be measured from the live parts (if they are exposed) or from the enclosure front or opening (if they are enclosed).

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RESEARCH AND DEVELOPMENT LABORATORIES AND SUPPORT SHOPS

This section describes requirements that apply to the electrical installations in areas with custom or special electrical equipment designed by the facility management for research and development (R&D) laboratories.

Electrical equipment that is *not* listed or labeled by a nationally recognized testing laboratory (NRTL), or equipment with an invalidated NRTL listing or labeling, must comply with this section of the manual. This will typically include:

- Research-related equipment that is custom built in house; or
- NRTL listed or labeled equipment that has been modified, which would invalidate the current NRTL listing or labeling. (NRTL listed or labeled electrical equipment has undergone rigorous testing to ensure that it is safe for use.)

GENERAL REQUIREMENTS

- Equipment and instillations that bear the seal of an NRTL are considered approved if they are installed and used in accordance with the instructions included in the listing and/or labeling.
- NRTL listed and/or labeled equipment must be acquired and used whenever possible, even if similar unlisted or unlabeled equipment is available. When equipment has a listing or label from NRTL, it must be field evaluated as described in this manual.
- OSHA allows for approval of custom-made equipment or related installations if the equipment is determined to be safe for its intended use by its manufacturer based on test data. The laboratory must keep this test data and make it available during inspections.
- The equipment must be free from recognized hazards that are likely to cause death or serious physical harm to personnel when electrical equipment must be custom fabricated because
    - NRTL listed or labeled equipment is not available; or
    - Foreign equipment is acquired to perform a unique experimental function in support of the laboratory's scientific mission; or
    - There is a need for continued use of legacy equipment.

- Electrical equipment fabrication, modification, or installation must be completed by, or under the direct supervision, of a Competent Person/Electrical Safety Authority. The laboratory responsible for modifying or custom building equipment is responsible for completing a field evaluation of the equipment to ensure that the equipment is safe for use.

Electrical Safety Authority

Each laboratory or R&D group must assign someone as their Electrical Safety Authority (also called Competent Person) to ensure the use of appropriate electrical safety-related work practices and controls.

The Electrical Safety Authority will have jurisdiction for R&D or laboratory electrical systems and electrical safe work practices. They will be competent in the requirements of this manual and the electrical system requirements applicable to the R&D sites or laboratories. Concepts they are expected to be competent in include:

- Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment
- Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts
- Approach distances and the corresponding voltages to which personnel working on the equipment will be exposed
- Decision-making skills necessary to perform job safety planning, identify electrical hazards, assess associated risks, and to select appropriate control methods.

The Electrical Safety Authority will also be responsible for the following:

- Job safety planning and job briefing before starting each activity that involves exposure to electrical hazards.
- Updating documents when a change in work scope occurs and ensuring to communicate these changes to those conducting the work. They must initiate a stop of work if changes occur during the course of work that might affect the safety of personnel.
- Ensure appropriate PPE is available and in use by personnel conducting the work to safeguard them from injuries while exposed to electrical hazards from exposed electrical conductors or circuit parts that are, or could become, energized. Personnel must also be trained on the appropriate use of PPE before use.
- Review and approve specific safety-related work practices to ensure that they are consistent with the electrical hazard(s) and associated risk(s).
- Ensure all required UW and site-specific trainings have been completed and documented appropriately.

ENERGY THRESHOLDS

Exposure levels must not exceed those identified below unless appropriate controls are implemented as approved by the Electrical Safety Authority.

- AC: 50 volts and 5 milliamps
- DC: 100 volts and 40 milliamps
- Capacitive Systems:
    - 100 volts and 100 Joules of stored energy
    - 400 volts and 1.0 Joules of stored energy
    - 0.25 Joules of stored energy

EQUIPMENT EXAMINATION

Examination of equipment must take into consideration the suitability of the equipment for an identified purpose such as the NRTL listing and labeling.

The equipment must be enclosed to protect personnel from the hazards of electrical shock and arc flash, and to contain fire or pieces that could be expelled.

Exposed metal parts of the enclosure must be bonded and grounded, and overcurrent protection must be installed.

Additional equipment examination considerations:

- Mechanical strength and durability, including parts designed to enclose and protect other equipment
- Wire-bending, connection space, and electrical insulation
- Heating effects under normal and abnormal conditions likely to arise while in service
- Arcing effects
- Classification by type, size, voltage, current capacity, and specific use
- Openings through which conductors enter must be adequately closed and strain relief provided
- Other factors that contribute to the practical safeguarding of persons using (or likely to come in contact with) the equipment

EQUIPMENT MARKING

Marking of equipment is required for equipment fabricated, designed, or developed for research testing and evaluation of electrical systems. The marking must sufficiently list all voltages entering and leaving control cabinets, enclosures, and equipment. Caution, warning, or danger labels must be affixed to the exterior describing specific hazards and safety concerns.

EQUIPMENT DOCUMENTATION

Sufficient documentation must be provided and readily available to personnel that install, operate, and maintain modified or fabricated equipment. Required documentation includes:

- A description of the operation, shutdown, safety concerns, and nonstandard installations
- Schematics, drawings, and bill of materials describing power feeds, voltages, currents, and parts used for construction, maintenance, and operation of the equipment (Drawings, standard operating procedures, and equipment must be approved by an Electrical Safety Authority or approved consultant.)
- Specific hazards, other than electrical, associated with research equipment must be documented
- Safety requirements and emergency shutdown procedures of equipment including lockout/tagout (LOTO) requirements and all associated LOTO documentation
- Justification for in-house modification of NRTL listed or labeled equipment or need for in-house fabrication of equipment
- Qualifications of the fabricator, which includes adequate technical electrical/electronic and electrical safety knowledge
- Completed Custom Electrical Equipment Field Evaluation Form for inspection during the life span of the equipment

Assembly of equipment must comply with national standards where applicable unless research applications require exceptions.

Proper safety shutdown procedures and PPE requirements must be considered in the absence of grounding and/or bonding.

