



Electrical Safety Program



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I. Policy

This California State University, Fullerton (CSUF) Policy affirms CSUF's management commitment to proactively identify all electrical hazards and assess and control their associated risks. An electrically safe work condition shall always be the first choice when feasible when working on any electrical equipment at CSUF.

This document provides all personnel at CSUF with basic electrical system safety requirements and incorporates existing written safety rules, practices and procedures for personnel working with or around electrical systems. At a minimum, all personnel performing activities with, or around electrical systems shall know, understand, and follow all the requirements contained within this written CSUF Electrical Safety Program.

II. Authority

National Fire Protection Association (NFPA) 70E; California Code of Regulations (CCR), Title 8, Section 2300-2589 (Low Voltage); CCR, Title 8, Section 2700-2989 (High Voltage).

III. Scope

Electrical work (herein referred to as "work") consists of any type of direct or indirect contact or interaction with electrical utilization equipment. These may include for example operating (such as inspecting, switching, and racking), maintaining (tightening, loosening, troubleshooting, disconnecting, changing, replacing), commissioning (installing, testing, tuning, building, and altering), and decommissioning (removing and demolishing).

This document establishes the minimum requirements and practices for the design, operation, and maintenance of electrical systems in all owned, managed, and leased facilities. This document applies to all personnel, contractors, vendors, and visitors (herein referred to as "persons").

In lieu of this document, personnel servicing and maintaining electrical office equipment, medical equipment, vending machines, appliances, and other similar equipment shall follow all manufacturer safety recommendations for the item.

These requirements shall apply to both new and modified installations. Existing installations need not be physically modified to comply with this document unless necessary to protect all persons from a recognized hazard. All persons shall be responsible for following the requirements of the specific written electrical safety rules, practices, and procedures.

As always STOP if unsure at any time and contact your supervisor or manager.

The safety considerations contained in this document serve as minimum requirements in the design, maintenance, and operation of the CSUF electrical systems. Users shall follow all local legislated codes or accepted employee safety standards, design criteria, etc., when they are more stringent than those identified within this document.

IV. Responsibilities

A. Capital Programs and Facilities Management (CPFM)

- i. Shall be responsible for disseminating this program.
- ii. Shall be responsible for implementing CSUF area-specific safety rules, practices, and procedures contained in this program. Managers may delegate the task of implementing the requirements of this document to an electrically qualified person or persons.
- iii. Management shall be responsible for verifying that newly installed or modified electrical equipment or systems have been inspected to comply with applicable



installation codes and standards prior to being placed into service.

- iv. Management shall inform contract employers of known hazards that are covered by this standard that are related to the contract employer's work.
- v. Management shall ensure that only qualified contractors are brought onto CSUF property.
- vi. Management shall provide ongoing funding of the Electrical Safety Program.

B. Environmental Health and Safety

- i. Shall review and update this program at intervals not exceeding three years.
- ii. Provide training as necessary.
- iii. Provide consultation to CPFM upon request.

C. Persons

i. Qualified Persons

- Task supervisors are responsible for the safety of all persons under their direction. When evaluating tasks to be completed, task supervisors shall see that persons have fulfilled training requirements, follow location safety rules, and adhere to operating procedures.
- Shall be responsible for keeping unqualified and unprotected persons out of the Limited Approach Boundary and Arc Flash Boundary of energized electrical work unless escorted by a qualified person.
- Shall be responsible for following the proper safety precautions and applicable CSUF job planning documents.
- Shall know the appropriate tools and devices for each task assigned to them and how to inspect and test those tools and devices before beginning work.
- Shall remain knowledgeable and current on the applicable specifications and rules applying to their jobs.

ii. Unqualified Persons

- Shall always be aware of possible electrical hazards even when their tasks do not involve electrical work, such as the operation of power tools or mobile cranes, use of ladders, and materials handling.
- Shall not enter an Arc Flash Boundary or Limited Approach Boundary of energized parts unless escorted by a qualified person and wearing the proper Arc-Rated PPE. Unqualified Personnel will not need shock protection PPE, because they are not permitted to cross the Restricted Approach Boundary.

iii. Escorts

- Shall be qualified persons.
- Shall continually safeguard the people in their care and ensure that safety regulations are observed.
- Shall ensure that unqualified personnel never cross the Restricted Approach Boundary.

iv. All Employees

- Employees shall comply with the following CSU/Teamsters CBA sections:



- 28.5: An employee who observes or detects any health or safety hazard shall report it to the appropriate administrator as soon as possible.
 - 28.6: When an employee, in good faith, believes that he/she is being required to work under unhealthy and unsafe conditions, or without adequate safety equipment and clothing, he/she shall notify the appropriate administrator.
- v. Contractors, Subcontractors and Contracted Services – Employees of contractors, subcontractors, and contracted services to CSUF (herein referred to as “contractors”) shall follow all safety regulations required through their own written Electrical Safety Program. Contractors to CSUF shall certify that their program is in concert with the latest NFPA 70E edition and has been updated within the last three years. When such persons are unable to provide their own program, they shall undertake to comply with this program. In such instances, a documented undertaking of compliance is required before work commences.

V. Definitions

Accessible (as applied to equipment) – Admitting close approach; not guarded by locked doors, elevation, or other effective means.

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

Note 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

Note 2: See NFPA 70E, Table 130.5(C) for examples of tasks that increase the likelihood of an arc flash incident occurring.

Arc Flash Suit – A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet.

Note: An arc flash suit may include pants or overalls, a jacket or a coverall, and a beekeeper-type hood fitted with a face shield.

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/cm² and is derived from the determined value of the arc thermal performance value (ATPV) or energy of breakopen threshold (EBT) (should a material system exhibit a breakopen response below the ATPV value). Arc rating is reported as either ATPV or EBT, whichever is the lower value.

Note 1: Arc-rated clothing or equipment indicates that it has been tested for exposure to an electric arc. Flame resistant clothing without an arc rating has not been tested for exposure to an electric arc. All arc-rated clothing is also flame-resistant.

Note 2: ATPV is defined in ASTM F1959/ F1959M, Standard Test Method for Determining the Arc Rating of Materials for Clothing, as the incident energy (cal/cm²) on a material or a multilayer system of materials that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.



Note 3: EBT is defined in ASTM F1959/ F1959M, Standard Test Method for Determining the Arc Rating of Materials for Clothing, as the incident energy (cal/cm²) on a material or a material system that results in a 50 percent probability of breakopen. Breakopen is defined as a hole with an area of 1.6 cm² (0.5 in²) or an opening of 2.5 cm (1.0 in.) in any dimension. Breakopen is a material response evidenced by the formation of one or more holes the defined size. [An area of 1.6 cm² (0.5 in.²) or an opening of 2.5 cm (1.0 in.) in any dimension] in the innermost layer of arc rated material that would allow thermal energy to pass through the material.

Arc-Rated Clothing Category (Category) – A determination of the PPE required outline in Table 4 for an arc flash hazard after the arc flash risk assessment has been performed using the NFPA 70E Arc Flash PPE Category (Table) Method.

Authorized (as applied to persons) – A CSUF Qualified person identified by management to perform a specific task.

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

Note 1: Some balaclava designs protect the neck and head area except for the eyes while others leave the eyes and nose area unprotected.

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.

Boundary, Arc Flash – When an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 cal/cm² (5 J/cm²).

Note 1: According to the Stoll skin burn injury model, the onset of a second degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal/cm² (5 J/cm²) for one second.

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.

Conductive – Suitable for carrying electrical current.

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.

Electrical Hazard – A dangerous condition 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.

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.

Note 1: An electrically safe work condition is not a procedure, it is a state wherein all hazardous electrical conductors or circuit parts to which a worker might be exposed are maintained in a de-energized state for the purpose of temporarily eliminating electrical hazards for the period of time for which the state is maintained.

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

Energized Electrical Work Permit (EERP) – A document complete by the task supervisor and authorized by management which permits certain energized work inside the restricted approach boundary.

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.

Escort – A CSUF qualified person who briefs an unqualified person(s) on the hazards of being within the limited approach boundary and accompanies them when within the limited approach boundary. Escorts safeguard the people in their care and ensure that safety regulations are observed.

EWP (Electrical Work Practice) – A detailed procedure for performing an electrical task that is part of a written program.

Exposed (as applied to wiring methods) – 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.

Grounded (effectively grounded) – Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to limit the buildup of voltages to levels below which may result in undue hazard to persons or to connected equipment.

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

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.

Incident Energy – The amount of thermal energy impressed on a surface, a certain distance from the source, a certain distance from the source, generated during an electrical arc event. Incident energy is typically expressed in calories per square centimeter (cal/cm²).



Job Safety Plan (JSP) – A documented, step-by-step analysis of a task, including hazard identification, estimation of risks, methods of risk control, and all other information to complete the task safely.

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, which 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.

Location Responsible Person(s) – The CSUF electrically qualified person or persons identified by management and documented in writing as the final authority for decisions related to this policy.

Policy – Intentions and direction of an organization, as formally expressed by its top management.

Qualified Person – One who has demonstrated the skills and knowledge related to the construction and operation of the electrical equipment and installations and who has received safety training to recognize and identify the hazards and reduce the associated risks. For activities and work within the limited approach boundary, such persons shall be trained at a minimum in the following:

- 1) The skills necessary to distinguish exposed live parts from other parts of electric equipment.
- 2) The skills necessary to determine the nominal voltage level of exposed energized parts.
- 3) The minimum safe approach distances.
- 4) The skills necessary to:
 - Perform job safety planning;
 - Identify electrical hazards;
 - Assess the associated risks; and
 - Select appropriate risk control methods, including PPE.

Note: Only CSUF can determine who is qualified.

Raceway – An enclosed channel of metal or nonmetallic material designed expressly for holding wires, cables, or busbars, with additional functions as permitted in NFPA 70E (latest edition).

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 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.

Note 1: As used in NFPA 70E, arc flash risk assessments and shock risk assessments are types of risk assessments.

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

Note 1: Injury and damage to health resulting from shock is dependent on the magnitude of the electrical current, the power source frequency (e.g., 60 Hz, ac, 50 Hz, dc), and the path and time duration of current through the body. The physiological reaction ranges from perception, muscular contractions, inability to let go, ventricular fibrillation, tissue burns, and death.



Task Supervisor or Employee-in-Charge (Person-in-Charge) – A CSUF qualified person in charge of completing an electrical task and the safety of assigned personnel. (This is not to be confused with the management supervisor who might be an unqualified person.)

Task Qualified Person – An employee who receives safety and knowledge training to perform a very specific electrical task and who demonstrates the ability to perform all duties safely shall be considered to be a task qualified person for that specific task only. A Job Safety Plan (JSP) shall be written by a qualified person for all tasks performed by task qualified persons.

Task Observer – If employees will be present in the test area during testing, a test observer as designated by the Task Supervisor shall be present. The test observer shall be capable of implementing the immediate de-energizing of test circuits for safety purposes if required.

Unqualified Person – A person who is not a qualified person.

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

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

Note 1: Incident energy increases as the distance from the arc source decreases.

Working On (energized electrical conductor 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.

There are two categories of “working on”: Diagnostic (testing) is 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. Repair is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing, or replacing components, etc.).

VI. Requirements

Knowledge of this document does not make a person qualified. Only CSUF shall determine the appropriate level of electrical work experience and the amount of training required to deem a person qualified for specific electrical work or specific tasks.

