Electrical Safety Policy

(Policy BAS-0005)

I. Purpose of the Policy

UC Santa Cruz (UCSC) recognizes that safety is achieved through an ongoing process of UCSC employees and management, working together daily to help reduce hazards and improve worker safety. This includes evaluation of the risks and hazards, proper training, development and revision of work practices and procedures, to help provide for a safe electrical work environment and to strive for a workplace that is accident free.

Contractors are responsible for providing and implementing their own safety program that meets or exceeds the minimum requirements of OSHA, CALDOSH, NFPA-70E, ANSI, ASTM and the UC Santa Cruz Electrical Safety Program. The UC Santa Cruz Electrical Safety Program is not to be used as a safety program for contractors and/or for Campus Department Maintenance crews "unqualified" by state contractor licensing boards or by state and federal electrical codes to perform electrical work.

II. Definitions

"Qualified" Electrical Personnel: A person who "by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project."
Electrical Distribution Equipment: Electrical equipment, such as disconnect switches, power panels, bus ducts, transformers, power distribution units, switchgear, circuits, etc., which distributes power to point of use appliances, tools and devices.

III. Detailed Policy Statement

UC Santa Cruz employees who perform electrical work within our facilities and those that may perform work in the area of energized electrical distribution equipment must meet program requirements outlined in current revision of the *UC Santa Cruz Electrical Safety Program*. The provisions of this policy have been adopted by Physical Planning & Construction, Physical Plant, Environmental Health & Safety and the Designated Campus Fire Marshal.

IV. Getting Help

The campus Physical Planning & Construction, Physical Plant, Environmental Health & Safety, and Designated Campus Fire Marshal may provide training and assistance to campus units (including help with completing forms, carrying out procedures, or interpreting policy.)

If you need help with ...	**Contact ...**
…questions about this policy	Physical Plant, Associate Director, Mike Hanson, mjhanson@ucsc.edu, 459-2581
…questions about electrical shutdowns	Physical Plant, Senior Superintendent, Gary Riggs, gcriggs@ucsc.edu, 459-1360
…questions about Electrical	Physical Planning and Construction, Rhonda Tramble, P.E,

Engineering services	rtramble@ucsc.edu, 459-2733
…questions about building code interpretation	Physical Planning and Construction, Felix Ang, AIA, felix@ucsc.edu, 459-3085
…questions about life and safety code compliance	Designated Campus Fire Marshal, Nick Otis, notis@ucsc.edu, 459-3473
…questions about accident prevention programs	Environmental Health and Safety, Safety and Industrial Hygiene Program. Manager, Kitty Woldow, kittyw@ucsc.edu, 459-1448

V. Applicability and Authority

This policy on electrical safety applies to all UC Santa Cruz employees and "Qualified" Electrical Personnel who perform electrical work within our facilities and those that may perform work in the area of energized electrical distribution equipment.

The Vice Chancellor of Business and Administrative Services is the campus authority for the Electrical Safety Policy, BAS-0005, with implementation authority, including exceptions to policy, delegated to the Associate Director of Physical Plant. This policy was reviewed and approved by Campus Provost/Executive Vice Chancellor, ____ on x/x/20xx. Next review date is x/x/20xx.

VI. Related Policies/References for More Information

Related Policies and Procedures

UCOP Facilities Manual, Volume 3, Part I, Chapter 4 http://www.ucop.edu/construction-services/facilities-manual/
UC Minors in Laboratories and Shops http://www.ucop.edu/risk-services/_files/safety-resources/minors-in-labs-policy-2012-01-09.pdf
UC Personal Protective Equipment http://policy.ucop.edu/doc/3500597/PersonalProtectiveEquip
UC Laboratory Safety Training http://www.ucop.edu/risk-services/_files/safety-resources/lab-safety-training-2012-01-09.pdf
California Code of Regulations, Title 8, Subchapter 5. Electrical Safety Orders (http://ccr.oal.ca.gov/linkedslice/default.asp?RS=GVT1.0&VR=2.0&SP=CCR- 1000&Action=Welcome).
California Code of Regulations, Title 22, Division 5. Licensing and Certification of Health Facilities (http://ccr.oal.ca.gov/linkedslice/default.asp?RS=GVT1.0&VR=2.0&SP=CCR- 1000&Action=Welcome).
California Code of Regulations, Title 8, §3314. The Control of Hazardous Energy for the Cleaning, Repairing, Servicing, Setting-Up, and Adjusting Operations of Prime Movers, Machinery and Equipment, Including Lockout/Tagout. (https://www.dir.ca.gov/title8/3314.html)

References

OSHA (Occupational Safety and Health Administration) https://www.osha.gov/law-regs.html
CAL-DOSH (State of California Division of Occupational Safety and Health) https://www.dir.ca.gov/dosh/
NFPA-70E (National Fire Protection Association – Standard for Electrical Safety in the Workplace) http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=70e
ANSI (American National Standards Institute http://www.ansi.org/
ASTM (America Society for Testing and Materials) http://www.astm.org/

Implementation Procedures

Appendix A: *UC Santa Cruz Electrical Safety Program*

VII. Revision History

BAS-0005 New policy draft dated July 17, 2017.

UC Santa Cruz
Electrical Safety Program

Rev. 0.1

(Reference Policy # BAS-0005)

Table of Contents

1.0 Introduction

1.1 UC Santa Cruz Electrical Safety Program

This safety program covers UC Santa Cruz employees who perform electrical work within our facilities and those that may perform work in the area of energized electrical distribution equipment. This safety program also provides minimum requirements for contracted resources that perform work within UC Santa Cruz facilities. It is designed to provide safety guidelines for those working with and around electrical distribution equipment. Following the requirements outlined in this document will help limit, but not prevent possible exposure to hazards and/or worker injury.
UC Santa Cruz recognizes that safety is achieved through an ongoing process of UC Santa Cruz employees and management, working together daily to help reduce hazards and improve worker safety. This includes evaluation of the risks and hazards, proper training, development and revision of work practices and procedures, and use of the necessary Personal Protective Equipment to help provide for a safe electrical work environment. UC Santa Cruz employees and management will update, enhance and supplement the requirements, practices and procedures outlined in the Electrical Safety Program to continue to strive for a workplace that is accident free.