FIELD EVALUATIONS

The equipment or systems used in R&D areas or laboratories must be field evaluated prior to installation as they can pose unique electrical hazards that might require mitigations. Electrical hazards can include (but are not limited to):

- AC and DC electrical current
- Low voltage and high voltage amperage
- High voltage and low current
- Large electromagnetic fields
- Induced voltages

- Pulsed power
- Multiple frequencies

The laboratory responsible for the modification or custom fabrication of electrical equipment must complete a **field evaluation** of the equipment.

The Electrical Safety Authority, (also known as the Competent Person) must conduct the field evaluation. In some cases, the Electrical Safety Authority may need to identify a subject matter expert (Qualified Person) to assist with the field evaluation.

The equipment must be inspected by the Electrical Safety Authority, or by a qualified subject matter expert contracted by the laboratory. The evaluation must be documented on the Custom Electrical Equipment Field Evaluation Form. The completed form must be retained in the laboratory's records and made available during any inspection.

The equipment must be:

1. Field evaluated and approved by the Electrical Safety Authority;
2. Documented on the Custom Electrical Equipment Field Evaluation Form (in Appendix G)

The completed form must be retained in the laboratory's records and made available during any inspection.

Ultimately, the Electrical Safety Authority must take responsibility for the equipment and ensure that it is safe for use.

EH&S is available to provide guidance and identify resources to aid in completion of the field evaluation; however, EH&S cannot perform a field evaluation on the equipment.

Any alteration to the building electrical system in a UW Seattle campus building must be approved by the UW Facilities Director of Maintenance and Construction per Administrative Policy Statement 56.6.

INTERLOCK REQUIREMENTS

Only Qualified Persons following the requirements for working inside the restricted approach boundary can be permitted to defeat or bypass an electrical safety interlock under the following conditions:

- The Qualified Person has sole control of the interlock, but only while the Qualified Person is working on the unit.
- The safety interlock system must be returned to its operable condition when the work is completed.

Locks, interlocks, and other safety equipment must be maintained in proper working condition to accomplish the control purpose.

LITHIUM BATTERIES

Please refer to the Lithium Battery Safety guidance document.

MISCELLANEOUS

OVERHEAD POWER LINES

When work is performed near overhead lines, the lines shall be de-energized and grounded, or other protective measures must be provided before work begins. If the lines are to be de-energized, arrangements must be made with the person or organization that operates or controls the electric circuits involved ahead of time to de-energize and ground them.

If protective measures (e.g., guarding, isolating, or insulating) are provided they must prevent personnel from contacting power lines directly with any part of their body or indirectly through conductive materials, tools, or equipment.

- Please refer to the OSHA Minimum Approach Distance Calculator to calculate minimum approach distances for phase-to-phase system voltages exceeding 72.5 kilovolts.
- A ground safety person must be designated if equipment must be operated in the vicinity of overhead power lines that are *not* de-energized. Their responsibility is to observe that safe working clearances are maintained around all overhead lines and to direct the equipment operator accordingly.
- When an Unqualified Person is working either in an elevated position or at ground level near energized overhead lines, their location and the longest conductive object being used must not come closer than 10 feet from the overhead line.
- All vehicles and mechanical equipment operating in the vicinity of energized overhead electrical lines must not approach the lines any closer than 10 feet. Personnel standing on the ground near equipment operating near overhead lines must stay 10 feet clear of the operating equipment.

VEHICLE AND MECHANICAL EQUIPMENT

Elevated Equipment

Where any vehicle or mechanical equipment structure will be elevated near energized overhead lines, they must be operated so the limited approach boundary distance listed in NFPA 70E Table 130.4(C), column 2, is maintained. However, under any of the following conditions, the clearances can be reduced:

- If the vehicle is in transit with its structure lowered, the limited approach boundary distance to the overhead lines in NFPA 70E Table 130.4(C), column 2, can be reduced by 6 feet.
- If insulated barriers, rated for the voltages involved, are installed and are *not* part of an attachment to the vehicle, the clearance can be reduced to the design working dimensions of the insulting barrier.
- If an aerial lift insulated for the voltage involved, and the work is performed by a Qualified Person, the clearance (between the un-insulated portion of the aerial lift

and the power line) can be reduced to the restricted approach boundary given in NFPA 70E Table 130.4(C), column 4.

Equipment Contact

Personnel standing on the ground must *not* contact any vehicle or mechanical equipment that is in contact with an energized power line, or any of its attachments, unless one of the following conditions applies:

- The employee is using protective equipment rated for the voltage.
- The equipment is located so that no uninsulated part of the structure (i.e., that portion of the structure that provides a conductive path to personnel on the ground) can come closer to the energized line than permitted in NFPA 70E 130.8(F)(1).

Equipment Grounding

If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, personnel working on the ground near the point of grounding must *not* stand at the grounding location whenever there is a possibility of overhead contact.

Additional precautions, such as the use of barricades or insulation, must be taken to protect individuals from hazardous ground potentials (step and touch potential), which can develop within a few feet or more outward from the ground point.

RESETTING CIRCUIT BREAKERS

Please refer to the Electrical Circuit Breaker Reset Procedure and Electrical Safety: Resetting Circuit Breakers Focus Sheet.

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ELECTRICAL EQUIPMENT SAFETY/INSTALLATION

DESIGN

New electrical wiring, and the modification, extension, or replacement of existing wiring must conform to the requirements of the National Electrical Code (NFPA 70) that is in effect at the time of installation per the local building code and applicable ASTM, NEMA, and OSHA standards and must be UL listed for the application.

ELECTRICAL PANELS

Doors into electrical control panel/equipment rooms/vaults must be marked with a visible and legible sign stating "**DANGER – HIGH VOLTAGE – AUTHORIZED PERSONNEL ONLY**" or something similar. Electrical safety signage is required to meet ANSI Z535 design standards.

Electrical panels must be kept free of any obstructions at a minimum of three (3) feet around the entire panel.

LISTING/LABELING EQUIPMENT

Safety signs, symbols, or accident prevention tags must be used where necessary to warn personnel about electrical hazards that may endanger them. Equipment such as switchboards, panel boards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized must be marked with a label containing the following information:

- Nominal system voltage
- Maximum available fault current; this must be amended as required to reflect modifications or changes to the installation over time
- Who performed fault current calculations and the date performed
- Available incident energy and the corresponding working distance, or the arc flash PPE category for the equipment (but not both)
- Who performed the incident energy analysis and the date performed
- Arc flash boundary value
- Shock protection limited and restricted approach boundary values

Labeling is intended to reduce the occurrence of serious injury or death due to arcing faults to individuals working on or near energized electrical equipment. Labels must be located so they are visible to the personnel before examination, adjustment, servicing, or maintenance of the equipment.