- A. Risk Assessments - CSUF shall identify all hazards (electrical and non-electrical), assess, and estimate the risk of the hazard resulting in harm, and provide means to control the risk using the Hierarchy of Risk Control methods. Where the hazard cannot be eliminated, appropriate personal protective equipment and training shall be provided. The risk assessments shall be completed through the Job Safety Planning Checklist (**Attachment B**) and the Energized Electrical Work Permit (**Attachment C**).
 - i. Hierarchy of Risk Control Methods - During the risk assessments, (Shock and Arc Flash), the qualified person(s) shall ensure that risks are controlled using the following Hierarchy of Controls in this order of effectiveness:
 - Elimination – Removal of the energy source(s); e.g., create an electrically safe work condition using the CSUF Lockout/Tagout (LO/TO) Policy



and Program and taking into consideration the failure of the physical lockout system or the infrastructure on which the lockout equipment is built

- Substitution – Replacing with less hazardous equipment or materials; e.g., utilization of control voltages less than 50 Vac, the use of internally arc resistant equipment, substitution of persons with remote racking devices.
 - Engineering Controls – Implementing safety through engineering control and design. These may include the optimization of protective device settings, use of Class A GFCIs at the distribution source instead of portable Class A GFCIs; system interlocks: preventing unauthorized access/operation by mechanically interlocking doors and switches.
 - Awareness – The use of alerting techniques through warning labels, barricades, and attendants.
 - Administrative Controls – These types of controls vary from organizational to individual level and will include, among others, compliance to this CSUF written Electrical Safety Program, training of groups, and training of individuals.
 - Personal Protective Equipment (PPE) – PPE for arc flash and electrical shock is the last line of defense against electrical hazards. It is important that workers understand that PPE is the last option when the above-mentioned controls fail to adequately control the risks. PPE is also considered the least effective control.
- ii. Shock Risk Assessment - A shock risk assessment shall be performed to identify the shock hazards, estimate the likelihood of occurrence, and potential severity of injury, risk control methods and additional protective measures required. For shock risk assessment, see Job Safety Planning Checklist (**Attachment B**).
- The following information is required as part of the assessment:
 - To identify the shock hazards.
 - To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health.
 - It shall take into consideration the following: the design of the electrical equipment and the electrical equipment operating condition and condition of maintenance.
 - The human performance error precursors and required human performance tools. (See “Informative” Annex Q in NFPA 70E)
 - Determine if additional protective measures are required, including the use of PPE.
 - If additional protective measures are required, they shall be selected and implemented according to [§VI(A)(i)] Hierarchy of Risk Control Methods.
 - When additional protective measures include the use of PPE, the following shall be determined:
 - The voltage to which the personnel will be exposed.
 - The boundary requirements.
 - The personal and other protective equipment required to protect against the shock hazard.
 - Shock Protection Boundaries



Shock protection boundaries are identified as the Limited Approach Boundary and the Restricted Approach Boundary. They are applicable to situations in which approaching personnel are exposed to uninsulated energized electrical conductors or circuit parts (e.g., busbar, terminations, lugs, etc.). Distances associated with various system voltages are defined in Table 1 and Table 2.

Table 1: Approach Boundaries to Exposed Vac Energized Electrical Conductors or Circuit Parts

Nominal Voltage, Phase to Phase	Limited Approach Boundary		Restricted Approach Boundary
	Exposed Movable Conductor	Fixed Circuit Part	
Less than 50	Not Specified	Not Specified	Not Specified
50 to 150	3.0 m (10 ft. 0 in.)	1.0 m (3 ft. 6 in.)	Avoid Contact
151 to 750	3.0 m (10 ft. 0 in.)	1.0 m (3 ft. 6 in.)	0.3 m (1 ft. 0 in)
751 to 15 kV*	3.0 m (10 ft. 0 in.)	1.5 m (5 ft. 0 in.)	0.7 m (2 ft. 2 in)

* Note: Voltage limited to 15 kV to align with this program.

Table 2: Approach Boundaries to Exposed Vdc Energized Electrical Conductors or Circuit Parts

Nominal Voltage, Phase to Phase	Limited Approach Boundary		Restricted Approach Boundary
	Exposed Movable Conductor	Fixed Circuit Part	
Less than 50	Not Specified	Not Specified	Not Specified
50 to 300	3.0 m (10 ft. 0 in.)	1.0 m (3 ft. 6 in.)	Avoid Contact
301 to 1000*	3.0 m (10 ft. 0 in.)	1.0 m (3 ft. 6 in.)	0.3 m (1 ft. 0 in)

* Note: Voltage limited to 1000 Vdc to align with this program.

- iii. Arc Flash Risk Assessment - An Arc Flash Risk Assessment is required before a person interacts or works on an electrical equipment (excluding cord and plug connected equipment) that has not been placed in an electrically safe work condition. The Arc Flash Risk Assessment aims to protect personnel from the possibility of being injured by an arc flash by identifying the arc flash hazards, determining the appropriate safety-related work practices, arc flash boundary, and PPE to be used within the arc flash boundary. The results of the arc flash risk assessment shall be documented. An arc flash risk assessment shall be performed to identify the arc flash hazards, estimate the likelihood of occurrence, potential severity of injury, risk control methods and additional protective measures required. For arc flash risk assessment, see Job Safety Planning Checklist (**Attachment B**).

The following information is required as part of the assessment:

- To identify the arc flash hazards
- To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health.
 - It shall take into consideration the following, the design of the electrical equipment, including its overcurrent protective device and



its operating time as well as;

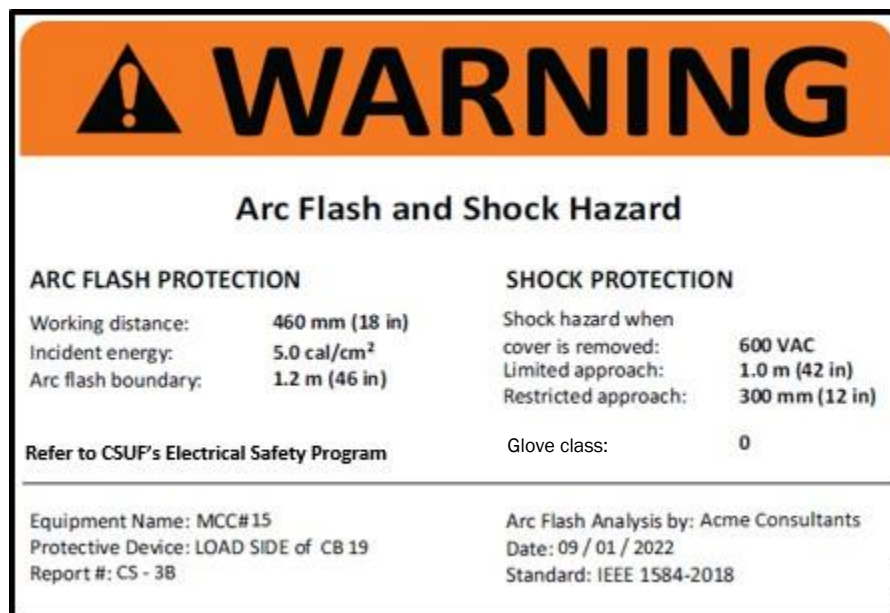
- The electrical equipment operating condition and condition of maintenance.
- The human performance error pre-cursors and required human performance tools. (See “Informative” Annex Q in NFPA 70E)
- If additional protective measures are required, they shall be selected and implemented according to [§VI(A)(i)] Hierarchy of Risk Control Methods.
- When additional protective measures include the use of PPE, the following shall be determined:
 - Appropriate safety-related work practices.
 - The arc flash boundary.
 - The PPE to be used within the arc flash boundary.
 - Table 130.5(C) from NFPA 70E shall be permitted to be used to estimate the likelihood of occurrence of an arc flash event to determine if additional protective measures are required.

1. The Arc Flash Boundary

The arc flash (protection) boundary shall be the distance at which the incident energy equals 1.2 cal/cm² (onset of a second degree burn). It shall be determined through an Incident Energy Analysis Calculation using IEEE 1584 or the Arc Flash PPE Category Method.

2. Arc Flash and Shock Labels

Labels with the voltage for shock PPE, arc flash boundary, and the site-specific PPE level or incident energy in cal/cm² and working distance shall be attached to all electrical devices that have space to accept at least a 4x4 inch label.



3. Methods for Determining Incident Energy

An Arc Flash Hazard Incident Energy Analysis Method shall determine the potential incident energy based on the IEEE 1584 guidelines and parameters using calculation software to predict the available arc thermal energy from the source of an electric arc fault. The incident energy analysis and shock equipment labels shall be updated when:



- A major modification or renovation or any changes in the electrical distribution system have taken place that could affect the results of the current arc flash incident energy analysis.
 - If no changes in the electrical distribution system have taken place, the current arc flash incident energy analysis shall be reviewed at intervals not exceeding five years.
- i. The Arc Flash PPE Category Method shall be used as follows if an Incident Energy Analysis has not been completed to predict the available arc thermal energy from the source of an electric arc fault.
 - ii. Determine the maximum available fault current and the maximum fault clearing time of your upstream protective device, for example at a fused disconnect switch or circuit breaker. They must fall within the parameters as found at NFPA 70E Tables 130.7(C)(15)(a) for AC or Table 130.7(C)(15)(b) for DC (**Attachment D**) or less to be valid. If not, an incident energy analysis shall be done.
 - iii. Next determine the arc flash boundary. These boundary distances can be found at NFPA 70E Tables 130.7(C)(15)(a) for AC or Table 130.7(C)(15)(b) for DC (**Attachment D**).
 - iv. The Arc Flash PPE Category and the Working Distance can also be found using NFPA 70E Tables 130.7(C)(15)(a) for AC or Table 130.7(C)(15)(b) for DC (**Attachment D**).



ARC FLASH PPE CATEGORY METHOD - See NFPA 70E Article 130.7(C)(15)

The requirements of NFPA 70E - Table 130.7 (C)(15) shall apply when the Arc Flash PPE Category method is used for the selection of arc flash PPE.

AC Equipment: When the arc flash risk assessment performed in accordance with 130.5 indicates that arc flash PPE is required and the arc flash PPE category method is used for the selection of PPE for AC systems in lieu of the incident energy analysis of 130.5(G), Table 130.7(C)(15)(a) shall be used to determine the arc flash PPE category.

The estimated maximum available fault current, maximum fault clearing times, and minimum working distances for various AC equipment types or classifications are listed in Table 130.7(C)(15)(a).

An incident energy analysis shall be required in accordance with 130.5(G) for the following:

- 1) Power systems with greater than the estimated maximum available fault current
- 2) Power systems with longer than the maximum fault clearing times
- 3) Less than the minimum working distance

DC Equipment: When the arc flash risk assessment performed in accordance with 130.5(G) indicates that arc flash PPE is required and the arc flash PPE category method is used for the selection of PPE for DC systems in lieu of the incident energy analysis of 130.5(G), Table 130.7(C)(15)(b) shall be used to determine the arc flash PPE category.

The estimated maximum available fault current, maximum arc duration, and working distances for DC equipment are listed in Table 130.7(C)(15)(b).

An incident energy analysis shall be required in accordance with 130.5(G) for the following:

- 1) Power systems with greater than the estimated maximum available fault current
- 2) Power systems with longer than the maximum arc duration
- 3) Less than the minimum working distance

Protective Clothing and PPE

Once the Arc Flash PPE Category has been identified from Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b), Table 130.7(C)(15)(c) shall be used to determine the required PPE.

Table 130.7(C)(15)(c) list the requirements for PPE based on arc flash PPE Categories 1 through 4. This clothing and equipment shall be used when working within the arc flash boundary. The use of PPE other than or in addition to that listed shall be permitted provided it meets 130.7(C)(7).

All of the Informational notes in Article 130.7(C)(15) shall be referenced.

See OSHA 1910.269 Appendix E – [Protection from Flames and Electric Arcs](#) for further guidance if required.



- B. Fall Protection - A fall protection assessment shall be done on equipment before any task begins. Fall protection shall meet the requirements of CSUF's fall protection program. Fall protection equipment shall be arc tested per ASTM F887 for use within an arc flash boundary.
- C. Human Performance - Human performance influences the risk of worker injury. To reference human performance, this electrical safety program is in concert with the NFPA 70E – *Informative Annex Q – Human Performance and Workplace Electrical Safety*. In addition to items listed elsewhere, human performance shall be specifically addressed in all job safety plans. The following error reduction tools assist in reducing the potential for human errors. These are just some of the examples.
 - i. Job Safety Planning Checklist and Tailgate
 - ii. Job site hazard identification: Shock and arc flash risk assessments included in the Job Safety Planning Checklist.
 - iii. Post job review: Learn from prior experiences to improve processes.
 - iv. Procedural use and adherence: Step-by-step list of actions to be performed, with each item checked off as the task is completed.
 - v. Self-check: Verbalize the action to be performed, again while performing the action, and finally upon completion.
 - vi. Communication: Usage of phonetic alphabet for “robust clarity” with three-way communication: action read out by the sender to the receiver, receiver verbally confirms action to sender, sender confirms instruction to receiver.
 - vii. Stop when unsure: Addresses vague or generic instructions or procedures. **STOP** all work and clarify with supervisors and/or managers before proceeding.
 - viii. Flagging and blocking: Identifies equipment that is energized and that which is de-energized. Prevent access or force access into a single zone only.
- D. Job Safety Planning Checklist - A “Quality” Job Safety Planning Checklist shall be completed before working on or near electrical circuits and parts. The Job Safety Planning Checklist shall be completed by a qualified person to identify information required. Following the completion of the Job Safety Planning Checklist, a formal tailgate shall be performed, shall be completed, and filed.
 - i. Job Briefing: The job briefing shall cover the job safety plan and the information on the energized electrical work permit, if a permit is required. Additional job safety planning and job briefings shall be held if changes occur during the course of the work that might affect the safety employees. For routine or repetitive tasks, a daily tailgate shall be conducted before the beginning of each shift. The tailgate is permitted to be a brief discussion and shall cover such subjects as identified hazards associated with the job, work procedures involved, special precautions, energy source controls and personal protective equipment requirements. Additional tailgates shall be held if any changes that might affect the safety of employees occur during the course of the work. Before a non-routine or complex electrical work operation begins, personnel shall evaluate the safety concerns and precautions regarding the task. Whenever work conditions or methods change that could potentially compromise personnel safety, additional safety evaluations shall be conducted.
- E. Emergency Preparedness - Workers shall never make direct physical contact with an injured person unless the injured person is completely removed from the energy source or the energy source is removed, and the area is safe. Always call for emergency assistance before



starting any first aid. Do not make contact with or try to remove burned clothing.