The Electrical Safety Program outlined in this document:

- Was developed to minimize hazardous electrical exposures to UC Santa Cruz personnel and ensure compliance with regulatory requirements applicable to electrical systems. It is the UC Santa Cruz Electrical Safety Program requirement to work equipment de-energized wherever possible.
- Outlines requirements for working on or near live parts operating at 50 volts or more, or where an electrical hazard may be present. The program is based on OSHA, CA-DOSH, ANSI, ASTM and NFPA 70E requirements and guidelines and is the basis of the minimum performance expectations for all UC Santa Cruz employees involved with Energized Electrical Work.
- Covers electrical safety related work practices and procedures for employees who work on or near exposed energized electrical conductors and circuit parts in the workplace rated **600 volts and below.**
- Contains the minimum requirements for “qualified” electrical personnel employed by UC Santa Cruz to follow when performing work on or near live electrical systems at UC Santa Cruz facilities. It is not to be used as an Electrical Safety Program for contractors or for Campus Department maintenance crews “unqualified” by state contractor licensing boards or by state and federal electrical codes to perform electrical work. Contractors are responsible for providing and implementing their own safety program that meets or exceeds the minimum requirements of OSHA, CA-DOSH, NFPA-70E, ANSI, ASTM and the UC Santa Cruz Electrical Safety Program.
- This program applies to all personnel who face a risk of electrical shock or related injuries from work on live electrical systems of 50 volts or more. Personnel working on or near energized electrical systems must be "qualified".

Note: Students, Faculty, Adjunct Faculty, Affiliated Faculty, Lecturers, Postdoctoral Scholars, Instructional Assistants and Lab Technicians performing work or research on energized systems must be supervised by a qualified person, and must be trained on the hazards of electricity and the methods used to control or eliminate these hazards. The design and use of such systems must comply with the requirements of this program.

1.2 Electrical Hazards

Electrical hazards include dangerous conditions such as electric shock, arc flash burn (including possible injury from molten metal and other associated injuries), arc blast injury (including internal organ and other bodily injuries from blast pressure waves) and hazards from catastrophic equipment failure that can result from contact with equipment or equipment failure.

1.3 Electrical Safety

Electrical safety is the practice of recognizing the hazards associated with the distribution and use of electrical energy and taking the necessary action, steps or precautions to minimize the associated risks and hazards.

2.0 Responsibilities

It is the responsibility of UC Santa Cruz to provide safety-related work practices, personal protective equipment and safety-related training for our employees, who shall then implement them. Safety-related work practices, personal protective equipment and worker skill and knowledge gathered from training shall be used to help protect employees who might be exposed to electrical hazards.

It is the responsibility of UC Santa Cruz employees to implement the safety-related work practices and training and to work with management and supervisory personnel to help evaluate the hazards, risks, work procedures, training and Personal Protective Equipment necessary to safely perform electrical work within these facilities. UC Santa Cruz employees shall also work with management and supervisory personnel in updating, enhancing and supplementing the requirements, practices and procedures outlined in the Electrical Safety Program as necessary to provide for a safe workplace.

While this safety program is comprehensive, following all of the elements in this program does not guarantee worker safety. It is the employee's responsibility to evaluate potential/existing risks and hazards, the potential exposure to these hazards and to develop a work plan specific to the job task and the job hazard/risk analysis. Should an employee determine that he/she does not have sufficient training, tools and/or assistance to perform the work in a safe manner, the work shall not be performed and the electrical supervisor shall be notified immediately to review the situation. The work shall not be performed until the parties involved with the project/task agree that the methods, tools and conditions for performing the in a safe manner are in place.

It is the employee's responsibility to review this safety program, to ask questions, address concerns and commit to be responsible for a safe work place. The affected UC Santa Cruz employees will study and become intimately familiar with the elements of this safety program, which is based on OSHA, CA-DOSH and NFPA 70E requirements. UC Santa Cruz employees shall demonstrate knowledge of the program and the practices outlined in the program and will sign the form acknowledging their responsibilities and understanding of the program.

All electrical incidents and near misses will be documented, reported to supervisory personnel and investigated per UC Santa Cruz policies and procedures. Where necessary to improve worker safety and reduce the risk and exposure to hazards, the safety program, policies, procedures, practices, protective equipment, etc. will be reviewed and updated as deemed necessary with input from UC Santa Cruz Physical Plant Building Utility and Fleet Services, Environmental Health and Safety (EH&S), and UC Santa Cruz Physical Planning and Construction (PP&C). Workers shall receive training as necessary for any updates.

3.0 Training

3.1 Safety Training for Electrical Work

Safety Training is required for all employees that work on or around electrical equipment. As a minimum, UC Santa Cruz employees will be trained to:

A. Understand UC Santa Cruz Safety Policies and Procedures.

B. Understand the difference between "Qualified" and "Unqualified" Persons and requirements for both.

C. Develop the skills and knowledge to maintain or become "Qualified" for the job tasks based on position requirements.

D. Identify potential hazards and steps for resolution.

E. Develop, apply and implement Job Briefings and Energized Electrical Work Permits.

F. Understand the hazards associated with electrical energy, and the safety related work practices and procedural requirements as necessary to help provide protection from the electrical hazards associated with their respective job or task assignments.

G. Understand the relationship between electrical hazards and possible injury.

H. Help develop Safety Awareness and Self-Discipline (Work Practices).

I. Instill safety principles.

All persons assigned to the UC Santa Cruz Physical Plant Electric Shop, working on electrical systems or working as an attendant for electrical workers will be offered training in:

1. First Aid
2. CPR
3. Methods of release of victims–(Release from energized circuit, shepherds hook, etc)
4. How to call for Emergency Help
5. Fire control methodology
6. Energized Electrical Work Attendant.
7. Related Safety Program Requirements (i.e. MSDS, Fall Arrest, etc.).

UC Santa Cruz employees that do not perform electrical work, but may work in the vicinity of or around live electrical distribution equipment are required to receive training for "unqualified" workers.

3.2 Safety Brief/Toolbox Topic

All employees performing electrical work and/or maintenance will receive ongoing training on safety topics, including expectations, policies and procedures while working at UC Santa Cruz facilities. As a minimum, training and review of accident prevention briefs shall be conducted on a monthly basis. This includes the Electrical Safety Program and specific topics. Specific topics will include the following:

A. SB1-Electrical Safety Program, OSHA and NFPA70E
B. SB2- Electrical Safety
C. SB3- Electricity and The Body
D. SB4- Working on or Near Live Parts
E. SB5- Arc Flash
F. SB6- Flash Hazard Analysis
G. SB7- Protective Clothing Characteristics
H. SB8- Shock Hazard Analysis
I. SB9- Energized Electrical Work Permit
J. SB10- Lockout/Tagout
K. SB11- Job Briefing
L. SB12- Battery Rooms
M. SB13- Portable Powered Tools

3.3 Competency

Each employee covered under section 1.1 of this document shall study the UC Santa Cruz Electrical Safety Program and be competent in the administration and implementation of the program. Such employees will be required to sign an acknowledgement indicating that they have read and understand the requirements and that they will either a) have the proper qualifications, training, tools and PPE necessary to perform the task, or b) they will not perform the task until they do have the proper qualifications, training, tools, PPE, etc. necessary to perform the task.