CUSTOM-MADE EQUIPMENT

Refer to the Research and Development section of this manual.

IDENTIFICATION OF DISCONNECTING MEANS AND CIRCUITS

- Each disconnecting means for motors and appliances must be legibly marked to indicate its purpose. The label or marking should be located at the point where the circuit originates, for example, on a panel that controls several motors or on a motor control center.
- Each disconnect must be clearly marked to indicate the motor to which each circuit is connected.
- Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, must be legibly marked to indicate its purpose.
- All labels and markings must be durable enough to withstand weather, chemicals, heat, corrosion, or any other environment to which they may be exposed.

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HAZARDOUS LOCATIONS

WET/DAMP

Conducting electrical work in wet or damp locations, such as areas surrounding or near water or other conductive liquids, must not be performed unless determined to be critical for operations. When possible, work should be postponed until all liquid can be cleaned up, or if not possible, the task must be approved by a Qualified Person and their supervisor. If work is allowed to be performed while the liquid is present, every attempt must be made to provide an insulated workspace. The following precautions must be incorporated while performing work in damp locations:

- Only use electrical cords that have Ground Fault Circuit Interrupters (GFCIs);
- Place a dry barrier over any wet or damp work surface;
- Remove standing water before beginning work (work in standing water is prohibited);
- Do not use electrical extension cords in wet or damp locations; and
- Keep electrical cords away from standing water.

Refer to Ground Fault Circuit Interrupter (GFCI) Focus Sheet.

UNDERGROUND ELECTRICAL INSTALLATIONS

Electrical installations conducted underground may have additional requirements due to the added confined space hazards that must be considered. The additional requirements for working in electrical manholes or sub-surface vaults include:

- Ladders must be used to enter and exit manholes or sub-surface vaults greater than or equal to four feet in depth.
- Personnel are *not* allowed to climb in or out of a vault using cables or hangers.
- Equipment used to lower materials into manholes or vaults must be capable of supporting the weight of the materials and must be inspected for defects prior to use.
- When equipment is lowered, personnel must be clear of the area directly under the opening.
- While work is being performed in a manhole containing energized electrical equipment, personnel with first aid and CPR training must be available on the surface in the immediate vicinity to render emergency assistance.
- When a confined space meets the definition of a permit-required confined space, all required documentation and training of the UW Confined Space Program must be completed prior to entering the space.

STATIONARY LEAD-ACID BATTERY SYSTEMS

Signage

Doors and entryways into rooms or areas containing stationary lead-acid battery systems that have a capacity of more than 50 gallons of electrolyte must have approved signage posted.

The signage must state

- The room contains lead-acid battery systems;
- The battery room contains energized electrical circuits; and
- The battery electrolyte solutions are corrosive liquids.

Emergency Eyewash

An approved emergency eyewash station must be available in the immediate area when servicing lead-acid battery systems.

In the event of electrolyte contact with the eyes, flush with large amounts of water for a minimum of 15 minutes. Initiate exposure response procedures as necessary.

Safety Equipment

The following equipment must be available to all personnel working with flooded (i.e., wet cell) batteries:

- Safety glasses, goggles, and approved face shield
- Acid-resistant gloves for handling batteries
- Protective apron or acid-resistant battery suit and overshoes
- Rubber gloves appropriately rated for possible voltage exposure, plus heavy-duty leather protector gloves
- Insulated tools
- Electrolyte neutralizing kit

Wear PPE, including eye/face protection, gloves, aprons or battery suits, and non-conductive safety toe boots when handling electrolyte and/or moving batteries as electrolyte is extremely corrosive. Remove all jewelry (watches, rings, necklaces, etc.) & keys before working with batteries.

Additional safety measures include the following:

- Use insulated tools if any work must be done on or around the battery.
- Always observe proper polarity connections.
- Always ensure unobstructed egress from the battery area.
- Adequate ventilation must be provided to remove explosive hydrogen gases that are generated during battery charging.

- Flame arresters must be installed on all batteries.
- No smoking or open flames are permitted near a battery.
- Solvents, detergents, and lubricants can damage the plastic compounds used in the battery case and covers. The use of chemical solvents and lubricants must be limited to specific approved materials.
- Use proper fuse leads for short circuit protection during all testing as extremely high currents are available from a battery. Even an apparently dead battery cell must never be short-circuited.
- Beware that battery cells connected in a series are likely to have high voltages that could present a shock hazard.
- Never directly short a battery cell or portion of a cell with a jumper to keep the DC circuit complete.
- Personnel handling batteries may accumulate static charge and must always touch a grounded surface to discharge static before touching a cell post.
- Transporting batteries safely includes:
    - Using proper material handling and lifting techniques.
    - Using carts as much as possible to minimize the need to carry batteries.
    - Never lift or move a battery by its cell posts; use lifting devices of adequate capacity when required. Inspect all lifting equipment before use.
- Visually check to ensure metal battery racks are properly connected to the station ground.
- Load test leads must be connected with sufficient lengths to prevent accidental arcing in the battery area.
- Avoid arcing in the immediate vicinity of the battery.
- When mixing electrolyte, the acid must always be added to water, never the reverse, as this may result in an explosion.

WORKING AT ELEVATED LOCATIONS

- Personnel working on electrical equipment on an elevated surface must take necessary precautions to prevent a fall from a sudden reaction to electrical shock or other causes.
- Portable ladders must have non-conductive side-rails if they are used where the person or the ladder could contact exposed energized parts. Metal ladders are not permitted. All ladders must be in compliance with the applicable ANSI A14 standard.
- Working at heights of four (4) feet or greater also requires specific documents and training from the fall protection program before work can begin.