- F. Investigations - Any incident that resulted in harm or could have likely resulted in harm to a person or damage to equipment shall be reported and documented. Note: Any electrical shock incident of any kind at any level shall require immediate medical attention at the nearest hospital. CSUF shall determine whether a formal investigation is required. CSUF shall trend and analyze incidents to determine areas of improvement. Electrical incidents shall be investigated using the existing investigation procedure. If an investigation procedure does not exist, CSUF shall ensure that a suitable procedure, addressing investigation guidelines with the necessary forms, is developed and workers are trained on the procedure. Contractor incidents shall be independently reviewed by CSUF and formally reported to form part of the safety trending and analysis.

VII. Protective Measures

A. Personal Protective Equipment (PPE):

Personnel shall wear the personal protective equipment required to provide protection against hazards associated with a specific task. When performing tasks on equipment that might produce an arc flash, personnel shall take the appropriate safety precautions and wear the appropriate level of personal protective equipment for the incident energy and estimated risks at the work location.

Minimum wear for “Qualified” or “Task Qualified” electrical workers shall be Level 2 as listed in Table 4.

Personnel shall not wear articles containing conductive material, such as rings, metal watch bands, metal-framed eyewear including metal-framed safety glasses, and dangling metal jewelry or keys, when within the most restrictive electrical safety boundary. These articles may be allowed, as per the risk assessments, only if totally covered or protected against conducting electricity from the source or heating (and exacerbating burns) from an arc flash.

i. Determining PPE for the Arc Flash Hazard

When the arc flash risk assessment is conducted using the Incident Energy Analysis Method, using IEEE 1584, Table 3 provides guidelines for selecting PPE. For ease of reference, a site-specific range, indicated by “Levels” is shown in Table 4.

Table 3: 130.5(G)

Personal Protective Equipment (PPE) Guidelines based on Incident Energy Estimate Method

Incident Energy Exposures:	PPE
1.2 cal/cm ² to 12 cal/cm ²	Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy ¹ Long-sleeve shirt and pants or coverall or arc flash suit (SR) Arc-rated face shield and arc-rated balaclava or arc flash suit hood (SR) Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) (AN) Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ² Hard hat Safety glasses or safety goggles (SR) Hearing protection Leather footwear



Greater than 12 cal/cm ²	Arc-rated clothing with an arc rating equal to or greater than the estimated incident energy ¹ Long-sleeve shirt and pants or coverall or arc flash suit (SR) Arc-rated arc flash suit hood Arc-rated outerwear (e.g., jacket, parka, rainwear, hard hat liner) (AN) Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ² Hard hat Safety glasses or safety goggles (SR) Hearing protection Leather footwear
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AN: As needed.

SR: Selection of one in group is required.

Note 1: Arc ratings can be for a single layer, such as an arc-rated shirt and pants or a coverall, or for an arc flash suit or a multi-layer system if tested as a combination consisting of an arc-rated shirt and pants, coverall, and arc flash suit.

Note 2: Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased material thickness, provide increased arc flash protection.

Table 4:
Site Specific Personal Protective Equipment (PPE) Levels

Level		PPE
0	Non arc-rated clothing	Non-melting or untreated natural fiber long-sleeve shirt and long pants or Coverall
	Protective equipment	Hard hat (AN) Safety glasses or safety goggles (SR) (AN) Hearing protection (ear canal inserts) (AN) Heavy -duty leather gloves ² Leather footwear
1	Arc-rated ¹ clothing with minimum arc rating of 4 cal/cm ²	Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated face shield or arc flash suit hood Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
	Protective equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy -duty leather gloves ² Leather footwear
2	Arc-rated ¹ clothing with minimum arc rating of 8 cal/cm ²	Arc-rated long-sleeve shirt and pants or arc-rated coverall Arc-rated flash suit hood or arc-rated face shield and arc-rated balaclava Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
	Protective equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather footwear

3	Arc-rated ¹ clothing with minimum arc rating of 25 cal/cm ²	Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR)
		Arc-rated arc flash suit hood Arc-rated gloves Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
	Protective equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy -duty leather gloves ² Leather footwear
4	Arc-rated ¹ clothing with minimum arc rating of 40 cal/cm ²	Arc-rated long-sleeve shirt (AR) Arc-rated pants (AR) Arc-rated coverall (AR) Arc-rated arc flash suit jacket (AR) Arc-rated arc flash suit pants (AR) Arc-rated arc flash suit hood Arc-rated gloves Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
	Protective equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Heavy -duty leather gloves ² Leather footwear

AN = As needed (optional); SR = Selection required

1. Arc rating for a garment or system of garments is expressed in cal/cm².
2. If rubber insulating gloves with leather protectors are used, additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.

- ii. Head Protection - Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with energized electrical conductors or circuit parts or from flying objects resulting from electrical flash / blast. Employees shall wear nonconductive protective equipment for the face, neck, and chin whenever there is a danger of injury from exposure to electric arcs or from flying objects resulting from arc blast. If employees use hair nets or beard nets, or both, these items shall be arc rated.
- iii. Eye Protection - Personnel shall wear ANSI Z87 approved eyewear with non-metallic frames when in areas with exposed, energized conductors.
- iv. Hearing Protection - Ear canal insert hearing protection shall be worn when working within the Arc Flash Boundary. Earmuffs can also be used at the same time for double protection.
- v. Hand Protection
 - Gloves - Personnel shall wear rubber insulating gloves with approved leather protectors when working with or on any of the following:
 - a) Energized or potentially energized conductors or parts.
 - b) Any task within the restricted approach boundaries in Table 1 or Table 2.
 - c) Using rated insulated or live-line tools.
 - Personnel shall use the appropriate gloves rated for the electrical voltage task involved.



- Personnel shall only use rubber insulating gloves that have been dielectrically tested within the previous six months. New rubber gloves shall be dielectrically tested before first use. The dielectric testing of insulating rubber gloves shall be in accordance with ASTM F496 Standard.
 - Personnel shall always inspect, and air test their rubber insulating gloves before each day's use. If any damage is suspected, personnel shall not use the gloves until the gloves have been dielectrically tested and approved for further use. Rubber insulating gloves shall be stored, fingers up, in an approved canvas glove bag or equivalent protective location. The approved leather protectors shall also be checked daily for damage, e.g.; embedded metal and contaminants.
- vi. Voltage-Rated Sleeves, Blankets, Covers - New voltage-rated blankets or covers shall be dielectrically tested before use and then again once every 12 months. They shall be visually inspected for damage each day before use. When not in use, they shall be stored in containers designed for the purpose. If damage is suspected, they should be dielectrically tested before being used again.
- vii. Foot Protection - Footwear shall comply with corporate or location requirements. Personnel shall wear leather footwear with EH (Electrical Hazard) rated soles meeting the requirements of ASTM F 2413 when in areas with exposed, energized conductors.
- viii. Fall Protection - Fall harnesses and lanyards used within the Arc Flash Boundary shall be arc tested and meet ASTM F887.
- ix. Arc Flash Protective Equipment
- Arc-rated clothing - Flash suits and daily work clothing shall meet the requirements of ASTM F1506.
Note: All AR is FR but not all FR is AR.
 - Arc-rated head protection - Arc-rated fabric used in head protection shall meet the requirements of ASTM F1506. Arc-rated flash suit hoods, face shields, arc rated goggles, balaclavas and completed head protection assemblies shall be tested to ASTM F2178.
 - Arc-rated hand protection - Arc-rated hand protection shall be tested to ASTM F2675
- x. Care and Maintenance of Arc-Rated Clothing - Arc-rated clothing that is heavily contaminated (with grease, oils, flammable liquids, etc.) shall not be used. An incidental amount of contamination will not normally impair the protective rating of the clothing. No arc-rated garment shall be repaired by the user. Garments requiring repair shall be returned to the supplier. All arc-rated clothing and protective equipment shall be stored in a storage bag, in a clean, room- temperature type environment.

B. Tools:

Listed and Rated Test Equipment and 1000V Insulated Hand Tools Each person shall use listed and rated insulated hand tools meeting ASTM F1505 and test equipment within the Restricted Approach Boundary of exposed electrical conductors or circuit parts where tools or handling equipment might make accidental contact. When using and caring for hand tools, personnel shall keep them in proper working condition.



VIII. Required Safe Work Practices

A. Applicable for 50 to 15 kV Vac and to 1000 Vdc

- i. Electrical Spaces - Employees shall not enter spaces containing exposed energized circuit parts or conductors nor perform tasks within the limited approach boundary of exposed energized circuit parts or conductors if the work cannot be seen because of obstructions or a lack of lighting.
- ii. Electrical Equipment
 - Labels: Electrical equipment shall be properly labeled such that the power source and service are well described as per accurate and up-to-date Single Line Diagrams (SLD's), and easily located. Notify staff personnel when labels are missing, incorrect, or illegible. This is a critical component of CSUF's LO/TO Program.
 - Fires: In the event of a fire in any electrical equipment, de-energize the source before extinguishing the fire(s). Do not use water to fight fires unless specifically trained to do so.
 - Do not rack electrical circuit breakers in or out while they are in the closed position or onto an energized bus.
 - Do not operate a non-load break switch under load.
 - Do not block push buttons in "start" or "run" positions.
 - Purged Enclosures (Enclosures which are purged to reduce Electrical Hazard Classification):
 - a) Do not open purged enclosures in hazardous areas without a safe/hot work permit unless all power is in the electrically safe work condition.
 - b) Do not restore power to an enclosure that has been opened by staff personnel until the enclosure has been sealed and purged for the time period stated on the enclosure nameplate.
 - c) Do not direct steam vents, water, or steam hoses directly on enclosures.
 - d) Report malfunctioning purge pressure gauges, damaged enclosures, faulty purge tubing and fittings, loose or missing bolts/latches, open doors, missing enclosure labels, and missing or loose sealing conduit plugs immediately to staff personnel for correction.
 - Employees shall not reach blindly into areas which may contain energized parts.
- iii. Electrical Supply Conductors
 - 0 to 22 kV, nominal, phase to ground:
 - a) Electrical supply conductors shall have a minimum vertical clearance over *roadways* of 18.5 feet from grade.
 - For any electrical supply conductors lower than the minimum vertical clearances listed above, safe work practices and documented procedures shall be taken to safely raise the conductors up to, or exceeding, the above minimum vertical clearances. Appropriate signage shall be safely placed under the conductors to warn personnel of the restricted clearances.
- iv. Damaged Electrical Equipment - Report to management any observed physical



damage to motor control centers, transformers, or other electrical equipment immediately. DO NOT TOUCH damaged equipment until proven safe by qualified electrical personnel.

- v. Hazardous Area Classification and Equipment
 - All equipment shall be approved for use in the Hazardous Area Classification in which it is located.
 - Notify management immediately of any loose or missing bolts or latches on explosion-proof or purged enclosures. All bolts and latches are required to be in place and tight. See [§VIII(A)(ii)]: Purged Enclosures.
 - Approved conduit seals shall be properly installed where required.
 - If unapproved equipment must be used temporarily in a hazardous area, CSUF safe work practices shall be used.
- vi. Operating Electrical Equipment - Under no circumstances shall unqualified or unauthorized personnel operate electrical equipment.
- vii. Overcurrent Protective Devices
 - The repetitive manual re-closing of circuit breakers or re-energizing circuits through replaced fuses is prohibited.
 - After any overcurrent protective device operation, DO NOT re-close the circuit until the fault has been repaired or cleared by a qualified person from the circuit and the circuit can be safely energized. The only exception is if a device indicates a trip due to an overload rather than a fault condition, the circuit may be re-energized one time only after the overload condition is cleared. If the circuit trips a second time, do not re-close; contact a qualified person for repair of the circuit.
 - Overcurrent protection of electrical equipment shall not be modified even on a temporary basis, beyond that allowed by the current edition of the National Electric Code (NFPA 70).
 - No system overcurrent protective device (OCPD) shall be removed from service while the circuit is energized, except as permitted by the current edition of National Electrical Code (e.g., removal for the purposes of an OCPD Preventative Maintenance (PM) program, as long as other circuit OCPDs are functional).
 - Trip circuits on energized circuit breakers shall never be made inoperative.
- viii. Equipment Access Interlock Systems - Interlock systems shall not be bypassed or otherwise rendered inoperative while the equipment is energized, except when authorized testing is being performed or when work is being completed under an Energized Electrical Work Permit (**Attachment C**). A qualified person shall perform these tasks. Upon completion of the task, the interlock system shall be restored to full operable condition. Under no other circumstances shall the interlock system be disabled or permanently rendered inoperable.
- ix. Working Surfaces - When performing any work on circuit parts or conductors, the working surfaces on which employees will stand or sit shall have the strength and structural integrity for adequate personnel support. Cable tray, cables, and raceways exist to support electrical wiring and, as such, do not inherently have the requisite strength and structural integrity to support personnel safely when working.
- x. Raising/Lowering Material, Tools, and Equipment - All small equipment and tools



used overhead shall be raised and lowered by a non-conductive hand line (such as clean polypropylene), canvas bucket, or other suitable method. Nothing shall be thrown or intentionally dropped. Personnel shall take care when working overhead to prevent dropping tools and materials. Tie off all tooling and devices as appropriate to the work task and area. Personnel below are to stay clear of overhead work to avoid being struck by falling objects. Always use danger barrier tape in a safe manner below to ensure this safe work area.