Before attempting any task for the first time, each person must receive specific training. This training may be formal (in a classroom), or informal (on the job) or a combination of both. The employee shall demonstrate their understanding and knowledge through practical application.

Training must cover such subjects as inherent hazards of the job, job hazard analysis, safe work methods, identification of parts/nomenclature, procedures, and emergency procedures. If an employee feels unqualified to safely perform the work assigned, the employee shall notify the supervisor.

Employees shall review the UC Santa Cruz Electrical Safety Program and the inherent requirements and work with their supervisor to determine if they are qualified to perform the

tasks that they are currently performing. Where necessary, additional classroom or on the job training shall be identified and provided as necessary.

All new UC Santa Cruz Physical Plant Electric Shop employees and contracted resources will be given a safety orientation before they begin work in their area. The orientation will encompass all safety related rules and regulations that pertain to them while working in the department. Employees will be required to sign a form acknowledging that they have studied, understand and will implement the plan.

4.0 Outside Personnel/Contractor Requirements

UC Santa Cruz requires all outside personnel and contractors that may work in or around the area of live electrical distribution equipment to comply with UC Santa Cruz Division 1 and the technical specifications of their construction contracts shall have an Electrical Safety Program and shall receive training on the hazards and risks involved with their work. This includes "Qualified" and "Unqualified" workers as defined in this document.

Unqualified workers (i.e. painters, plumbers, janitorial workers, electrical equipment sales personnel, factory representatives, and others) that perform tasks, or come within the vicinity of electrical distribution equipment shall understand the hazards and risk associated with electrical distribution systems and shall also understand arc flash and electrical shock boundaries.

Examples of companies that might be included in this category include electrical contractors, lighting maintenance contractors, equipment repair firms, testing agencies, etc.

UC Santa Cruz is responsible for modifying Division 1 and the technical specifications in the Contract that involves electrical work. UC Santa Cruz Physical Plant employees are not responsible for determining the suitability of the contractor's Electrical Safety Program, however if it is observed that the contractor personnel fail to meet UC Santa Cruz requirements for electrical safety, the UC Santa Cruz Physical Plant employee shall notify in writing the UC Santa Cruz Project Manager, Physical Plant Supervisor and EH&S. Where deemed necessary the physical plant employee will recommend stopping the work until corrected.

Where UC Santa Cruz employees and contractors are involved with a project, more than one party may be responsible for hazardous conditions or activities that violate safe work practices. Where multiple parties are involved such as a General Contractor with sub-contractors, the UC Santa Cruz Physical Plant employee shall immediately notify the UC Santa Cruz Physical Plant Supervisor who in turn shall notify in writing Physical Planning and Construction, Building Official and UC Santa Cruz Project Manager followed by an incident report. The UC Santa Cruz Project Manager shall notify the General Contractor in writing of the potential hazards, existing hazards, safe work practices, personal protective equipment, emergency procedures, emergency equipment, site requirements and evacuation procedures applicable for the location and the work being performed.

5.0 Requirements for Electrical Work

This section outlines the minimum requirements for safety related work practices and procedures for work performed on or near electrical distribution equipment or components. The intent of the UC Santa Cruz Electrical Safety Program is to provide for employee safety relative to electrical hazards.

The principles on which this program was developed include, but are not limited to:

A. Workers must be properly trained to identify hazards and potentially hazardous conditions, recognize the risks associated with electrical work and take the steps necessary to mitigate exposure and risk.

B. The electrical equipment needs to be routinely inspected and properly maintained.

C. Electrical installations at UC Santa Cruz need to follow California Electrical Code (CEC) requirements as adopted by the State of California at the time of installation.

D. Electrical equipment enclosures and conductor insulation integrity need to be maintained.

E. Every job that falls under the UC Santa Cruz Electrical Safety Program will be properly planned and documented. Considerations include:

   1. Hazards need to be identified and minimized.
   2. Worker training and qualifications need to be evaluated.
   3. The risks need to be assessed.
   4. Worker alertness needs to be reviewed.
   5. Proper Personal Protective Equipment needs to be utilized for the potential hazards involved.
   6. The proper tools shall be utilized for the job.
   7. The UC Santa Cruz Electrical Safety Program, including, but not limited to training, practices, equipment, procedures, tools and personal protective equipment need to be reviewed and updated on an ongoing basis.

F. It is a UC Santa Cruz requirement to de-energize equipment unless allowed per OSHA regulations and the work can be conducted safely (see 5.1 below).

G. Electrical one-lines need to be up to date. (UC Santa Cruz PP&C is the office of record and the ultimate authority for updating single lines)

H. Management will work with employees to promote a safe work place and to provide the resources necessary to limit hazards and exposure to hazards including shock, burn, and blast due to the environment.

This section also provides requirements for “unqualified” workers that may be working in the area of energized electrical equipment and “qualified” workers that may be in the area or be directly involved with work on live/energized electrical systems. Additional safety planning, training, requirements, procedures and personal protective equipment may be necessary for

certain tasks or projects, thus the employee and/or contractor is responsible for performing a job hazard analysis and job briefing.

5.1 Energized Electrical Work

It is a UC Santa Cruz Electrical Safety Program requirement to perform electrical work on de-energized systems unless the following can be met:

A. Justification can be provided within OSHA regulations (see OSHA Notes to 1910.333(a)(1) below):
B. The appropriate job hazard analysis is performed.
C. Workers and supervisory staff acknowledge they are "qualified" for the task(s).
D. The work can be conducted in a safe manner.
E. Proper safety planning and preparation occurs.
F. Proper Personal Protective equipment is utilized.
G. This Electrical Safety Program

Applicable documents may include, but not be limited to PPE Checklist, Job Hazard Analysis, Job Briefing Checklist and Energized Electrical Work Permit.

In addressing work on electrical equipment, 29 CFR 1910.333(a)(1) states: Live parts to which an employee may be exposed shall be de-energized before the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

OSHA Notes for 1910.333(a)(1):

Note 1: Examples of increased or additional hazards include interruption of life support equipment, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment, or removal of illumination for an area.