BUCKET TRUCKS

- Considerations must be given to the location of overhead conductors and the surrounding condition before the truck is moved into the work position. The truck must be placed in a location near the work area to minimize the need to move the boom while to work in ongoing.
- Take precautions when operating vehicular and mechanical equipment in the vicinity of energized overhead electrical lines.
- Equipment or materials must *not* be passed between a pole or structure and a bucket truck while personnel working from the basket are within reaching distance of energized conductors or equipment that is *not* covered with insulating protective covering.
- Insulated parts of an aerial lift device must *not* be altered with any material that might reduce its insulating value.
- The use of corded electrical tools from the basket is *not* permitted.
- Bucket trucks with insulated arm(s) must be electrically tested annually.
- In the event of adverse weather conditions, the work must be discontinued. Adverse weather conditions include, but is not limited to, thunderstorms in the immediate vicinity, high winds, snowstorms, and ice storms.

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CONTRACTORS

Contractors must *not* utilize University owned, leased, or managed electrical equipment unless approved by the organization/unit/department.

Personnel working on energized parts and/or equipment associated with construction projects are covered under construction project requirements and are *not* addressed in this manual.

Contractors working on UW property (leased or owned) must follow their own electrical safety program in accordance with the Washington Administrative Code (WAC) Section 296-24-957 Part L Electrical and the requirements of this manual, where applicable. The UW hiring manager must request the following documents from the contractor prior to work commencing:

- Job Hazard Analysis (JHA)
- Company electrical safety program
- Electrical safety training records

The UW responsible party must have a Qualified Person review and accept the information submitted. Any gaps that are identified must be addressed and resolved by the contractor before work is performed.

EMERGENCY PROCEDURES

ELECTRICAL INJURIES

Individuals exposed to shock hazards must be trained in methods to safely release victims in contact with energized electrical conductors and circuit parts. If someone has received an electrical shock, do not touch the person, equipment, cord, or any other objects touching them or in the immediate vicinity. Call 9-1-1, and if certified to do so, start first aid and CPR procedures if the situation is safe to do so.

If it is safe to do so, disconnect the power source immediately. Do not touch any power source or energized equipment if unsure whether it is safe to do so.

ELECTRICAL FIRES

In the event of an electrical fire, leave the area immediately and follow the building Fire Safety and Evacuation Plan to exit the building to safety and call 9-1-1.

If it is safe to do so, shut down the power source while exiting the area. Only employees trained in the use of a fire extinguisher may use one to extinguish an electrical fire by using a type ABC, BC, or C extinguisher.

INCIDENT REPORTING

UW personnel must report any work-related injury or illness to their supervisor as soon as possible. After reporting the incident to a supervisor, submit a report of the incident within 24 hours to EH&S via the UW Online Accident Reporting System (OARS). Some incidents require immediate reporting.

Visit the Accident and Injury Reporting webpage on the EH&S website for more information.

UW units and departments must hold personnel accountable for following all safety policies and protocols and ensure they understand the consequences and risks associated with non-adherence to electrical safety requirements.

TRAINING

UNQUALIFIED WORKER

All Unqualified Personnel who have the potential to be exposed to energized parts during their work activities, but do not work on them, must complete the UW Electrical Safety in the Workplace course. This course teaches general safety regulations, hazard identification, safe work practices, and PPE requirements. It also provides mandatory level classroom training in shock and arc flash safety for Unqualified Personnel. This course is required initially before work begins and every three (3) years.

QUALIFIED WORKER

All Qualified Personnel who work with exposed electrical circuits operating at 50 to 600 volts to ground must complete the following courses:

- UW Low Voltage Electrical Safety course; required initially before work begins and every three (3) years thereafter.
- UW Lockout/Tagout Initial course; required initially before work begins.

All Qualified Personnel who work with exposed electrical circuits operating at 50 to 600 volts to ground must be certified in First Aid & CPR. This course is required initially before work begins and every two (2) years thereafter.

AWARENESS TRAINING

The Electrical Safety Awareness Online course is recommended for University personnel who do *not* encounter exposed energized electrical parts but want basic electrical safety awareness and recognition skills.

REFRESHER TRAINING

Refresher training is required:

- When new equipment is planned to be used.
- Following an accident or incident.
- Performing an unsafe operation (observed).
- When a deficiency related to safe operation is identified during an inspection or audit.
- Where a performance evaluation by the trainer indicates deficiencies.

PROGRAM AUDITS AND INSPECTIONS

Departments/units/organizations must assign a designated person the responsibility of reviewing this UW Electrical Safety Program Manual.

EH&S conducts inspections of limited electrical components, such as panels and equipment, during shop inspections; the frequency of the inspections is every two years.

The program audits and inspections performed by EH&S are documented; any identified deficiency is assigned a corrective action and communicated to management. Corrective actions must be tracked to completion.

RECORDKEEPING

The following records must be retained according to UW policy and regulatory record retention requirements:

Record	Retention Requirement
Job Safety Plan & Briefing Checklist	6 years
Energized Electrical Work Plan and Permit	6 years
Custom Electrical Equipment Field Evaluation	6 years
Program audits and inspections	6 years
Training documents	6 years

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REFERENCES

WAC Section 296-24-957 Part L Electrical

NFPA 70 National Electric Code (2023)

NFPA 70E Standard for Electrical Safety in the Workplace (2024)

UW EH&S Extension Cords, Surge Suppressors and Power Strips Focus Sheet

UW EH&S Ground Fault Circuit Interrupter (GFCI) Focus Sheet

UW EH&S Lithium Battery Safety Guidelines

UW EH&S Electrical Safety: Resetting Circuit Breakers Focus Sheet

UW EH&S Electrical Circuit Breaker Reset Procedure

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APPENDIX A: DEFINITIONS

Accessible – Admitting close approach; not guarded by locked doors, elevation, or other effective means

Approved – Acceptable to the authority having jurisdiction

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

Arc Rating – The value attributed to materials that describes their performance to exposure to an electrical arc discharge; the arc rating is expressed in cal/cm^2 and is derived from the determined value of the arc thermal performance value (ATPV) or energy of breakopen threshold (E_{BT}) (should a material system exhibit a breakopen response below ATPV value). Arc rating is reported as either ATPV or E_{BT}, whichever is the lower value

Attachment Plug (Plug Cap) (Plug) – A device that, but insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle

Automatic – Performing a function without the necessity of human intervention

Balaclava – An arc-rated head-protective fabric that protects the neck and head expect for a small portion of the facial area

Barricade – A physical obstruction such as tapes, 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 energized electrical conductors and circuit parts

Bonded – Connected to establish electrical continuity and conductivity

Bonding Conductor or Jumper – A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected

Boundary, Arc Flash – When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm^2 (5 J/cm^2)

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

Boundary, Restricted Approach – 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

Cabinet – An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung

Circuit Breaker – A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating

Conductive – Suitable for carrying electric current

Conductor, Bare – A conductor having no covering or electrical insulation whatsoever

Conductor, Covered – A conductor encased within material of composition or thickness that is not recognized by *NFPA 70, National Electrical Code,* as electrical insulation

Conductor, Insulated – A conductor encased within material of composition and thickness that is recognized by *NFPA 70, National Electrical Code,* as electrical insulation

Controller – A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected

Current-Limiting Overcurrent Protective Device – A device that, when interrupting currents in its current-limiting range, reduces the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance

Cutout – An assembly of a fuse support with either a fuse holder, fuse carrier, or disconnecting blade; the fuse holder or fuse carrier may include a conducting element (fuse link), or may act as the disconnecting blade by the inclusion of a non-fusible member.

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

Device – A unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function

Diagnostic (Testing) – Taking readings or measurements of electrical equipment, conductors, or circuit parts with approved test equipment that does not require making any physical change to the electrical equipment, conductors, or circuit parts

Disconnecting Means – A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source supply

Disconnecting (Isolating) Switch (Disconnector, Isolator) – A mechanical switching device used for isolating a circuit or equipment from a source of power

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

Electrical Safety – Identifying hazards associated with the use of electrical energy and taking precautions to reduce the risk associated with those hazards

Electrical Safety Program – A documented system consisting of electrical safety principles, policies, procedures, and processes that directs activities appropriate for the risk associated with electrical hazards

Electrically Safe Work Condition – A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established

standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection

Enclosed – Surrounded by a case, housing, fence, or wall(s) that prevents persons from unintentionally contacting energized parts

Enclosure – The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from unintentionally contacting energized electrical conductors or circuit parts or to protect the equipment from physical damage

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

Equipment – A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like, used as a part of, or in connection with, an electrical installation

Equipment, Arc-Resistant – Equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee

Exposed (energized electrical conductors or circuit parts) – Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated

Exposed (wiring methods) – On or attached to the surface or behind panels designed to allow access

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

Fitting – An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function

Fuse – An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it

Ground – The Earth

Ground Fault – An unintentional, electrically conductive connection between an ungrounded conductor of an electrical circuit and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or Earth

Grounded (Grounding) – Connected (connecting) to ground or to a conductive body that extends the ground connection

Grounded, Solidly – Connected to ground without inserting any resistor or impedance device

Grounded Conductor – A system or circuit conductor that is intentionally grounded

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

Grounding Conductor, Equipment (EGC) – The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both

Grounding Electrode – A conducting object through which a direct connection to Earth is established

Grounding Electrode Conductor – A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system

Guarded – Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger

Hazard – A source of possible injury or damage to health

Hazardous – Involving exposure to at least one hazard

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).

Incident Energy Analysis – A component of an arc flash risk assessment used to predict the incident energy of an arc flash for a specified set of conditions

Insulated – Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current

Interrupter Switch – A switch capable of making, carrying, and interrupting specified currents

Interrupting Rating – The highest current at rated voltage that a device is identified to interrupt under standard test conditions

Isolated – Not readily accessible to persons unless special means for access are used

Labeled – Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner

Listed – Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose

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

Motor Control Center – An assembly of one or more enclosed sections having a common power bus and principally containing motor control units

Outlet - A point on the wiring system at which current is taken to supply utilization equipment

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, would cause damage or dangerous overheating; a fault, such as a short circuit or ground fault, is not an overload

Panelboard – A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front.

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

Raceway – An enclosed channel of metal or nonmetallic materials designated expressly for holding wires, cables, or busbars, with additional functions as permitted

Receptacle – A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device with no other contact device on the same yoke; a multiple receptacle is two or more contact devices on the same yoke.

Repair – Any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.)

Risk – A combination of the likelihood of occurrence of injury or damage to health and the severity of injury or damage to health that results from a hazard

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

Service Drop – The overhead conductors between the utility electric supply system and the service point

Service Lateral – The underground conductors between the utility electric supply system and the service point

Service Point – The point of connection between the facilities of the serving utility and the premises wiring

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

Short-Circuit Current Rating – The prospective symmetrical fault current at a normal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptable criteria

Special Permission – The written consent of the authority having jurisdiction

Step Potential – A ground potential gradient difference that can cause current flow from foot to foot through the body

Switch, Isolating – A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means

Switchboard – A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments; these assemblies are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets.

Switchgear, Metal-Clad – A switchgear assembly completely enclosed on all sides and top with sheet metal, having drawout switching and interrupting devices, and all live parts enclosed within grounded metal compartments

Switchgear, Metal-Enclosed – A switchgear assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows), containing primary power circuit switching, interrupting devices, or both, with buses and connections. This assembly may include control and auxiliary devices; access to the interior of the enclosure is provided by doors, removable covers, or both. Metal-enclosed switchgear is available in non-arc-resistant or arc-resistant constructions.

Switching Device – A device designed to close, open, or both, one or more electric circuits

Touch Potential – A ground potential gradient difference that can cause current flow from hand to hand, hand to foot, or another path, other than foot to foot, through the body

Ungrounded – Not connected to ground or to a conductive body that extends the ground connection

Unqualified Person – A person who is not a Qualified Person as they have not demonstrated the skills and knowledge to work on energized electrical parts

Utilization Equipment – Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes

Voltage (of a Circuit) – The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned

Voltage, Nominal – A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 volts, 480Y/277 volts, 600 volts)

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

Working Near – Any activity within a limited approach boundary

Working On (energized electrical conductors or circuit 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 personal protective equipment (PPE) a person is wearing

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APPENDIX B: JOB SAFETY PLAN AND BRIEFING CHECKLIST

View the most recent accessible version of the Job Safety Plan and Briefing Checklist on the EH&S website.