B. Creating and Identifying the Safe Work Zone

CSUF shall comply with this policy for creating a safe work zone or its equivalent. Each task supervisor shall identify the safe work zone steps for the task(s) that is to be performed. The task supervisor shall detail the steps listed in this section and the personnel responsible for completing each step. Until these steps are completed, a safe work zone is not established. This method shall be used to establish a safe work zone together with the CSUF Lock Out/Tag Out Program.

i. Isolation and Safe Work Zone Creation

- De-energize and Confirm: The de-energize and confirm step includes instruction or switching orders (**Attachment E**) (See CSUF's Lockout/Tagout Policy and Program) and confirmation of energy isolation to protect personnel and equipment, and to minimize disruption to plant operation. See [§VIII(B)(v)], "Switching Requirements".
- Tag and Lock Isolation Devices: Isolation devices shall be tagged and locked. Refer to CSUF's Lock Out/Tag Out Policy and Program.
- A written procedure outlining the agreed-upon lockout/tagout procedure to be used shall be mandatory between parties when generating and switching locations are influenced by distance, ownership, or organizational structure.
- Identify Work Zone: Personnel shall identify the safe work zone with appropriate barricading and warning signs. See Grounding & Barricading of Electrical Equipment during Diagnostic Testing (**Attachment G**).
 - a) During maintenance, testing, troubleshooting, renovations to existing installations and additions to installations where exposed energized parts or conductors are present, appropriate barricades or other identification shall be erected. The minimum boundaries of the work zone shall be determined by the size of the work area required for the task at hand, the arc flash boundary and limited approach boundary, whichever is greatest.
 - b) Appropriate warning signs and barricades shall be installed and/or attendants utilized to identify the work area, restrict unqualified personnel from entering, and prevent accidental contact with exposed, energized parts. At a minimum, the following protective measures shall be taken:
 - Restrict unqualified personnel from entering the area by displaying danger signs and erecting barricades or by posting an attendant.
 - Clearly mark the safe work zone.
 - In areas where equipment is similar in location and appearance, a clear identification method shall be used to identify the equipment safe to work on. This does not eliminate the need for independent verification of energy isolation.
 - Barricades and warning signs or attendants shall be used to differentiate and separate energized equipment from de-energized equipment and to lead personnel to the equipment



safe for work or safe work zone.

- Protection for qualified personnel from accidental contact with adjacent energized equipment shall be determined. Where protection is necessary, barricades or temporary barriers shall be installed.
- In areas where the safety of vehicles and unqualified pedestrian traffic may be compromised, appropriate warning signs and barricades or attendants shall be used to identify where work on electrical equipment is being conducted.

- ii. Verify by Testing and Grounding - A qualified person shall test that all energy sources have been de-energized, verified for the absence of voltage and put in the electrically safe work condition using CSUF's LO/TO Program and Policy.

The test equipment used shall be verified both before and after testing.

Grounding is not generally used on lower voltage systems, 480 V/600 V, but it shall be used at 4.160 kV and 13.8 kV. If grounding is required, it shall be approved on the Energized Electrical Work Permit (**Attachment C**) by a Professional Engineer.

- iii. Releasing the Safe Work Zone

- Upon completing the work and it is safe to do so, the responsible personnel using CSUF's LO/TO Policy and Program shall:
 - a) Remove warning signs and barricades.
 - b) Remove personal locks and tags.
 - c) Release the safe work zone for restoration of power.
 - d) Notify the affected departments or units that power is ready to be restored before switching begins.
- Power shall be restored to the safe work zone in a controlled, safe way through a properly issued CSUF LO/TO Policy and Program process and procedures.

- iv. Signage - Signs shall be used to provide information regarding a potential electrical hazard.

- Signs shall be made of a durable material consistent with the anticipated environmental conditions and expected length of exposure.
- The color and shape of signs shall be consistent with regulatory requirements.
Reference ANSI Z535.
- The letters shall be large, highly visible, and easily seen in darkened, low-light situations.
- Standard International symbols (using SI units) shall be used as much as is practical.
- At a minimum, information or warning signs shall be located at the following locations:
 - a) On all substation doors, gates, and fences.
 - b) On all doors to all switchgear rooms, or other similar compartments where exposed, energized electrical parts are located.
 - c) Where a low voltage bus is supplied from two or more sources and an interlock system is not provided, thereby creating a back feed opportunity. Signs warning of this potential back feed shall be prominently displayed.



- d) If temporary alterations made to the secondary voltage supply system may have back feed potential, a sign warning of this potential problem shall be conspicuously displayed until the need for the temporary alteration is abated.
 - e) At all low-profile electrical equipment installations where physical distance requirements for personnel and/or handling of conductive material cannot be met or are marginal.
 - f) At all overhead pipes, bridges, etc., where adjacent exposed, energized electrical conductors and parts pose potential electrical shock hazards to maintenance or construction personnel
 - g) Where inadvertent electrical contact is possible and can reasonably be anticipated.
 - h) Where electrical supply conductors are lower than the minimum clearances as stated in [§VIII(A)(iii)].
 - i) These signs are temporary until minimum clearances are met.
- v. Switching Requirements: Operating Electrical Switches and Breakers with Doors Closed

Using the proper stand-to-the-side method: the following may be used by CSUF qualified and task qualified persons for operating electrical switches and circuit breakers. This method of operating switches and circuit breakers should only be used after arc flash analysis calculations have been completed and arc flash and shock labels applied on non-internally arc resistant switchgear. For arc-resistant switchgear and motor control centers, personnel shall wear PPE protection as indicated by the manufacturer of the equipment and the site shock and arc flash risk assessment procedures.

- For electrical switches or breakers with an incident energy of 1.2 cal/cm² (Level 0) or less and considering a comprehensive arc flash risk assessment procedure and with all doors closed and all latches and covers in place per the manufacturer's design, e.g.; normal operating condition, no arc-rated clothing is required but is highly recommended if any arc flash risk is estimated at all. PPE shall be selected as per this CSUF Electrical Safety Program.
- For all electrical switches or breakers with incident energy greater than 1.2 cal/cm², PPE appropriate for the calculated incident energy and appropriate to a comprehensive arc flash risk assessment procedure shall be used when operating switches with doors closed. If any air vents or other openings are in the front or side of the enclosure, personnel shall wear the required level of PPE indicated on the arc flash label.
- For enclosures containing a Level 2 or less hazard the following applies:
 - Wear a clean heavy duty all-leather work glove, arc-rated glove or voltage-rated glove on the hand operating the switch or breaker. This will offer protection from any heat escaping around the enclosure gasket.
 - If the circuit breaker has tripped or the switch fuses have opened due to a fault condition, wear the required PPE defined by the arc flash label and a comprehensive arc flash risk assessment procedure when the breaker is reset.
- Transient personnel passing through electrical equipment rooms and outside the arc flash and limited approach boundary of any electrical work being performed require no special electrical PPE.



C. Maintenance

A maintenance program for CSUF is suggested for their electrical equipment as noted below.

Where applicable, the following minimum condition-based monitoring shall be performed at the listed intervals. (See NFPA 70B for guidance)

- i. A thermographic inspection of all current carrying components shall be completed annually. Components needing repair found during the survey shall be scheduled as soon as possible. (Reference NFPA – 70B Annex L Table L.1)
- ii. A visual inspection for cleanliness of all switchgear, motor control centers and power panels shall be completed annually. (Reference NFPA – 70B Annex L Table L.1)
This inspection can be combined with the thermographic inspection. Cleaning can be scheduled as required by condition with all panels cleaned every three years. It is recommended that one-third of the panels be scheduled for cleaning each year.
- iii. Vibration analysis on all motors greater than 50HP
- iv. Transformer oil analysis (where applicable) with the following tests/observations: color, dielectric breakdown voltage, dissolved gas analysis; e.g., ASTM D3612, frantic compounds (as needed), and Karl Fischer method of moisture detection.
- v. The site ground grid shall be tested every three years in accordance with NFPA 70B 14.3.2.
- vi. Substation Power Circuit Breakers shall be removed from service every three years for cleaning, lubricating, maintenance as per the manufacturer's instructions and re-calibration. (Reference NFPA 70B Annex L Table L.1)
- vii. Standby generators shall be exercised monthly for a minimum of 30 minutes (reference NFPA 110 – 2016 Article 8.4). As part of the monthly exercise, perform engine checks of oil, fuel, and battery water level.
- viii. On an annual basis, standby generators shall be operated under load for a minimum of 1.5 hours. Generator use during an actual power outage that lasts 1.5 hours or longer can be substituted for the required annual test.

D. Electrical Work (50 Volts – 15 kV Volts Vac and to 1000 Vdc)

Always consider electrical equipment energized until locked, tagged and verified for absence of voltage, (electrically safe work condition). All persons working in the area of low voltage systems shall understand and comply with the arc flash and shock PPE requirements [§VII(A)].

When the task requires working near exposed, energized parts:

- i. Unqualified persons shall not cross the three-foot six inch (42 inch) (is voltage dependent) limited approach boundary for fixed parts as shown in Table 1 and in Table 2. An unqualified person shall be continuously escorted by a qualified person if a need is present to cross the limited approach boundary, but under no circumstances can the unqualified person cross the restricted boundary.
- ii. If a qualified person is working at or inside the restricted approach boundary listed in Table 1 or Table 2 special precautions shall be used. See [§VII(A)] for PPE and Tools.
- iii. Working inside the restricted approach boundary is considered energized work. See [§VIII(D)(v)] for Energized Work Policy.
- iv. To ensure equipment is de-energized by verifying for the absence of voltage, as per the electrically safe work condition in NFPA 70E, qualified personnel shall perform the following using all PPE as appropriate for the arc flash and shock hazards and risks:
 - Choose a CAT III or CAT IV direct contact meter as approved by CSUF appropriate for the system voltage to be measured. Solenoid operated meters (Wiggies, etc.) and proximity detectors shall not



be used for this purpose.

- Check the test equipment for proper operation immediately before use (see Note below).
- Verify that all necessary energy sources within the work zone have been de-energized using the CSUF LO/TO Program and Policy.
- Test circuit elements and exposed electrical parts to verify that all elements and parts are de-energized.
- Verify that no energized condition exists (or may exist) as a result of accidentally induced voltage or back feed.
- Check the test equipment for proper operation immediately after use (see Note below).

Note: Test the meter on the setting (function) that it will be used on.

v. Working on Energized Parts

- No maintenance work shall be performed on energized parts (inside the restricted approach boundary) without an Energized Electrical Work Permit (**Attachment C**) authorized by a signature of the appropriate CSUF supervisor or their designee.
- vi. When performing authorized and justified testing or troubleshooting work on or in close proximity to insulated cables or wiring, the cables or wiring shall not be moved, handled, contacted, or otherwise touched while energized without a Job Safety Planning Checklist. Cables and wiring exempted from this requirement are those that are inside an enclosure, are contained in a raceway, are part of a festoon cable assembly, or are temporary flexible cord and cables intended for that use. (See NFPA's National Electrical Code (NEC)®, Article 400.4 for types of flexible cords and cables.) See raceway definition.

The condition of the insulation shall be safely examined by a CSUF qualified person before personnel perform construction or installation work on or in close proximity to the cables or wiring.

E. Mobile Equipment

For operation of mobile equipment e.g.; manlift, in the general vicinity of exposed energized parts (50 V to 15 kV Vac or to 1000 Vdc), shock and arc flash risk assessment procedures shall be used before starting any tasks.

F. Utilization Equipment Operation and Maintenance Requirements

Refer to **Attachment H** for specific guidelines on the operation and maintenance of utilization equipment. This consists of, but is not limited to, extension cord sets, portable cord-connected electric tools and power strips, anti-restart devices, GFCIs, etc.