Note 2: Examples of work that may be performed on or near (See NFPA70E Tables) energized circuit parts because of infeasibility due to equipment design or operational limitations include testing of electric circuits that can only be performed with the circuit energized and work on circuits that form an integral part of a continuous industrial process in a chemical plant that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

5.2 Facility Electrical Hazard/Risk Review

As a minimum, UC Santa Cruz facility electrical distributions shall be reviewed periodically by "qualified" personnel for potential electrical hazards or concerns including, but not limited to:

A. Inadequate housekeeping.
B. Lack of proper signage.
C. Water leakage.
D. Uncovered and improperly covered openings in electrical gear.

5.2 Facility Electrical Hazard/Risk Review…continued

E. Improper storage in electrical rooms.

F. Mechanical support.

G. Physical integrity.

H. Equipment degradation.

I. Suspicious equipment noises or performance.

J. Proper testing and periodic maintenance.

K. Out of date one-line drawings.

L. Improper Installations (i.e. fusible switch, circuit breaker or electrical apparatus that is under-rated for the available short circuit current, improper or inadequate grounding, CEC violations, etc.).

5.3 General Electrical Safety Program Requirements

A. Electrical Hazards – the following is a brief summary of some of the hazards involved with electrical work.

1. **Shock Hazard** – A dangerous condition associated with the possible release of energy caused by contact or approach to live parts. An electric shock occurs when electrical current flows through the body part. Electrical currents of sufficient magnitude can cause a muscle to contract and to remain in this state until the source of current is removed. Electrical current flow can result in pain, loss of muscle control, difficulty in breathing, internal burns, ventricular fibrillation and loss of heart muscle function. The severity of injury from electrical shock depends on the amount of electrical current and the length of time the current passes through the body. Level of shock and bodily damage is based on many factors, including:

    - Voltage of source.
    - Resistance of any material between the skin and source.
    - Resistance of skin (moisture, contact area, contact pressure and skin properties are all factors).

2. **Flash Hazard (Arc Flash)** – A dangerous condition associated with the release of energy caused by an electric arc. An electrical arc exists when an insulating material fails or is breached by a conductive component. The resulting arc flash releases energy when current is conducted through a path that it is not intended to flow through (i.e. worker tool, ionized air, etc.). The arcing current releases energy, creating hazardous conditions that can include extreme heat, pressure waves, shrapnel vaporized metal, infrared and ultraviolet waves, electromagnetic waves and visible light. <u>Important Note: Arc Flash Hazard Analysis is focused on thermal energy and does not include other hazards.</u>

3. **Blast Hazard (Arc Blast)** – A dangerous condition associated with the release of energy caused by an electric arc and the associated blast hazard due to the arcing current releasing energy, creating hazardous conditions that can include pressure waves and shrapnel (from vaporized metal). Important Note: even though PPE, including FR clothing may help prevent fatal burns, the blast energy may cause serious or fatal injuries. NFPA 70E does not provide recommendations for PPE for incident energy >40 Cal/cm^2.
4. **Catastrophic Equipment Failure Hazard** – Equipment can fail due to overstress, resulting in catastrophic failure. For example a circuit breaker that is rated to handle 25,000 amps of fault current during a short circuit may fail catastrophically if subject to a system that provides 35,000 amps of fault current. Important Note: It is essential that properly designed, applied and rated components be installed and used in compliance with Nationally Recognized Test Laboratory (i.e. UL) requirements, manufacturer requirements, national and local electrical codes, etc. to help provide for safe operation.
5. **General Job Hazards** – general hazards always exist including cuts, scrapes, eye injuries, falls, etc. These should be considered and addressed in the workplace and job hazard analysis.

All energized electrical work will be carried out in a manner that protects the workers from the possibility of electrical shock, arc flash/blast, burns and other hazards. The hazard will dictate the PPE required. Refer to the PPE Section in this document and NFPA 70E, Table 130.7(C)(9) Hazard/Risk Category Classifications, Table 130.7(C)(10) Protective Clothing and Personal Protective Equipment (PPE) Matrix, and Table 130.7(C)(11) Protective Clothing Characteristics.

Note: The Tables in NFPA 70E are guidelines only and are subject to certain restrictions and conditions. Please review the restrictions and conditions as outlined in the footnotes very carefully to determine if the Hazard Risk Categories are appropriate.

Where arc flash hazard calculations have been performed, these values will be used for determining arc flash hazard energy categories and estimated energy levels. Since arc flash hazard values can be significantly impacted by short circuit current, duration of arcing fault and worker distance from the arc point to the worker's chest (location used to calculate arc flash hazard energy), it is imperative that the worker understand the arc flash hazard calculations and how they were derived, utilize the appropriate work practices for the project and the proper PPE.

It is a UC Santa Cruz's Electrical Safety Program requirement that energized work will NOT be performed above 40 Cal/cm^2.

B. Test Instruments and Equipment – Proper test instruments and equipment shall be used. It is up to the "qualified" employee to determine the suitability of the test instrument and equipment that will be used on a project. The following requirements apply**:**

1. **Rating** - Test instruments, equipment, and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used. Multi-meters are the preferred means of testing for the energized circuits. Multi-meters shall, as a minimum, be rated Category III, 600 Volts or higher for work on systems up to 600V RMS.

2. Application – Test instruments and equipment shall be designed for the environment in which it is to be used (i.e. outdoor, wet, etc.).

3. **Use** - Only Qualified Persons shall perform testing work on or near live parts operating at 50 volts or more.

4. **Training** - All employees who are qualified persons shall be trained to test for the absence of voltage. Each qualified person must be able to operate each meter that he/she might be expected to use and to interpret any possible meter indication.

5. **Visual Inspection** - A visual inspection shall be made of test instruments, equipment and all associated leads, cables, power cords, probes, and connectors, for external defects and damage before use. If any defect or damage is noted that might expose any employee to injury, the defective or damaged item is to be tagged and removed from service and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

6. Condition - Required equipment, tools, and testing instruments must be available and in good condition. Where applicable, all certifications must be kept up-to-date.

7. Tic Tracer Use - Where tic tracers are used, additional meter measurements shall be performed to confirm that circuits are de-energized.

8. Inductive Voltmeter Use – Inductive Voltage Testers **(**i.e. Wiggies) shall not be used for voltage testing >480 volts.

9. Manufacturer Updates and Replacement Parts – Only manufacturer provided, authorized or approved replacement parts may be used for metering equipment (i.e. only proper protective fuses shall be used).