JOB SAFETY PLAN & BRIEFING CHECKLIST

IDENTIFY

- ☐ The hazards
- ☐ The shock protection boundaries
- ☐ The voltage levels involved
- ☐ The available incident energy
- ☐ Any "foreign" (secondary source) voltage source
- ☐ Potential for arc flash (conduct an arc flash risk assessment.)
- ☐ Skills required
- ☐ Arc flash boundary
- ☐ Any unusual work conditions
- ☐ How many people are needed to do the job?

ASK

- ☐ Can the equipment be de-energized?
- ☐ Can the circuits to be worked on back fed?
- ☐ Is a standby person required?

CHECK

- ☐ Job plans
- ☐ Safety procedures
- ☐ Single-line diagrams and vendor prints
- ☐ Vendor information
- ☐ Status board
- ☐ Individuals are familiar with the facility
- ☐ Information on plant and vendor resources is up to date

KNOW

- ☐ What the job is?
- ☐ Who is in charge?
- ☐ Who else needs to know – Communicate!

THINK

- ☐ About the unexpected event... What if?
- ☐ Install and remove grounds
- ☐ Lock – Tag – Test – Try
- ☐ Install barriers and barricade
- ☐ Test for voltage - FIRST
- ☐ What else...?
- ☐ Use the right tools and equipment, including PPE

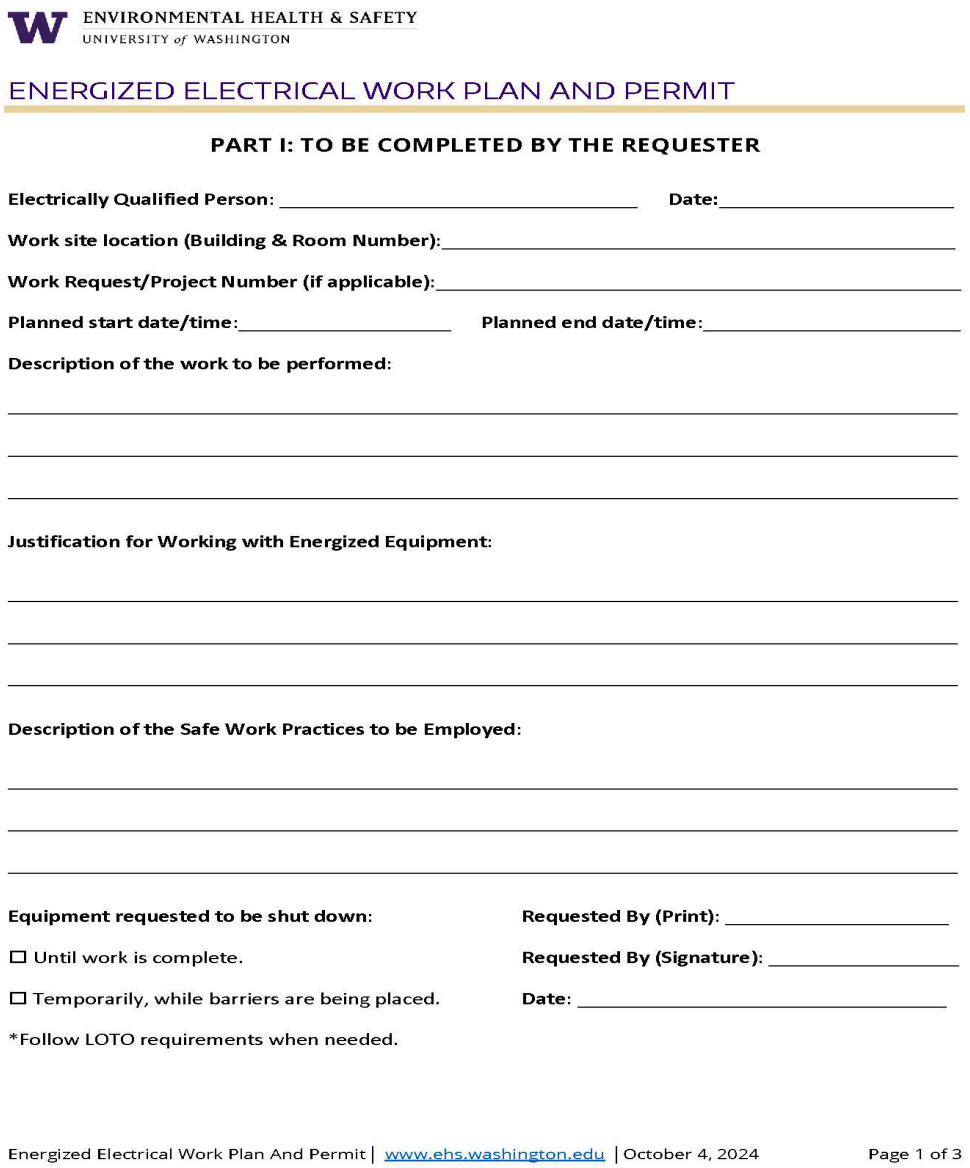
PREPARE FOR AN EMERGENCY

- ☐ Is the standby person CPR/AED trained?
- ☐ What is the exact work location?
- ☐ Is the required emergency equipment available? Where is it?
- ☐ How is the equipment shut off in an emergency?
- ☐ Where is the fire alarm?
- ☐ Where is the nearest telephone?
- ☐ Where is the fire extinguisher?
- ☐ Are the emergency telephone numbers known?
- ☐ Are radio/cell phone communications available?
- ☐ Is confined space rescue available?

job Safety Plan & Briefing Checklist | www.ehs.washington.edu | October 7, 2024 Page 1 of 1

APPENDIX C: ENERGIZED ELECTRICAL WORK PLAN AND PERMIT

View the most recent accessible version of the Job Energized Electrical Work Plan and Permit on the EH&S website.



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ENERGIZED ELECTRICAL WORK PLAN AND PERMIT

PART I: TO BE COMPLETED BY THE REQUESTER

Electrically Qualified Person: _____ **Date:**_____

Work site location (Building & Room Number):_____

Work Request/Project Number (if applicable):_____

Planned start date/time:_____ **Planned end date/time:**_____

Description of the work to be performed:

_____

_____

_____

Justification for Working with Energized Equipment:

_____

_____

_____

Description of the Safe Work Practices to be Employed:

_____

_____

_____

Equipment requested to be shut down:

☐ Until work is complete.