G. Control Houses, Switchgear, Motor Control Centers, and Similar Equipment

If exposed, energized parts are present, control houses, motor control centers, and similar equipment shall be locked or otherwise restricted to allow access to only qualified personnel.

In control houses, switchgear, motor control centers and similar equipment, all equipment doors shall be closed, all latches shall be in place and operable, and all equipment shall be kept in proper safe, operable, and normal equipment condition.

Control houses, switchgear, motor control centers and similar equipment shall be kept free of debris. Only materials and equipment necessary for electrical system repair and maintenance (R&M) may be stored in control houses and switchgear facilities. Those storage locations established for electrical system R&M materials shall be specifically identified and periodically inspected.

Materials and equipment are not to be stored in front of electrical equipment. A clear working space the width of the equipment or 30 inches, whichever is wider, and the height of the



equipment or 6 ½ feet, whichever is higher, shall be provided and maintained for a minimum depth of 36 inches.

Combustible and flammable material shall not be stored in these locations unless properly stored in an approved metal cabinet or enclosure.

H. New Electrical Equipment and Modifications

New electrical installations shall minimize touch potential, access to energized parts, and minimize electrical arc flash hazards. (See *NFPA 70E – Informative Annex O – Safety-Related Design Requirements for guidance*). All new electrical systems shall be designed and constructed in accordance with CSUF company-drafted engineering specifications and legislated codes if applicable. Touch safe terminals shall be seriously considered in all designs.

Existing installations need not be physically modified to comply unless such modifications are considered necessary to protect personnel.

When any modifications are made to existing electrical systems, these modifications shall be designed to current standards and best practices.

Modification to equipment or new installations shall comply with the state-legislated electrical wiring code, OSHA 1910 Subpart S, the locally adopted version of the National Electrical Code, and any CSUF company-specific procedures (in the order mentioned). CSUF shall ensure that new installations and modifications are approved by a local inspector, site engineer, or outside consultant as applicable for electrical safety compliance before energizing the equipment.

It is recommended that:

- i. All new electrical installations be designed, installed, and maintained to limit personnel exposure to arc thermal energy to 8 cal/cm² or less as a minimum. All new switchgear and motor control centers should be an arc resistant design to accepted standards if the calculated potential arc thermal energy is greater than 40 cal/cm².
- ii. All new static capacitor banks should have a permanently installed shorting/grounding switch key or be mechanically interlocked with the main line disconnect switch. The interlock will prevent both the line disconnect and the grounding switches from being closed simultaneously and will require the five-minute waiting interval between opening the line disconnect and closing the grounding switch. Conspicuous signage warning that the capacitor bank frame is energized will be placed on all sides of the frame accessible to personnel. (See *NFPA 70E-21, Informative Annex R: Working with Capacitors*)
- iii. Substation auxiliary systems, such as lighting, shall be installed so maintenance personnel cannot come within close proximity to any exposed or unguarded energized parts while servicing the device.
- iv. Control voltages, indication lamps, local push buttons, switches etc., shall operate at below 50 Vac.

IX. Training

A. Policies

- i. Training may be in the form of classroom, on-line, on-the-job, or in combinations.
- ii. This training shall be documented (content of training), and records (through sign-in sheets or similar) maintained for the duration of employment.
- iii. Initial training shall be given upon employment with annual refresher training.
- iv. Safety proficiency shall be audited and documented on an annual basis and refresher training shall be provided if deficiencies in the employee's safety related work practices are found.



- v. For tasks performed less than once per year, refresher training shall be conducted before the task is performed.
- vi. Training providing an understanding of new technology, work techniques and procedural changes shall be provided.
- vii. Retraining shall be performed at intervals not exceeding three years.
- viii. Length/type of retraining can be determined by the location based on the results of the supervisory audit, see [§X(B)].

B. Qualified Personnel

All qualified personnel shall remain knowledgeable and stay current on the rules and specifications contained in this document. To be considered either qualified or task qualified for electrical work, individuals shall be trained on the requirements and shall then demonstrate competency in all safety related work practices, procedures, and requirements regarding their respective job assignments. Training shall include as well as determined by a Training Needs Analysis:

- i. Skills and techniques to distinguish exposed energized parts from the non-energized parts of structures and other items in the environment.
- ii. Skills and techniques to determine the nominal voltage of exposed energized electrical conductor or circuit parts and how to verify absence of voltage. Employees shall be trained to select an appropriate voltage detector and they shall demonstrate how to inspect and use the device to verify for the absence of voltage.
- iii. Knowledge and understanding of the required distances that must be maintained from exposed energized parts for both arc flash and shock. This shall include the interpretation of the arc flash and electrical shock warning labels.
- iv. Proper inspection, use, and storage of personal protective equipment for arc flash and electrical shock protection, insulating and shielding materials, and rated, insulated tools associated with working on or near exposed, parts of electrical equipment.
- v. Knowledge and understanding of the required distances that must be maintained from parts as required by Table 1 and Table 2.
- vi. The decision-making process necessary to determine the degree and extent of the hazard to which they will be exposed along with the PPE and job safety planning necessary to the perform the task safely. This training shall include:
 - a) Identifying potential arc flash and shock hazard tasks and locations.
 - b) The safe work practices and risk controls necessary to eliminate injury from the electrical hazards.
 - c) Arc-rated and shock personal and other protective equipment required to be worn for specific electrical tasks.
- vii. Skills needed to apply the appropriate alerting techniques (barricades, signs, or attendants).
- viii. Skills and techniques needed to understand capacitive and inductive residual energies, and for knowing how to “drain” these energies.
- ix. Skills to safely free someone, e.g.; contact release, from electrical shock.
- x. Qualified persons working at a site without readily available qualified medical assistance that can arrive at the accident site within four minutes must have the following additional emergency response training:
 - a) Emergency first aid training.
 - b) Cardiopulmonary resuscitation training.



- c) Automated External Defibrillator (AED) training if employer's emergency response plan includes use of this device.
- d) Training shall occur at frequencies determined by the certifying body.
- xi. Any location-specific skills and rules required of qualified personnel.

C. Task Qualified Personnel

All task qualified personnel shall remain knowledgeable and stay current on the task's Job Safety Planning Checklist, rules, and specifications contained in this document.

To be task qualified, individuals shall be trained by a qualified person and shall demonstrate proficiency in all safety related work practices, procedures, and requirements regarding the specific task assignment and Job Safety Planning Checklist. This ESP provides for task qualified persons to perform minor electrical work or operate equipment (either inside or outside the arc flash boundary) only as approved by CSUF. The specific job requirements for each task qualified person shall determine their training requirements. Some task qualified persons may only be exposed to the shock hazard; others may be exposed to both shock and arc flash.

Training for low voltage tasks shall include as well as determined by a Training Needs Analysis such as:

- i. Skills and techniques needed to distinguish exposed energized parts from the non-energized parts of structures and other items for completion of the task.
- ii. Skills and techniques needed to determine the nominal voltage of exposed energized electrical conductor or circuit parts and how to verify absence of voltage. Employees shall be trained to select an appropriate voltage detector and they shall demonstrate how to use the device to verify absence of voltage and for the appropriate PPE to be used.
- iii. Knowledge and understanding of the required distances that must be maintained from parts as required by Table 1 and Table 2.
- iv. Proper use of personal protective equipment for arc flash and electrical shock protection, insulating and shielding materials, and rated insulated tools associated with working on or near exposed parts of electrical equipment. This training shall include:
 - Identifying potential arc flash and shock hazards associated with the task.
 - The safe work practices necessary to eliminate injury from arc flash and shock hazards.
 - The use and care of arc-rated and shock personal protective equipment required to be worn for the specific electrical task including personal protective equipment determined from the Job Safety Planning Checklist.
- v. Skills and techniques needed to apply proper barricades if required for the task.
- vi. Skills to free someone from electrical shock.
- vii. Any location-specific rules required for the task.

D. All Other Personnel

All other personnel not classified as CSUF qualified or task qualified shall receive electrical safety awareness training as required for their job assignment. This training shall include emergency shock procedures and knowledge of the barricading used at the location. These personnel are considered unqualified for electrical work and may not operate, service, or repair any equipment that is not in an electrically safe work condition as per CSUF's LO/TO Policy and Program.



X. Audits

A. Electrical Safety Program Audit

- i. The electrical safety program shall be reviewed to ensure the principles and procedures included herein are in compliance with OSHA 1910 Subpart S, OSHA 1910.269, as applicable and NFPA 70E (latest edition).
- ii. An electrical infrastructure documented audit for each location will be conducted, so that any changes to equipment can be incorporated into the program.
- iii. Comprehensive documented audits shall be performed at intervals not exceeding three years.
- iv. Annual spot audits, on randomly selected sections in this program, shall be performed.
- v. Audits will be conducted by trained and experienced CSUF personnel and/or qualified 3rd party consultants.
- vi. All identified items will be documented with repair/remediation plans developed.

B. Supervisory Audit

- i. Supervisors shall conduct documented field audits on a monthly basis to ensure that electrical safety work practices and procedures are being performed in compliance with the company's electrical safety program and procedures.
- ii. Re-training shall be performed to address any deficiencies noted in the supervisory audits.

C. CSUF LO/TO Policy and Procedure Audit

- i. A CSUF qualified person shall audit compliance to the CSUF LO/TO Program and Policy for electrical equipment annually.
- ii. In addition to the CSUF LO/TO Program and Policy audit, at least one in-progress task shall be audited. The audit results shall be used to:
 - a) Address gaps in the CSUF LO/TO Program and Policy.
 - b) Improve the CSUF LO/TO Program and Policy training program.
 - c) Optimize the execution of the CSUF LO/TO Program and Policy.

D. General Audit Requirements

A core CSUF team shall convene annually for a Post-Electrical Safety Audit meeting. During this time, results from the various audits, safety program changes, and previous meeting items are to be holistically addressed. During this review session, electrical engineering, operational, projects, and maintenance-related incidents shall be discussed. The core team shall plan to address and remediate all audit findings. Learning opportunities shall be shared and the core team shall disseminate the contents and outcomes of these meetings.

XI. References

If no jurisdictional requirements are applicable, the standards below will supplement the program.

ASTM D120 titled "Specification for Rubber Insulating Gloves."

ASTM D178 titled "Specification for Rubber Insulating Matting."

ASTM D1048 titled "Specification for Rubber Insulating Blankets."

ASTM F479 titled "Specification for In-Service Care of Insulating Blankets."

ASTM F496 titled "Specification for In-Service Care of Insulating Gloves and Sleeves."

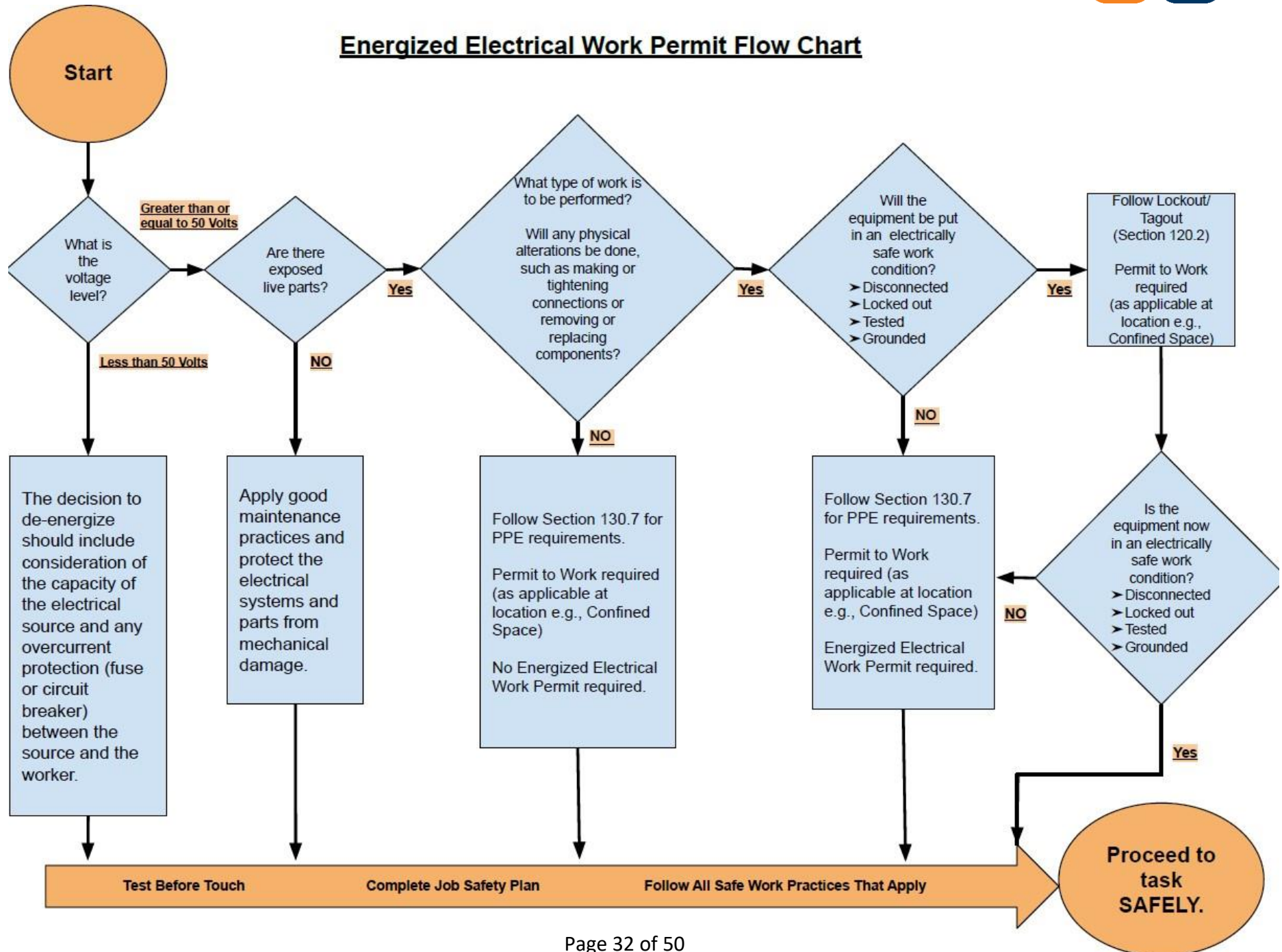
ASTM F855 titled "Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment."