C. Insulated Tools and Non-Conductive Equipment-Rated insulated tools must be used for all electrical work on or near live electrical devices. Every person working on equipment in the electrical maintenance department will have access to insulated tools. Insulated tools must be inspected before each use and contain no defects. Insulated tool use is encouraged, even for de-energized work, as an extra level of safety. The following requirements apply**:**

1. **Insulated tools** - shall be rated for the voltages on which they are used and shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.

2. **Fuse or fuse-holder handling equipment** – shall be insulated for the circuit voltage and shall be used to remove or install a fuse.

3. **Protective shields, protective barriers, or insulating materials** - shall be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near live parts that might be accidentally contacted or where dangerous electric heating or arcing might occur.

4. **Insulated Rubber Mats -** Approved insulated rubber mats may be used when working on energized circuits where there is a potential for completing a circuit to ground through the body. The use of rubber mats is not required, but is suggested as an additional step and left to the discretion of the electrician.

5. **Rated Insulated Blankets -** Rated Insulated blankets shall be placed over/across the front of exposed energized components when work is being done nearby. It is preferable that circuits be de-energized before work is performed.

6. **Nonconductive Ropes and hand lines** – shall be used near exposed live parts operating at 50 volts or more, or used where an electrical hazard does or may exist.

7. **Fiberglass reinforced plastic rod and tube** - used for live line tools shall meet the requirements of ASTM 711.

8. **Portable ladders with non-conductive side rails** – shall be used near exposed live parts operating at 50 volts or more, or used where an electrical hazard does or may exist. Prior to using a ladder, it must be inspected for suitability and condition.

9. **Man Lifts -** Prior to using a man lift, it must be evaluated for suitability and condition. Live electrical work shall not be performed from un-insulated man lifts. All personnel using a man lift must have training on its safe use and hazards.

D. Maintenance Requirements for Protective Equipment and Tools -The insulation of protective equipment and tools listed below shall be verified by the appropriate test and visual inspection to ascertain that insulating capability has been retained before initial use, and at intervals thereafter as service conditions and applicable standards and instruction require.

1. Grounding equipment.
2. Hot sticks.
3. Rubber insulating gloves and sleeves.*[1]
4. Leather protectors.
5. Voltage test indicators and equipment.
6. Rubber insulating blankets.*[2]
7. Rubber insulating covers and line hose.*[3]
8. External circuit breaker rack-out devices.
9. Portable lighting units.
10. Safety grounding equipment.
11. Dielectric footwear.
12. Protective clothing.
13. Tools and associated equipment.

*[1] 29 CFR 1910.137. Before first issue and every 6 months thereafter. If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.

*[2] 29 CFR 1910.137 – Before first issue and every 12 months thereafter. If the insulating equipment has been electrically tested but not issued for service, it may not be placed into service unless it has been electrically tested within the previous 12 months.

*[3] 29 CFR 1910.137 – Upon indication that insulating value is suspect.

E. Portable and Stationary Cord and Plug Equipment - Portable and stationary cord and plug equipment must be suitable for the application and workers shall understand equipment operation and be able to safely operate the equipment. The following requirements apply:

1. **Ground Fault Circuit Interrupter's (GFCI's) for cords and portable cord and plug devices** – GFCI's shall be used with extension cords and portable cord and plug devices.

2. **GFCI's for temporary wiring** - GFCI's shall be provided for all temporary wiring installations. This applies to temporary wiring installations used to supply temporary power to equipment used by personnel during construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment or similar activities. GFCI's shall be routinely tested to help ensure proper operation.

3. **Portable electric equipment** - shall be handled in a manner, which will not cause damage. Portable electric equipment shall be visually inspected before use and shall be removed from service if there is evidence of defects or physical damage that might expose an employee to injury.

4. **Flexible electric cords** - shall not be used for raising or lowering the equipment. Flexible cords shall not be fastened with staples or hung in such a way that might damage the outer jacket or insulation.

5. **Grounding type equipment** - A flexible cord used with grounding-type equipment shall contain an equipment-grounding conductor. Plugs and receptacles may not be altered to defeat the equipment grounding conductor and adapters shall not be used to defeat the grounding conductor.

6. **Electric Hand Tool Repair** - All repairs to electric hand tools (such as replacement of a cord on a drill motor) must meet UL and CEC requirements and be accomplished by qualified electrical personnel.

7. **Highly Conductive Work Locations** - Portable electric equipment used in highly conductive work locations (such as areas saturated with water or other conductive liquids), shall be approved for those locations. Portable and stationary-grounded cord and plug attached equipment other than hand tools shall have its ground continuity tested periodically by users. (example, arc welders, personal heaters, fans, pipe threading machines, bearing heaters, sump pumps, etc.)

8. **Maintenance Requirement for Portable Electric Tools and Equipment –** equipment, attachment plugs, receptacles, cover plates, and cord connectors shall be maintained such that the following apply:

   A. There are no breaks, damage, or cracks exposing live parts.
   B. There are no missing cover plates.
   C. Terminations have no stray strands or loose terminals.
   D. There are no missing, loose, altered, or damaged blades, pins, or contacts.
   E. Polarity is correct.

F. Illumination - Employees may not enter spaces containing exposed energized parts unless illumination is provided that enables the employees to perform work safely. Employees may not reach blindly into areas that may contain energized parts.

G. Raceways - Conduit and electrical raceways are only designed for support of cable or wiring. No other use of electrical conduits or raceways are authorized or allowed, including climbing on conduits or raceways.

H. Conductive Apparel and Jewelry - Conductive articles, such as metal watchbands, necklaces, belt buckles, conductive frame glasses, body piercing apparatus, rings, bracelets, key chains, etc, shall not be worn when performing work on or near live electrical systems or equipment.

I. Safety System Override - An override of a safety system may only be performed when directed by management. If a "jumper" is used, it should be a non-standard color, be made up longer than needed and have a tag attached.

J. Backfeeds - No equipment shall be backfed from an alternate power source unless it is part of a system designed for normal and alternate feeds and/or any potential for backfeed to the facilities power system is eliminated. Mechanical interlocks or SOP's are approved means of accomplishing this requirement. The preferred method is mechanical interlock.

K. Housekeeping Duties - All electrical rooms and areas containing energized electrical equipment are to be maintained in a clean, orderly condition. Doors are to be closed when not being used. All equipment contained in a Motor Control Center (MCC) /Electrical Room must be maintained to factory specifications. Specifically, all covers and doors must be secured by all screws and door locks—missing screws must be replaced immediately. Outside transformers and switchgear are to be maintained in clean, orderly condition. Motor control center rooms, transformer and switchgear areas must be kept free of stored combustible materials. Appropriate clear space will be maintained to assure easy access to all electrical equipment. Employees may not perform housekeeping duties if there is a likelihood of electrical contact.