☐ Temporarily, while barriers are being placed.

*Follow LOTO requirements when needed.

Requested By (Print): _____

Requested By (Signature): _____

Date: _____

Energized Electrical Work Plan And Permit | www.ehs.washington.edu | October 4, 2024 Page 1 of 3

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

Risk Assessment Results

1. **Voltage to which personnel will be exposed:** _____
2. **Limited approach boundary (feet):** _____
3. **Restricted approach boundary (feet):** _____
4. **Required PPE to safely perform the assigned task:** _____

Results of the Arc Flash Hazard Analysis: _____

_____

_____

Protective Clothing, Equipment, and Tools Required:

☐ Voltage-rated tools
☐ Voltage-rated gloves
☐ Safety Glasses
☐ Hearing Protection
☐ Leather gloves
☐ Leather work shoes
☐ Hard Hat
☐ Hard hat liner – arc-rated
☐ Shirt, short sleeve (natural fiber)
☐ Shirt, long sleeve (natural fiber)
☐ Long Pants (natural fiber)
☐ Shirt, long sleeve arc-rated
☐ Logn pants – arc-rated
☐ Coveralls – arc-rated
☐ Jacket/rainwear - arc-rated
☐ Flash suit jacket – arc-rated
☐ Flash suit pants – arc-rated
☐ Face Shield – arc-rated
☐ Flash Suit Hood – arc-rated
☐ 25-Cal Suit
☐ 40-Cal Suit

Arc Flash PPE Category: ☐ 1 ☐ 2 ☐ 3 ☐ 4 ***NFPA 70E 130.7 (C)(15)/Table 130.7(C)(15)(a)**

Arc Flash PPE Max Cal Rating (cal/cm^2): ☐ 4 ☐ 8 ☐ 25 ☐ 40 ***NFPA 70E 130.7 (C)(15)/Table 130.7(C)(15)(a)**

Means employed to restrict the access of Unqualified Persons from the area:

☐ Signs/Tags ☐ Barricades ☐ Attendants Other (describe):_____

Has a documented job briefing been conducted? ☐ Yes, see attached. ☐ No

Can the work be conducted safely as described? ☐ Yes ☐ No (If *no*, return to requester)

Has a second person been identified to accompany the Qualified Person conducting the work to meet a unit required 2-person rule?

☐ Yes

☐ No (If *no*, describe below why there is no need for a second person. Supervisor must approve the work without a second person.)

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

(Signatures not required for tasks that are exempt from a permit, such as testing, troubleshooting, or taking voltage measurements)

Qualified Person Name (Print): _____ **Date:**_____

Qualified Person Name (Signature): _____ **Date:**_____

Supervisor Name (Print): _____ **Date:**_____

Supervisor Name (Signature): _____ **Date:**_____

The department is required to retain the completed permit for six (6) years.

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APPENDIX D: HAZARD RISK CATEGORY (HRC)/ARC FLASH PERSONAL PROTECTIVE EQUIPMENT CATEGORIES

PPE CATEGORY 1: MINIMUM ARC RATING OF 4 CAL/CM^2

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/CM^2

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/CM^2

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/CM^2

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)
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APPENDIX E: APPROACH DISTANCES TO EXPOSED ENERGIZED PARTS

View the most recent accessible version of the Approach Distances to Exposed Energized Parts on the EH&S website.

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APPROACH DISTANCES TO EXPOSED ENERGIZED PARTS

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

SHOCK PROTECTION BOUNDARIES

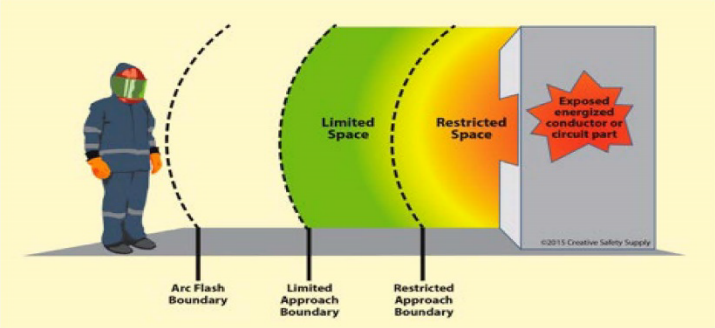
The distance for the limited and restricted approach boundaries are found in NFPA 70E tables 130.4(D)(a) and (b).

Within the **limited approach boundary**, unqualified persons must *not* be inside the boundary unless escorted by a Qualified Person and informed of potential safety hazards.

Within the **restricted approach boundary**, only a Qualified Person with proper PPE and tools may enter. Inside this boundary, accidental movement can put a part of the body or conductive tools in contact with live parts or inside the prohibited approach boundary.

To cross the restricted approach boundary, the Qualified Person must:

- Perform hazard identification and risk assessment.
- Complete an energized work plan and permit that is approved by the supervisor when performing work beyond testing and trouble shooting.
- Use PPE rated for working near exposed energized parts and rated for the voltage and energy level involved.
- Ensure that no part of the body enters the prohibited space.
- Minimize risks from unintended movement by keeping as much of the body as possible out of the restricted space (body parts in the restricted space should be protected).



ARC FLASH PROTECTION BOUNDARY

When interacting with electrical equipment within the Arc Flash Protection Boundary, protective equipment and measures are required.

Approach Distances To Exposed Energized Parts | www.ehs.washington.edu | October 3, 2024 | Page 1 of 2

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The Qualified Person must:

- Determine if interaction meets the criteria for normal operation of electric equipment. A hazard identification assessment must be done with the arc flash hazard label and NFPA 70E Table 130.5(C) to provide guidance on assessing the likelihood of an arc flash occurrence. Arc-rated PPE may not be required for normal operation of electric equipment.
- If criteria for normal operation is not met, arc flash PPE is necessary to conduct work activities.
- Use PPE appropriate for working near exposed energized parts and rated for the voltage and energy level involved.

If an arc flash analysis has been performed, a Qualified Person can use the incident energy value on the arc flash analysis label and the arc flash hazard Table 130.5(G) to specify arc-rated clothing and other PPE.