ATTACHMENTS



Energized Electrical Work Permit Flow Chart





Job Safety Planning Checklist

Equipment:		Work Order #:		
Task:				
Location:				
Qualified Electrical Worker:		Date:		
Section A: General				
<i>Mark "Y" or "N" as appropriate</i>				
No.	Item	Yes	No	Instructions
1.	Is there justification for the energized work? a. Equipment operating at less than 50 volts b. Additional hazard or increased risk c. Infeasible to de-energize d. Normal operating condition			If NO , the equipment must be placed in an electrically safe working condition. If YES , complete 1a, 1b, and 1c, and Energized Electrical Work Permit are required to determine the appropriate hazard controls. Proceed to Line 2.
2.	Will the worker be exposed to energized parts?			If NO , a shock risk assessment is discretionary and completing Sections B and C is optional. Proceed to Line 3.
3.	Is there an arc flash hazard?			If NO , arc flash risk assessment is discretionary and completing Sections D or E and F is optional. Proceed to Line 4.
4.	Did the arc flash risk assessment determine that additional protective measures are required?			If NO , completing Parts D or E and F is discretionary. If YES , Part D or E is required to be completed. Proceed to Line 6.
5.	Is the required working distance available?			If YES , proceed to Line 7. If NO , additional risk assessment is required before completing Section D or E or performing any work. Proceed to Line 7.
Section B: Shock Hazard Information				
<i>Use Table 130.4(D)(a) for ac system boundaries or Table 130.4(D)(b) for dc system boundaries</i>				
6.	Voltage between phases: Limited approach boundary: Restricted approach boundary:			Establish the shock boundaries. Proceed to Line 8.
Section C: Shock Control Information				
<i>Mark "Y" or "N" as appropriate</i>				
7.	Will the task require the worker to cross the restricted approach boundary?			If NO , shock protection controls are discretionary. Proceed to Section D or E as appropriate. If YES , shock protection controls are required. Proceed to Line 9.
8.	Will rubber insulating gloves and leather protectors be used for the task?			If YES , proceed to Line 10. If NO , proceed to Line 11.
9.	Minimum glove class required for insulating gloves			Establish minimum glove class. Proceed to Line 11.
10.	Will insulating blankets be used for the task?			If YES , proceed to Line 12. If NO , proceed to Line 13.
11.	Minimum voltage rating for insulating blankets			Establish minimum voltage rating. Proceed to Line 13.
12.	Are insulated or insulating hand tools required for the task?			If YES , proceed to Line 14. If NO , proceed to Section D or E as applicable.



13.		Identify the hand tools, including the minimum voltage rating required. Proceed to Section D or E as applicable.
Section D: Arc Flash Control Information – Incident Energy Analysis Method See Attachment A		
14.	Incident energy: Working distance: Level of PPE: Minimum arc rating of clothing: Arc flash boundary:	Include: the arc flash boundary and at least one of the following: the incident energy and the working distance or the level of PPE or the minimum arc rating of clothing. Proceed to Section F.
Section E: Arc Flash Hazard Control Information – Arc Flash PPE Category Method See Attachment A		
15.	Determine the estimated available fault current and clearing times for the task.	
	Available fault current:	Overcurrent device clearing time:
<i>Mark "Y" or "N" as appropriate</i>		
16.	Do the estimated available fault current and clearing times for the task exceed the maximum allowed by Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b)?	If YES , an incident energy analysis is required. If NO , proceed to Line 18.
17.	Arc flash boundary:	Proceed to Line 19.
18.	Arc flash PPE category: Working distance:	Proceed to Line 20 and 21, Section F.
Section F: Arc Rated Clothing and Other Arc Flash Protection Equipment Information See Attachment A		
19.	Minimum arc rating in cal/cm ² for protective clothing and other PPE	Establish the required arc rated clothing and other PPE.
20.		List the required arc rated clothing and other arc flash PPE. PPE Category Method: Use 130.7(C)(15)(c) Incident Energy Analysis Method: Use 130.5(G)
Section G: Energy Source Controls		
21.		List all sources of electrical supply to the specific equipment. Include location and method to lock or tag. Include method to verify and test for absence of voltage. List temporary protective grounding equipment.
Section H: Work Procedures and Special Precautions		
22.		List specific work procedures required to complete the task. List any special precautions needed to safely complete the task (i.e., discharge time for capacitors).
Job Briefing Sign-Off		
	Print:	Sign:
1.		
2.		
3.		
4.		
5.		

Note: Once work is complete, retain this form for your records.



ENERGIZED ELECTRICAL WORK PERMIT(EERP)

Attachment C

This permit is **REQUIRED** for testing above 600V. *Specifically, Breaker Replacement, Buss Modification, Hot Tap, Racking Out/In or as deemed necessary.* Also, **REQUIRED** for energized parts and direct contact with 600V and below.

Work Order #: _____

XIII. PART I: TO BE COMPLETED BY THE QUALIFIED ELECTRICAL WORKER DOING THE WORK

(1) Description of circuit/equipment/job location:

(2) Description of work to be done:

(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage:

Check when
complete

(4) Detailed job description procedure to be used in performing the above detailed work:

(5) Description of the safe work practices to be employed:

(6) Results of the shock risk assessment:

(a) Voltage to which personnel will be exposed _____

(b) Limited approach boundary _____

(c) Restricted approach boundary _____

(d) Necessary shock, personal protective equipment to safely perform assigned task:

(7) Results of the arc flash risk assessment:

(a) Available incident energy at the working distance or Arc Rated PPE Category _____

(b) Arc flash boundary _____

(c) Necessary arc flash personal protective equipment to safely perform the assigned task:

(8) Means employed to restrict the access of unqualified persons from the work area:

Barricade Attendants Other(specify) _____

(9) Evidence of completion of a job briefing, including discussion of any job-related hazards:

(10) Do you agree the above-described work can be done safely? Yes No

YOU ARE RESPONSIBLE FOR YOUR SAFETY AND THE SAFETY OF OTHERS. PLEASE FOLLOW ALL POLICIES AND PROCEDURES.

Qualified Electrical Worker (Signature) Date

Qualified Electrical Worker (Signature) Date

Qualified Electrical Worker (Signature) Date

Qualified Electrical Worker (Signature) Date



Table 130.7(C)(15)(a) Arc-Flash PPE Categories for Alternate Current (ac) Systems

Equipment	Arc-Flash PPE Category	Arc-Flash Boundary
Panelboards or other equipment rated 240 volts and below Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts Parameters: Maximum of 25 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) Parameters: Maximum of 42 kA available fault current; maximum of 0.33 sec (20 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards Parameters: Maximum of 35 kA available fault current; maximum of 0.5 sec (30 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment Parameters: Maximum of 65 kA available fault current; maximum of 0.03 sec (2 cycles) fault clearing time; minimum working distance 455 mm (18 in.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Metal-clad switchgear, 1 kV through 15kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 Cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)
Arc-resistant switchgear 1 kV through 15 kV [for clearing times of less than 0.5 sec (30 cycles) with an available fault current not to exceed the arc-resistant rating of the equipment], and metal-enclosed interrupter switchgear, fused or unfused of arc-resistant-type construction, 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	N/A (doors closed) 4(doors open)	N/A (doors closed) 12 m (40 ft)
Other equipment 1 kV through 15 kV Parameters: Maximum of 35 kA available fault current; maximum of up to 0.24 sec (15 cycles) fault clearing time; minimum working distance 910 mm (36 in.)	4	12 m (40 ft)

Note: For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below flash PPE category 1.

Informational Note to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current limiting fuse when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous internal grip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip



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

Equipment	Arc-Flash PPE Category	Arc-Flash Boundary
Storage batteries, dc switchboards, and other dc supply sources Parameters: Greater than or equal to 100 V and less than or equal to 250 V Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)		
Available fault current less than 4 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 7 kA and less than 15 kA	2	1.2 m (4 ft)
Storage batteries, switchboards, and other dc supply sources Parameters: Greater than 250 V and less than or equal to 600 V Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)	3	1.8 m (6 ft)
Available fault current less than 1.5 kA	2	
Available fault current greater than or equal to 1.5 kA and less than 3 kA	2	900 mm (3 ft)
Available fault current greater than or equal to 3 kA and less than 7 kA	3	1.8 m (6 ft)
Available fault current greater than or equal to 7 kA and less than 10 kA	4	2.5 m (8 ft)

Notes

(1) Apparel that can be expected to be exposed to electrolyte must meet both of the following conditions:

- (a) Be evaluated for electrolyte protection

Informal note: ASTM F1296, *Standard Guide For Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte

- (b) Be arc-rated

Informal Note: ASTM F1891, *Standard Specifications for Arc Rated and Flame Resistant Rainwear*, contains information on evaluating arc-related apparel

(2) A two second arc duration is assumed if there is no overcurrent protective device (OCPD) or if the fault clearing time is not known. If vault clearing time is know and is less than 2 seconds, an incident energy analysis could provide a more representative result

Informational Note No. 1: when determining available fault current, the effects of cables and other impedances in the circuit should be included. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer. See Informative Annex D.6 for the basis for table values and alternative methods to determine dc incident energy. Methods should be used with good engineering judgement.

Informational Note No. 2: The methods for estimating the dc arc-flash incident energy that were used to determine the categories for this table are based on open-air incident energy calculations. Open-air calculations were used because many battery systems and other dc process systems were in open areas or rooms. If the specific task is within an enclosure, it would be prudent to consider additional PPE protection beyond the value shown in this table. Research with an arc flash has shown a multiplier of as much as 3x for arc-in-a-box [508 mm (20 in.) cube] verses open air. Engineering judgment is necessary when reviewing the specific conditions of the equipment and task to be performed, including the dimensions of the enclosure and the worrying distance involved.



Switching Orders

PURPOSE:	Provide a sequential order of operation for all electrical equipment as required.
POLICY:	This Procedure shall be used on all equipment listed in the SCOPE.
SCOPE:	<p>The equipment covered in this procedure will be all electrical equipment serviced by CSUF that requires switching orders. This equipment includes:</p> <ul style="list-style-type: none"> • Distribution Substations • Generators • Transmission lines • Transformers <p>This EWP does not include Utilization Equipment lockout/tagout.</p>
REFERENCES:	<p>CSUF Electrical Safety Program Switching Order Voltage Testing and Applying Protective Grounding of Lines and Electrical Equipment</p>
SAFETY:	All work to be performed by qualified personnel knowledgeable of the power distribution system.
RESPONSIBILITIES:	Familiarize yourself with current status of the power system before proceeding.
PROCEDURE:	Switching Orders
<i>Planned and Routine Switching</i>	<p>For planned and routine work a Switching Order listing the sequential order of operation for all higher voltage devices as determined by CSUF shall be prepared by a qualified, knowledgeable person and reviewed for accuracy by a second knowledgeable and qualified person using a switching order form. No switching operation shall begin until a written switching order is completed. Each step of the order shall be confirmed using operation verification, Repeat Back ensuring clarity, and noted completion of the operation before moving to the next step. If the switching order is interrupted by any new event, stop the switching, re-evaluate the situation, and verify the completed steps by starting back at Step 1 of the switching order.</p> <p>Fixed or standing switching orders for routine and/or straightforward events are acceptable practices if approved by CSUF.</p>
<i>Emergency Switching</i>	For emergency switching the switching order can be prepared and executed by only one knowledgeable person if needed because of time constraints.
<i>Three-Way Communication</i>	Each person receiving an oral message concerning the switching of lines and equipment shall immediately repeat it back to the sender before the operation of the device is performed. Verification of the operation will be completed in the same manner.
<i>One Switch Operation</i>	In situations involving simple, one-switch operation, it is acceptable to use lock/tag/verify in lieu of a switching order. This is the only exception to not using a switching order.