L. Medium Voltage Equipment (4160 to 21kv) – All work is to be performed by "Qualified" UC Santa Cruz Physical Plant electricians or outside electrical Contractors.

M. Underground Lines - Before excavation work is performed, the electrical site supervisor or other knowledgeable person shall be notified and the proper measures taken to prevent inadvertent contact or damage with underground lines.

N. Overhead Lines - Before work is to be performed within 10 feet of un-insulated overhead lines, the lines should be de-energized and grounded by qualified personnel. If this is not possible, other protective measures must be provided before work is started. Such protective measures would include guarding, isolating or insulating the lines by qualified persons. If equipment is to be lifted over un-insulated/uncovered power lines, the lines should be de-energized, locked out/tagged out, verified and grounded. If this is not possible, contact the facility electrical supervisor or other knowledgeable person in charge of the project.

Vehicular and Mechanical Equipment—Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines must be operated so that a clearance of 10ft. is maintained (for 50kV and less).

O. Temporary Wiring, Abandoned and Spare Wires and Conduit - Temporary wiring is permitted during and for remodeling, maintenance, repair, construction, or demolition of equipment or buildings, structures, equipment, or similar activities. (Reference the current California Electrical Code (CEC) for exact code requirements)

Temporary electrical power and lighting installations shall be permitted for a period not to exceed 90 days for holiday decorative lighting and similar purposes (i.e. party/event). Temporary electrical power and lighting installations shall be permitted during emergencies and for tests, experiments, and developmental work.

Temporary wiring shall be removed upon completion of construction project. Temporary cord(s) shall be removed upon completion of project or task for which they were used.

When spare conductors are called for, the free lengths shall be neatly coiled and tied where they emerge from the conduit or cable termination fittings and tagged "spare." Free lengths of conductors shall be long enough to reach any terminal in the enclosure they enter. All exposed portions of the conductors shall be appropriately insulated for the voltage level involved.

P. Barrier Tape Use - Unqualified persons shall not be permitted to enter spaces with energized electrical conductors or circuit parts unless the equipment can be made electrically safe. Red danger tape shall be used in conjunction with barricades/stanchions and safety signs to warn all employees of unsafe conditions and prevent entry. It is important that employees understand the significance of safety tape and heed the warnings that it represents. It is also important that red danger tape be removed once the danger has been eliminated. For that reason, it is expected that all employees will observe the following procedures when isolating an area with safety tape:

The danger tape will completely encircle the area where the danger exists. The employee putting up the tape will attach a safety sign that gives his or her name, the reason why the tape was installed, the date it was installed, PPE required within the boundary, contact phone number(s) and/or pager number(s). It is preferred that the person who put the tape up to be the one who removes it once the danger has been eliminated.

When normally enclosed live parts are exposed for maintenance or repair, they shall be guarded to protect unqualified persons from contact with live parts or exposure to flash hazards. Barricades shall be used in conjunction with safety signs where it is necessary to prevent access by unqualified employees into work areas where electrical shock/flash hazards exist.

Note: Typical protection can consist of barricades, cones, or red danger tape with signs/symbols/tags warning employees of electrical work in progress and the electrical hazards present (29 CFR 1910.335). No person may cross the red danger tape without the permission of the qualified person performing EEW.

Q. Equipment Labeling - All electrical equipment shall be labeled appropriately, clearly, and consistently. If any labeling discrepancies are found, temporary corrections should be made immediately with a caution tag or temporary label, a work order shall be generated to the area Electrical/Maintenance Supervisor. All OSHA signage shall be present and arc flash hazard warning labels shall be installed on electrical distribution equipment as per industry mandates, standards and recommended practices. All electrical equipment and devices shall be labeled as to their power source.

R. Apprentice Limitations - Working on or near energized circuits is prohibited for apprentices. Apprentices may work on equipment that is placed in an electrically safe work condition by a Journeyman, however the apprentice shall also verify that an electrically safe work condition exists in the presence of "qualified" personnel and shall wear all of the proper PPE that is necessary for an energized system.

For purposes of verification of lockout/testing dead, any apprentice may verify a circuit of any voltage < 600V subject to the following conditions:

1. The circuit has been verified de-energized by the journeyman and witnessed by the apprentice.
2. A job briefing is performed and all hazards are identified and communicated to the apprentice.
3. A qualified journeyman is present and directly supervising the apprentice. Direct supervision means that journeyman is within direct line of site sight (<25') of the apprentice.
4. All required PPE is worn.

S. Energized Electrical Work Assistant – Using an EEW Assistant is a good practice, but not required, when working on (not troubleshooting) energized circuits. "Working on energized circuits," means handling or touching components, which are carrying or could carry electrical energy. Verification of circuit de-energization is included in this EEW Assistant requirement.

EEW Assistant Requirements - The EEW Assistant must remain in sight (≤ 25') of the electrician performing the work, be familiar with the power source and how to operate disconnects, how and where to get help if needed, and be current in CPR certification. (See section U. for additional requirements)

T. Electrical Room Access Restrictions - Personnel, who are not trained on UC Santa Cruz's Electrical Safety Program requirements/policies, OSHA, CA-DOSH and NFPA 70E Electrical Safe Work Practices, will not be allowed inside electrical rooms at UC Santa Cruz unless specifically approved by UC Santa Cruz Physical Plant Management.

The Qualified Worker shall post the EEW Permit at the location where the EEW will be performed. If work is being performed in an electrical room and the EEW Permit is posted on the door, no person that is not part of the EEW team shall enter the area unless they receive permission from the person(s) performing EEW.

In order to be allowed to enter the electrical rooms to accomplish any of the tasks outlined above, the following safety rules will be followed:

1. If electrical work is to be performed and it is possible that non-qualified personnel may enter the area or are present in the area, a safety hazard briefing shall be conducted by the qualified person in charge.

2. Tripped circuit breakers will not be operated by anyone except qualified electrical personnel – and only after verification that the trip is not due to a short circuit, or verification that the short circuit has been removed. Refer to SOP for resetting tripped breaker. See tab "Circuit Breaker Reset."

3. Motor overloads are to be reset only one time. If problems persist, qualified personnel shall be called. Circuit breakers on Variable Frequency Drives (VFD's) are to be operated by qualified persons only.

4. Manufacturer technical representatives or other third party persons requiring access to equipment in the electrical rooms in support of a project must do so under the supervision of a person who is "qualified" the supervising person is responsible to ensure proper PPE is worn and all safety rules are followed.