When a system of 600 volts and less does not have an arc flash analysis performed and no incident energy levels listed, do the following:

- Use NFPA 70E Table 130.7(C)(15)(a) and/or Table 130.7(C)(15)(b) to determine the arc-flash PPE category.
- Use NFPA 70E Table 130.7(C)(15)(c) to choose the appropriate clothing and PPE.
- NFPA 70E Table 130.4(D)(a) and/or Table 130.5(D)(b) will provide the limited and restricted approach boundaries.

NFPA Table 130.7(C)(15)(a) and/or Table 130.7(C)(15)(b) will provide arc flash boundary distance, provided the equipment meets the maximum short circuit current and fault clearing time criteria in the tables.

Refer to the UW Electrical Safety Manual for more information.

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APPENDIX F: PPE INSPECTION, MAINTENANCE AND CARE GUIDANCE

View the most recent accessible version of the PPE Inspection, Maintenance and Care Guidance on the EH&S website.

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PPE INSPECTION, MAINTENANCE AND CARE GUIDANCE

Personnel working in areas where there are potential electrical hazards are required to wear personal protective equipment (PPE) that protects against electrical hazards. Protective equipment must be maintained in a safe, reliable condition and must be periodically inspected and/or tested according to the manufacturer's requirements.

Refer to the UW Electrical Safety Manual for more information.

Equipment	Test Interval	Storage, Care Guidance	Inspection Items
Gloves Rubber Insulators	Before first issue and every six months after. All surfaces of the rubber-insulating gloves must be inspected for damage. Roll gloves and test that air does not leak.	Store rubber insulating gloves and leather protector in glove bags or protective containers. Gloves contaminated with petroleum-based lubricants must be discarded.	Holes in gloves. Dirty gloves. Metal particles embedded in the gloves. Chemical substances that can damage the gloves.
Gloves Leather Protectors	Inspect before each use. Perform glove air test.	Store in clean, dry location. Store gloves in storage bags. Glove dust can be used to reduce friction between the hand and insulation glove.	Holes in gloves. Dirty gloves. Metal particles embedded in the gloves. Chemical substances that can damage the gloves.
Blankets/Sleeves	Before first issue and every 12 months.	Store in clean, dry, dust free location. Protect from extreme light, temperature, humidity, and ozone locations.	Holes. Deteriorated fabric material. Chemical contamination.
Safety Glasses and Goggles	Inspect before each use.	Store in clean, dry, dust free location.	Scratches or cracks in lens area.
Line Hose/Covers	Upon indication that insulation value is devalued.	Store in clean, dry, dust free location.	Holes. Chemical contamination.
Arc Face Shields	Inspected for physical integrity and free of cracks or excessive wear.	Store in a face shield bag to protect from dust and scratches. Ensure no residue is left on shield after cleaning. Always clean with water and a mild soap. Dry with a soft cloth.	Dirty face shield. Crack in mask.

PPE Inspection, Maintenance and Care Guidance | www.ehs.washington.edu | October 3, 2024 Page 1 of 2

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Equipment	Test Interval	Storage, Care Guidance	Inspection Items
Arc-Rated Garments	Inspect before each use.	Store in kit bags or hang up in a clean, dry location. When laundering, follow manufactures guidance. Failure to launder properly could affect the flame resistance of the garment. Do not use chlorine bleach, hydrogen peroxide, softeners, or starch when laundering.	Oil or dirt on fabric. Tears in garments. Contaminated or damaged articles that diminish protective qualities must not be used.
Footwear	Inspect before each use.	Store in clean, dry area.	Chemical contamination. Tears in shoe. Holes in soles.
Insulated Equipment	Inspect before each use.	Store in clean dry location away from sunlight, excessive humidity, ozone, oils, petroleum products, hand lotion, baby powder.	Embedded foreign objects, holes, punctures. Tears or cuts, ozone damage, swelling, softening, sticky or hardening. Chemical contamination.

APPENDIX G: CUSTOM ELECTRICAL EQUIPMENT FIELD EVALUATION FORM

View the most recent accessible version of the Custom Electrical Equipment Field Evaluation Form on the EH&S website.

ENVIRONMENTAL HEALTH & SAFETY
UNIVERSITY of WASHINGTON

CUSTOM ELECTRICAL EQUIPMENT FIELD EVALUATION FORM

Equipment Name: _____ **Equipment Fabricator:** _____

Department: _____ **Competent Person/Inspector:**_____

Equipment Satisfaction Review (Mark the box when completed.)*

#	ITEM		DONE
1	Equipment examination		
2	Execution of work		
3	Exposed metal parts grounded		
4	Electrically conductive material likely to become energized is bonded		
5	Strength		
6	Electrical spacing		
7	Overcurrent protection appropriate for intended use		
8	Safety Interlocks		
9	Emergency Stop (E-Stop)		

*Refer to the UW Electrical Safety Manual for inspection criteria.

Comments: Include all designer/builder instructions, restrictions on use, drawings or information that is relevant to the safe installation and use of this equipment. Attach additional sheets as necessary.

_____

_____

_____

_____

☐ Approved for use ☐ Not approved for use (document reason)

Date: _____ **Inspector Name (Print):** _____

Inspector Name (Signature): _____

Once approved for use, if this equipment is modified, relocated, damaged, repaired, or utilized for other than the intended use stated above, this approval will become void pending a new evaluation.

The department/unit/organization is required to retain the completed evaluation form.

Custom Electrical Equipment Field Evaluation Form | www.ehs.washington.edu | October 4, 2024 Page 1 of 1

APPENDIX H: ELECTRICAL SAFETY PROGRAM MANUAL REVIEW DOCUMENTATION

View the most recent accessible version of the Electrical Safety Program Manual Review Documentation on the EH&S website.

ENVIRONMENTAL HEALTH & SAFETY
UNIVERSITY of WASHINGTON

ELECTRICAL SAFETY MANUAL REVIEW DOCUMENTATION

Department/Unit/Organization/Lab Name: _____

Name	Review Date	Signature

By signing this log, you confirm that you have read this program manual, that you understand its content, and that you have had an opportunity to ask questions.

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