Voltage Testing and Applying Protective Grounding of Lines and Electrical Equipment

PURPOSE:	To establish electrical equipment and lines in a safe condition for maintenance.
POLICY:	<p>Electrical equipment and lines identified in the SCOPE shall be considered energized until de-energized, comprehensively tested for absence of voltage and grounded.</p> <p>It is critical to always <i>“Identify, Isolate, Test and Ground”</i> your electrical equipment as appropriate to the task before any work is done.</p>
SCOPE:	<p>The equipment covered in this procedure will be for all electrical equipment up to 15 kV equipment, as appropriate, in service at CSUF. This equipment includes:</p> <ul style="list-style-type: none"> • Distribution Substations • Generators • Transformers • All Utilization Equipment
REFERENCES:	<p>Electrical Safety Program</p> <p>Switching Orders</p> <p>Grounding & Barricading of Electrical Equipment During Diagnostic Testing</p>
DEFINITIONS:	<p>Protective Grounding: The act of providing an intentional connection to earth using copper leads and appropriate clamps capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault to help prevent a buildup of voltage at the work location, which could result in undue hazard to persons.</p>
SAFETY:	<ul style="list-style-type: none"> • All work to be performed by qualified personnel. • Familiarize yourself with all of the above referenced material. • Familiarize yourself with the test equipment required to perform this job task. • Wear required Shock and Arc Flash Rated PPE, as per equipment signage, engineered assessments, Shock and Arc Flash Risk Assessment Procedures, and any other CSUF approved procedures for equipment being worked on. • Have all of the required PPE ready and inspected. • Always verify the operation of the test equipment before and after for the absence of voltage test using the Live-Dead-Live method.
RESPONSIBILITIES:	
Electrical Power Engineer is responsible for:	<ol style="list-style-type: none"> 1. Determining the correct size of protective ground sets. 2. Assist with the determination of arc flash incident energy values in cal/cm² for specific tasks to determine all required PPE.
PROCEDURE:	
Testing and Grounding of Lines and Electrical Equipment	<p>Electrical equipment and lines shall be considered energized until de-energized, tested for absence of nominal voltage and grounded. Protective ground leads and clamps shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault. This grounding equipment shall have a minimum ampacity greater than or equal to that of No. 2 AWG (33 square millimeters) copper. Fixed or standing switching orders for routine and/or straightforward events are acceptable practices.</p>
Testing and Verifying Equipment is De-energized	<p>To test and verify equipment is de-energized, qualified personnel shall perform the following actions:</p> <ol style="list-style-type: none"> 1. Verify all energy sources within the work zone have been de-energized, as part of the CSUF LO/TO Program.



2. Test circuit elements and exposed electrical parts to verify all elements and parts are de-energized. Proximity detectors or glow detectors of an industrial grade (e.g., Salisbury, AB Chance, etc.) shall be used at greater than 480 volts. Check the tester for proper operation immediately before the test.
3. Verify no energized condition exists or may exist as a result of accidentally induced voltage or back feed.
4. Check the test equipment for proper operation immediately after the test (Live-Dead-Live).

Grounding of Lines and Equipment

Before installing protective ground sets, personnel shall visually inspect the grounding equipment to confirm it is in working order and in good condition. Personnel shall use an approved and tested live-line tool and wear the required shock and arc flash personal protective equipment when attaching or removing a grounding connection to a circuit or to equipment. In areas where live-line tools cannot be effectively used, the responsible person may grant exceptions to the grounding policy only through a CSUF approved documented procedure. Exceptions shall offer an equivalent level of safety and in absolutely no way compromise personnel safety.

Qualified personnel shall place protective grounding equipment as close to the work location as possible and between all potential sources of energy and the point of work. Equi-Potential grounding is the only acceptable means of grounding. When equipment is fully enclosed and designed with a ground switch, it may not be possible to test for voltage before grounding. Clearly identify each location where temporary protective grounds (TPGs) are installed and/or grounding switches are closed following the CSUF approved documented standard operating procedures. **Ensure all protective grounds are removed and/or grounding switches are open before re-energizing.**

When grounding lines or equipment, personnel shall:

1. Attach the grounding device to an effective ground connection.
2. Then attach the grounding device to the circuit or equipment.

When removing grounds, personnel shall:

1. Remove the grounding device from the circuit or equipment.
2. Then remove the grounding device from the ground connection.

Grounding or Shorting Static Capacitors

A five-minute waiting period, or as per the manufacturer’s recommendations, shall be required between isolating static capacitors and then testing and grounding or shorting. This time allows trapped charges to bleed off the capacitors. **Note:** See NFPA 70E-2021, “Informative” Annex R – Working With Capacitors for information if required.

Materials Required

Protective Ground Cables sized for the specific *equipment location* and electrical parameters.

Tools Required

Voltage tester attached to the appropriate live-line tool.
Proper live-line tool for attaching and removing the protective grounds.

TRAINING REQUIREMENTS:

Electricians/Technicians, as appropriate, performing these electrical tests and inspections shall be fully Qualified and have experience with the apparatus, test equipment, and system being evaluated. These individuals shall conduct testing and apply grounding in a safe manner, with complete knowledge of the hazards identified, and estimated risks of damage to health and the risk control methods involved.



Grounding and Barricading of Electrical Equipment during Diagnostic Testing

PURPOSE:	This document describes the safety practices for grounding and barricading of electrical equipment during diagnostic testing, field testing, or at a temporary work site.
POLICY:	<p>The safety practices described in this document shall apply to interim diagnostic testing and do not include testing involving continuous measurements for routine metering or relaying. A mandatory check of temporary or field test areas for all safety hazards shall occur at the beginning of each series of tests. The test operator in charge shall conduct these mandatory safety checks before each series of tests and shall verify at least the following conditions:</p> <ul style="list-style-type: none">• Barriers and guards are in workable condition and are properly placed to isolate hazardous areas.• System test status signals, if used, are in operable condition.• Test power disconnects are clearly marked and readily available in an emergency.• Ground connections are clearly identifiable.• Personal protective equipment (PPE) is provided and used as appropriate to the identified hazards and in the circumstances.• Signal, control, ground, and power cables are properly separated.
SCOPE:	The equipment covered in these safety practices is any electrical equipment or materials under diagnostic testing, in field testing, or a temporary work site. Such test areas shall include guarding, grounding, and the safe use of measuring and control circuits and a means providing for periodic safety checks of the field test areas or temporary worksite.
REFERENCES:	OSHA 29 CFR 1910.269(o) "Testing and test facilities". NFPA 70E, Standard for Electrical Safety in the Workplace, Article 130.7(E) Alerting Techniques.
DEFINITIONS:	<p>Diagnostic Testing - Diagnostic (testing) is taking readings or measurements of electrical equipment with approved test equipment.</p> <p>Guarding - Covering, shielding, fencing, enclosing, or otherwise protecting personnel 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.</p> <p>Insulated - Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of electrical current.</p> <p>Task Supervisor or Employee in-Charge (Person-in-Charge) - A CSUF qualified person in charge of completing an electrical task and the safety of assigned personnel. (This is not to be confused with the management supervisor who might be an unqualified person).</p> <p>Test Observer - If employees will be present in the test area during testing, a test observer, as designated by the Task Supervisor, shall be present. The test observer shall be capable of implementing the immediate de-energizing of test circuits for safety purposes if required.</p>



SAFETY:

- All work to be performed by qualified personnel.
- Familiarize yourself with all of the above referenced material.
- Familiarize yourself with the test equipment required to perform this job task.
- Wear required Shock and Arc Flash Rated PPE, as per equipment signage and CSUF Electrical Safety Program Risk Assessment Procedures for equipment being worked on.
- Have all of the required PPE ready and inspected.
- Always verify the operation of the test equipment before and after the absence of voltage testing (Live-Dead-Live).

RESPONSIBILITIES:

Task Supervisor

Responsible for ensuring adequate supplies of:

- Insulating material, blankets, covers, mats, PPE, etc.
- Barricade tape, cones, A-frame-type wood, or metal structures as appropriate for limiting access to a specific area.
- Red barricade tape along with warning signs that state the hazard and give direction such as “DANGER HIGH VOLTAGE - KEEP OUT.” As an alternate, a red barricade tape imprinted with black lettering stating, “DANGER HIGH VOLTAGE.”
- Adhesive tapes colored red and green for use as indicating what equipment is safe to touch and work on (e.g. green), and what is not safe to touch and work on (e.g. red). This guards against potential “Look-Alike Equipment” scenarios.

PROCEDURE:

Grounding

In field testing or at a temporary test site, the following grounding requirements shall apply:

- Test trailers and vehicles shall be grounded.
 - All conductive parts accessible to the test operator shall be grounded except those portions of the equipment isolated from the operator by guarding.
 - Ungrounded terminals of test equipment shall be treated as energized until proven de-energized and put into the electrically safe work condition.
 - Common ground connections shall be attached to test equipment and to the apparatus under test.
 - If control wiring, meter connections, test leads or cables must be run outside of the test area, they shall be contained in grounded metallic sheaths and terminated in grounded metallic enclosures unless other equivalent safety precautions are taken.
 - If a qualified person must enter a test area after equipment has been de-energized, high voltage and other exposed terminals shall be grounded.
 - Grounds may be temporarily removed during testing. If grounds are removed, the test equipment and the equipment under test shall be treated as energized until proven otherwise by test. The person in charge of testing shall follow these procedures to protect personnel in case the previously grounded lines or equipment becomes energized. These precautions may include:
 - Wearing rubber insulating gloves with approved leather protectors when within the shock protection boundaries.
 - Physically disconnecting the voltage source leads to the equipment.
 - Grounding the circuit at a point adjacent to the test area between the de-energized equipment and the voltage source.
 - During the test procedure, the person in charge of testing shall ensure that everyone uses insulated equipment and is isolated from any hazards. If an unqualified person must be present within the test area, an escort shall be present at all times.
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Barricading and Guarding

In field testing or at a temporary test site where permanent fences and gates are not provided, the test area shall be barricaded or guarded to limit access to the area and to ensure hazard recognition. Additional barricades may be required to control personnel access to test equipment or to apparatus that may become energized as part of the testing. Added precautions are to prevent accidental contact with energized parts. These methods of protection may include one or more of the following:

1. Guarding the test area by the use of red barricade tape or equivalent. The safety tape or equivalent must be about waist high and have safety sign(s) attached. As an alternate, red barricade tape with black lettering stating "DANGER HIGH VOLTAGE" may be used.
2. Restricting access to the test area by a barrier or barricade approximately waist high and having sign(s) attached.
3. Guarding the test area by one or more persons. These individuals shall be stationed so that the entire test area is under observation.

Guarding shall be provided within test areas to control access to test equipment or to apparatus under test that may become energized as part of the testing by either direct or inductive coupling, in order to prevent accidental employee contact with energized parts. The barriers and guarding within and around the test area shall be removed when the protection they provide is no longer needed.

Meters and other instruments with accessible terminals or parts shall be insulated from test personnel to protect against hazards arising from such terminals and parts becoming energized during testing.

The routing and connections of temporary wiring shall be made secure against damage, accidental interruptions, and other hazards. To the maximum extent possible, signal, control, ground, and power cables shall be kept separate.

If employees will be present in the test area during testing, a test observer shall be present. The test observer shall be capable of implementing the immediate de-energizing of test circuits for safety purposes.

Materials Required

- Insulating material, blankets, covers, mats, etc.
- Barricade tape, cones, A-frame-type wood, or metal structures for limiting access to a specific area.
- Red barricade tape along with warning signs that state the hazard and give direction such as "DANGER HIGH VOLTAGE KEEP OUT."
As an alternate, a red barricade tape imprinted with black lettering stating, "DANGER HIGH VOLTAGE."

TRAINING REQUIREMENTS:

Electricians/Technicians performing these tests at temporary or field test areas shall be qualified, trained, and have experience with the use of the following:

- Grounding requirements with respect to test equipment and the materials or equipment under test.
- Barricading and guarding equipment and materials.
- Proper shock and arc flash personal protective equipment, as per the Arc Flash and Shock Risk Assessments and use.