Panels that are not located in electrical rooms, such as those in office areas, shall be managed similar to electrical rooms, as discussed above. This area includes a minimum three-foot clear space in front of the equipment when all doors are closed and a minimum ten-foot clearance when panel is open/exposed (unless arc flash hazard study has been completed – then arc flash hazard boundary from study applies).

U. Emergency Communications - Electricians and EEW Assistant performing electrical work must have ready access to emergency communications. If a telephone or radio is not readily available near the electrical room, a radio/cell phone must be available for emergency communications.

V. Other Safety Requirements - Depending on the job, other safety requirements may apply such as Confined Space, Fall Protection, etc. After reviewing the project / work task, refer to UC Santa Cruz EH&S for other potential requirements.

5.4 Job Hazard Analysis, Work Permits and Job Briefing Requirements for Electrical Work

The employee shall identify the appropriate job hazard/risk evaluation procedures to be used before work is started on or near live parts operating at 50 volts or more or where any electrical hazard may exist. This includes Lockout/Tagout procedures where a hazard may be present before, during and after Lockout/Tagout is performed.

UC Santa Cruz Physical Plant Electrical work performed in UC Santa Cruz facilities can typically be divided into four categories for Job Hazard Analysis (JHA) as outlined below. Depending on the project and the work tasks, the Category can transition between levels (i.e. simple troubleshooting reveals that a breaker needs to be replaced). Workers shall conduct a job briefing for each project.

The categories and minimum requirements are outlined in the table below:

General Job Hazard Analysis, Job Briefing, Work Permit Requirements			
Level	**Category Description**	**Examples of Possible Tasks in this Category**	**Associated Minimum Requirements**
A	Simple Routine Tasks	Voltage Measurements, Lighting Control Panel Troubleshooting and Reset of Circuit Breaker.	Job Briefing Checklist for Electrical Work PPE Checklist
B	De-energized Work - Simple	Replacement of Lighting Ballast, Replacement and Installation of a Branch Circuit Breaker.	Lockout/Tagout Job Briefing Checklist for Electrical Work PPE Checklist
C	De-energized Work - Complex	Installation / Replacement of a Feeder in a Distribution Panel	Lockout/Tagout Job Briefing Checklist for Electrical Work PPE Checklist
D	Electrical Energized Work (see Section 5.2)	Emergency tightening of Data Center Feeder Breaker Lugs, terminating a conductor(s) and Infrared Evaluations.	Energized Electrical Work Permit Job Briefing Checklist for Electrical Work PPE Checklist

5.5 Job Hazard / Risk Evaluation and Briefing Procedures

A. Job Hazard Analysis- Before performing any task on or near exposed or live parts, workers should determine if there might be exposure to hazards and the associated risks of injury to themselves and to those individuals that may be working with them or around them.

The worker should determine the steps necessary to:

1. Reduce or eliminate the hazards (i.e. properly close equipment openings that provide for exposure to live electrical equipment).
2. Reduce or eliminate exposure to the hazards (i.e. shut down the equipment or systems and perform the work de-energized).
3. Obtain and properly utilize the appropriate personal protection equipment (i.e. hard hats, safety glasses, face shields, face sock, FR clothing, insulating gloves, boots, etc.).
4. Obtain and utilize the appropriate equipment/tools (i.e. verify that the meters used for testing are appropriate for the task and are in proper operating order, use the appropriate voltage rated insulated tools for the project, etc.).
5. Properly plan and implement the work.

B. Job Briefing - Before starting each job, the employee in charge shall conduct a job briefing with the workers involved. The briefing shall include, but not be limited to the following subjects:

1. Electrical hazards and risks associated with the work task.
2. Procedures that must be followed when executing the work task.
3. Any special precautions that are required by the working conditions.
4. When and how to remove the source of energy.
5. Required PPE.
6. Contractors involved with the project, their role and coordination.
7. Emergency response and emergency communications.
8. Other work in the immediate physical area.
9. Other work associated with the same electrical circuits or equipment.
10. Tool and equipment requirements.
11. Barriers and signage.
12. EEW Attendant when used.

If the work or the operations that will be performed during the workday or shift are repetitive and similar, at least one job briefing shall be conducted before the day or shift or before the start of the first job. A brief discussion shall be satisfactory if the work involved is routine and if the employee, by virtue of training and experience can reasonably be expected to recognize and avoid the hazards involved in the job.

Where the task allows one worker to perform the task at a remote site without direct supervision, the job briefing will also be conducted with any contractors that are involved or non-qualified employees that will be involved. Where the task allows one worker to perform the task at a remote site without direct supervision and no other contractors or non-qualified workers are involved, the worker will review the job briefing checklist.

5.6 Safe Work Condition – Lockout/Tagout

Live parts to which an employee might be exposed shall be put into an electrically safe work condition (lockout/tagout) before an employee works on or near them, unless work on energized components can be justified, can be performed in a manner that minimizes hazards and risks, is acceptable to the "qualified" worker(s), and has been authorized by person having authority over facility electrical work.

This section establishes the minimum requirements for lockout/tagout. All employees shall comply with procedures outlined and where necessary, shall supplement requirements as needed to minimize risks and exposure to hazards.

A. Electrically Safe Work Condition - The following items are necessary to create an electrically safe work condition, and, until they are completed, the worker should treat the system as live (energized), following required work procedures and donning the

appropriate PPE based on the degree of potential hazard. All electrical circuit conductors and parts shall not be considered to be in an electrically safe work condition until all sources of energy are removed, the disconnecting means is under lockout/tagout, the absence of voltage is verified by an approved voltage testing device, and where exposure to energized facilities exists, are temporarily grounded per SOP's.

Examples of activities involved with creating an electrically safe work condition:

- Wearing appropriate PPE.
- Identifying all potential sources of energy.
- Opening and closing disconnects and breakers.
- Removing panels and dead fronts.
- Opening equipment doors for inspection/verification to verify a physical break in the power conductors/circuit.
- Taking meter measurements between all phase, neutral and ground conductors for verification.
- Installation of appropriate lockout and tagout devices on all energy sources.
- Installing safety grounds per SOP where system may become energized by induced voltage or stored electrical energy

B. Purpose - OSHA and NFPA 70E require electrical equipment and systems operating at 50 volts or greater to be de-energized (Unless the work falls within the Energized Electrical Work "EEW" criteria) to provide employees primary protection from exposure to energized electrical hazards. All equipment shall be locked and tagged out to protect against accidental release of any type of hazardous energy that could cause injury to personnel. For control of other types of hazardous energies, refer to 29 CFR 1910.147.