Operation and Maintenance Requirements of Utilization Equipment

PURPOSE:	This document describes the operation and maintenance of specific utilization equipment listed in the SCOPE.
POLICY:	This procedure shall be used on all equipment listed in the SCOPE.
SCOPE:	<p>The equipment covered in this procedure shall be for <i>600 volts and below</i> equipment, tools, and electrical devices used by CSUF.</p> <p>This equipment includes:</p> <ul style="list-style-type: none"> • Extension cords including 120, 240 and 480 volts. • Plug & Cord connected portable electric tools. • Portable electric power strips. • Anti-restart devices. • Ground-fault circuit interrupters (GFCI's). • Three-prong plug adapters.
REFERENCES:	<p>CSUF Electrical Safety Program National Fire Protection Association – NFPA 70 National Electric Code (NEC) NFPA 70E Standard for Electrical Safety in the Workplace, Article 110.5 OSHA 29 CFR 1910.304(b)(3)(ii)(C). OSHA 29 CFR 1910.303(b)(2)</p>
DEFINITIONS:	<p><u>Qualified Person</u> - 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.</p> <p><u>Ground-Fault Circuit-Interrupter (GFCI)</u> - 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.</p> <p><u>Portable Electric Power Strips</u> - An outlet case that houses multiple grounded (three-prong) outlets, a circuit breaker, a mechanism for power control and a cord assembly in one unit. These units shall be tested and listed as an assembly by a product safety testing and certification organization.</p> <p><u>Double Insulated Portable Electric Tool</u> - A tool with a plastic or other non-electrical conductive body that has been constructed in such a way that the electrical material and parts inside the tool has double layers of insulation around them. Such a tool usually has a label stating, or a symbol indicating, it is a double insulated tool.</p> <p><u>Task Qualified Person (TQW)</u> - A non-electrical employee who receives safety training to perform a specific electrical task and who demonstrates the ability to perform all duties safely, shall be considered to be a qualified person for that specific task only. A Job Safety Planning Checklist (Attachment B) shall be written by a qualified person for all tasks performed by task qualified persons.</p> <p><u>Three-Prong Plug Adapter</u> - A device that converts a grounded (three-prong) plug to a non-grounded (two-prong) plug for use with ungrounded receptacles that only have two connections.</p>
SAFETY:	<ol style="list-style-type: none"> 1. All work shall only be performed by qualified or task qualified personnel. 2. Familiarize yourself with all of the above referenced material.



RESPONSIBILITIES:	<ol style="list-style-type: none">3. Familiarize yourself with the test equipment required to perform the various tests listed4. Always verify the operation of any the test equipment before and after the test. <p>Electrical Preventative Maintenance Group is responsible for:</p> <ol style="list-style-type: none">1. Maintaining all records for the assured equipment grounding program established for extension cord sets and portable electric tools.2. Maintaining all records for fixed wiring GFCI a per a quarterly testing program.3. Removing and discarding any three-prong plug adapters found on company property. <p>Note: An Electrical Specialist(s) or Engineer(s) shall be designated as the competent person for the assured equipment grounding program.</p>
PROCEDURE:	<p>Extension Cord Sets</p> <p>The following safe work practices apply to the use of extension cord sets:</p> <ol style="list-style-type: none">1. Extension cord sets shall be suitable for the intended environment, voltage, and rated capacity.2. No extension cords shall be allowed to run through walls or doors.3. All manufactured extension cords shall be listed by an appropriate product safety testing and certification organization.4. Custom made extension cord sets shall be suitable for the intended environment, voltage and rated capacity and shall be made of listed and approved parts for extension cord sets. Custom made extension cord sets shall be assembled and tested by a qualified person before first use. For all extension cords, testing is required following the Assured Equipment Grounding Program on page 4. The following tests shall be performed on all custom assembled extension cords after assembly and before first use:<ol style="list-style-type: none">a. Each plug and receptacle shall be tested by a qualified person for correct attachment of the current carrying conductors and the equipment grounding conductor. This is accomplished by using an ohmmeter and testing all the conductors for continuity and resistance. Test each conductor for phase to phase and phase to ground shorts. In lieu of an ohmmeter an approved Extension Cord and Portable Tool tester may be used. If using a tester, the results will be Pass or Fail.b. Each conductor ohmmeter reading shall be equal to or less than 0.5 ohms. All ohmmeter readings greater than 0.5 ohms indicate a faulty mechanical connection or mis-wiring.5. Extension cord sets shall not be used as permanent wiring.6. Extension cord sets shall be protected from mechanical damage, oil, solvents, abrasion, pinch points and sharp objects, vehicles, and pedestrians.7. Extension cord sets shall be placed so they do not cause slip, trip, or fall hazards.8. Extension cord sets shall be secured or suspended using non-conductive means.9. All extension cord sets shall be visually inspected prior to each use. Any worn, frayed, damaged, crushed, pinched, spliced, or defective extension cord sets shall be immediately removed from service.10. UNDER NO CIRCUMSTANCES shall any extension cord set be used without a ground prong on the grounded (three-prong) plug. Any extension cord set found without a ground prong on the grounded (three prong) plug shall be immediately tagged, removed from service, repaired, or cut up and discarded.



11. All 120 Volt single phase extension cord sets used for maintenance, remodeling, repair of buildings, structures or equipment shall be protected by a daily (when used) tested Ground-Fault Circuit Interrupter (GFCI) either portable or fixed wiring type.
12. Extension cord sets shall be inspected using the assured equipment grounding program outlined in Assured Equipment Ground Program on page 4. When GFCI protection is commercially available it shall be used and tested daily (when used) for this category of cord in lieu of the assured equipment grounding program.
13. Extension cord sets connected to a receptacle supplied from a field disconnect switch shall be plugged or unplugged ONLY with the field disconnect switch in the open (de-energized) position.
14. Portable electric power strips or their cords shall not be covered by carpeting, clothing, furniture, or other objects that could prevent adequate ventilation, circulation, and cooling.
15. Portable electric power strip cords shall not be run through any doorway or window opening.

Portable Electric Tools

When portable electric tools are used to perform a task, the following safe work practices shall apply:

1. Portable electric tools shall be suitable for the intended task, environment, and voltage, and shall be listed by an appropriate product safety testing and certification organization. Portable electric tools should be double insulated, if available. (Battery operated tools are best when appropriate to the task)
2. All portable electric tools shall be visually inspected before each use:
 - Check the casing, cords, and plugs to ensure they are free from damage and apparent electrical shock hazards.
 - Check the proper operation of any switches and adjustments.
 - Check that all labels are readable.
 - Plug in the portable tool and check for proper operation of the tool specifically listening for any unusual operational sounds.
3. Any portable electric tool found damaged or otherwise inoperable shall be immediately tagged and removed from service.
4. Each portable electric tool shall be tested for safe operation by a qualified person or task qualified person any time damage is suspected.
5. Each portable electric tool that is not a double insulated tool shall be tested using the assured equipment grounding program on page 4.
6. UNDER NO CIRCUMSTANCES shall a portable electric tool that has a grounded (three prong) plug ever be used with a three prong plug adapter.

Assured Equipment Grounding Program

This assured equipment grounding conductor program covers extension cords other than all non-double insulated portable electric tools with a cord and plug that are required to be grounded. Double insulated and battery operated portable electrical tools are exempt from this program.

The tests shall be performed before first use, before equipment is returned to service following any repairs, before equipment is used after any incident which can be reasonably suspected to have caused damage and at intervals not to exceed three months.

The assured equipment grounding conductor program has the following requirements:



1. All extension cords and all portable electric tools with a cord and plug required to be grounded shall receive an appropriate identifying number as established by CSUF.
2. The following tests shall be performed on all required extension cords and all portable electric tools with a cord and plug required to be grounded.
3. Each plug and receptacle shall be tested for correct attachment of the equipment grounding conductor. This is accomplished by using an ohmmeter and testing the equipment grounding connection for continuity and resistance. In lieu of an ohmmeter an approved Extension Cord and Portable Tool tester may be used. If using a tester, the results will be Pass or Fail.
 - a. When the ohmmeter reading is equal to or less than 0.1 ohms, the extension cord or portable electric tool's ground conductor has passed the test. All ohmmeter readings greater than 0.1 ohms fail the test.
 - b. Any equipment that fails the tests required in item (a) above shall be immediately tagged with a "DO NOT USE" tag and removed from service.
 - c. All required extension cord and electric portable tool PMs and test records shall be documented and kept electronically for retention by CSUF.

Portable Electric Power Strips

The following safe work practices shall apply when portable electric power strips are used:

1. Portable electric power strips shall be suitable for the intended environment and voltage and rated capacity, shall incorporate a circuit breaker, on/off switch, grounded flexible power cord and shall be listed by an appropriate product safety testing and certification organization.
2. Portable electric power strips shall be protected from mechanical damage, oil, solvents, abrasion, pinch points, and sharp objects.
3. Portable electric power strips and their associated flexible cords shall be placed so they do not cause slip, trip, or fall hazards.
4. Portable electric power strips shall be visually inspected before each use and periodically by the user for damage. If found to be damaged it shall be immediately removed from service.
5. UNDER NO CIRCUMSTANCES shall any portable electric power strip be used without a ground prong on the grounded (three prong) plug. Any portable electric power strip found without a ground plug on the grounded (three prong) plug shall be immediately removed from service, repaired, or discarded after cutting off the flexible cord.
6. UNDER NO CIRCUMSTANCES shall a portable electric power strip that has a grounded (three prong) plug be used with a three prong plug adapter.
7. Portable electric power strip shall be connected to permanent receptacle. They cannot be plugged into another portable electric power strip or an extension cord, e.g., "piggy backed."
8. Major appliances such as heaters, microwaves and refrigerators shall be plugged directly into wall outlets and not into portable electric power strips.

Anti-Restart Devices

1. Anti-restart devices shall be installed on all fixed mounted rotating shop-type equipment where restart after a power interruption may cause injury. Foot switch controlled equipment or non-locking trigger switch controlled equipment are exempt from this requirement.
2. Any rotating tool with a lockable trigger switch or an "On-Off" toggle switch requires an anti-restart device.



3. Portable anti-restart devices shall be suitable for the intended environment and voltage and rated capacity and shall be listed by an appropriate product safety testing and certification organization.

At a minimum, anti-restart devices shall be tested annually for proper operation. Test records shall be documented and kept electronically by the appropriate department.

Ground Fault Circuit Interrupters (GFCI)

Each location shall conduct a survey to determine, per local regulations or consensus standards, all circuits requiring the installation of GFCIs. Each location shall install GFCI's on any circuits found that require them and do not have them installed. Where GFCIs are used, the following safe work practices shall apply:

1. Portable GFCIs and 120 Volt outlets with integral GFCI protection for general use shall be inspected and tested prior to each use. Any damaged or non-functioning GFCI's shall be immediately tagged and removed from service.
2. For 120 Volt outlets with integral GFCI protection that supply equipment for an extended period of time, such as but not limited to vending machines, drinking fountains, laboratory equipment, a documented inspection program shall be implemented for testing monthly. This PM inspection and record of completion shall be documented and kept electronically for retention by the appropriate department. Any damaged or non-functioning GFCI breakers shall be immediately tagged and removed from service.
3. A portable GFCI shall be plugged directly into a receptacle and an extension cord shall be plugged into the portable GFCI.
4. For permanently installed GFCI circuit breakers, a documented inspection program shall be implemented for testing monthly. The test is accomplished by pushing the "Test" button and observing the disconnecting of the energized circuit. Then "Reset" the breaker to re-energize the circuit. This PM inspection and record of completion shall be documented and kept electronically for retention by the appropriate department. Any damaged or non-functioning GFCI breakers shall be immediately tagged and removed from service.

Note: Every GFCI has an integral "test button". This test button shall be used as the required test on all GFCI's whether portable or permanently installed. The internal test circuit performs a complete test of the functionality of the GFCI. External GFCI testers are not allowed by OSHA for the required monthly test. Some will falsely indicate that the GFCI does properly operate.

Three Prong Plug Adapter

UNDER NO CIRCUMSTANCES shall a three prong plug adapter be used in order to connect any device with a grounded (three prong) plug to ungrounded (two prong) receptacle.

Electricians/technicians performing any of these electrical tests and inspections shall be qualified, trained in the skills, knowledge and the appropriate safety procedures and have experience with the apparatus, test equipment, and equipment being evaluated. These individuals shall conduct testing and inspections in a safe manner, with complete knowledge of the hazards involved. They shall evaluate the test and inspection data and make a judgment on the serviceability of the specific equipment.

TRAINING
REQUIREMENTS:

RECORD
REQUIREMENTS:

All PM and test records for non-double insulated plug and cord connected hand tools, 120 Volt outlets with integral GFCI protection supplying extended service equipment and GFCI circuit breakers shall be documented and kept electronically for retention by the appropriate department.