C. Responsibility: The responsibility for verifying that this procedure is followed is binding upon all workers involved with electrical system operation and maintenance. All employees shall be instructed in the significance of the lockout/tagout procedure. Each person who could be exposed directly or indirectly to a source of electrical energy shall be involved in the lockout/tagout process and are responsible for safe work practices.

D. Preparation for Lockout/Tagout: Workers authorized to lockout/tagout equipment shall verify which switch or other energy isolation devices apply to the equipment being locked out.

E. Lockout for Electrical Personnel Performing Electrical Work - Workers must verify a valid lockout/tagout has been accomplished prior to commencing work on or near circuit components which are energized or which usually convey electrical energy. The upstream disconnect should be verified by referring to an up to date one-line. Single lines may not always be accurate so field verification should be performed. Valid verification includes going to the upstream disconnecting means (several may exist, including automatic switching systems) that have power on the incoming side, and testing to be certain that the disconnecting device or devices are functioning properly and that all power has been removed.

Testing and inspection shall be performed to determine if any energized condition exists, or can exist as a result of inadvertently induced voltage or unrelated voltage back-feed. The disconnecting device is then locked in the "open" position. The worker performing the test must verify that the circuit is de-energized using an approved voltage testing device that has been verified to be in proper working order.

The person who installs the lock shall provide their name, their contact information, and their signature on the tagout device applied with the lock. Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put in an electrically safe work condition.

All electrical circuit conductors and parts shall not be considered to be in an electrically safe work condition until all sources of energy are removed, the disconnecting means is under lockout/tagout, the absence of voltage is verified by an approved voltage testing device, and where systems could potentially be energized, the system(s) are temporarily grounded.

F. Sequence of Lockout/Tagout Procedure (removal from service) – for removal of equipment from service:

1. Conduct the appropriate Job Hazard Analysis, including determination of all possible sources of electrical supply to the specific equipment and evaluation of arc flash/blast hazard potentials. Check applicable up-to-date drawings, diagrams and identification tags. Check for possible back up power supplies, tie breakers and back feeds.
2. Notify all affected employees that a lockout/tagout procedure is required and the reason for its use.
3. Obtain and apply the appropriate PPE.
4. After properly interrupting the load current, open the disconnecting devices for each source.
5. Wherever possible, visually verify that all blades of the disconnecting devise are fully open or that draw out type circuit breakers are withdrawn to the fully disconnected position.
6. Lockout/tagout all energy isolating devices with an assigned individual lock according to this program.
7. Use an adequately rated voltage detector for each conductor or circuit part to verify they are de-energized. Test each phase conductor or circuit part phase-to-ground, phase-to-neutral, phase-to-phase and neutral-to-ground (as available). Before and after each test, determine that the voltage detector is operating satisfactorily.
8. Where the possibility of induced voltages or stored electrical energy exists, ground the conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

G. Sequence of Lockout/Tagout Procedure (restoration to service) – for restoration of equipment back into service:

1. When the task is complete and before electric circuits or equipment is re-energized, every worker involved with the project shall confirm that the system can be safely re-energized.
2. Individuals that may be exposed to any potential hazards (i.e. unqualified workers present in the vicinity of equipment) shall be required to leave the area where a hazard may exist (i.e. shock, flash or release of energy) before system is re-energized.
3. When the task is complete and before electric circuits or equipment is re-energized, appropriate tests and visual inspections shall be conducted to verify all tools, mechanical restraints and electrical jumpers, shorts and grounds have been removed and accounted for, so that the circuits and equipment are in a condition to be safely re-energized.
4. After circuits and equipment have been checked, lockout/tagout devices shall be removed only by the authorized employees who applied them. If authorized employees are not available, and appropriate measure were taken to try to contact them, the supervisor can authorize removal of the lock.
5. Proper PPE shall be worn to re-energize and test the equipment.
6. Proper procedures shall be used to safely re-energize the equipment.

H. Electrical System Lockout/Tagout Procedures – Please refer to the UC Santa Cruz EH&S LOTO process and procedures for existing equipment specific LOTO procedures or to develop a new LOTO procedure.

I. Procedure Involving More Than One Person -In the preceding steps, if more than one individual is exposed to electrical hazards and required to lockout/tagout circuits and equipment, each exposed worker shall place and remove their personal assigned lock and tag to the energy-isolating device.

NOTE: One individual cannot lockout for an entire crew. A "gang lockout" is only permitted when a lock box containing the key to a single lock is supplied and all exposed workers are allowed to place their lock on the lock box. This procedure requires specific employee training, written procedures and safeguards to be implemented to ensure worker safety. Project Managers shall be notified of procedures not being followed.

J. Coordination - Lockout/tagout shall be coordinated with other lockout/tagout procedures (i.e. hydraulic, pneumatic, mechanical, etc.), other trade workers and contractors.

K. Planning and Controls – lockout/tagout shall include, but not be limited to the following planning and control elements as necessary to help ensure worker safety:

1. Identify the equipment and systems to be de-energized.
2. Up to date one-line drawings shall be maintained and be readily available for locating sources of energy. The one-lines shall be supplemented with equipment labeling (i.e. source for control power in MCC) where necessary to help identify energy sources.
3. Planning shall include identification of all workers that might be exposed to an electrical related hazard during the execution of the work.
4. The person in charge shall be identified in all work planning.
5. The person in charge shall be responsible for selecting the lockout/tagout procedure to be used and for oversight of the procedure.
6. Methodology for transfer of responsibility should a change in personnel be required due to shift change, vacation, etc. This should include full employee-to-employee briefing of the entire plan, procedures, controls and workers involved.
7. Shutdown procedures shall establish who will de-energize the load, where it will be de-energized, how it will be de-energized. (See Brady Procedures and/or Switching Orders)
8. Procedures shall establish how all sources of stored energy that could potentially endanger personnel are released. (See Brady Procedures and/or Switching Orders)
9. Procedures shall identify the means to verify that the circuit is de-energized and is maintained in a de-energized state (particularly when workers leave the area).
10. The person who is responsible to verify that the lockout/tagout procedure is implemented is also responsible to verify that the work is complete and the system is safe to re-energize before removing locks and tags.
11. A process of verification and testing to help ensure that all sources of energy have been removed.
12. The appropriate test methods and equipment to be used for the systems have been tested and verified.
13. The appropriate tools and equipment (i.e. properly rated safety grounds meeting requirements of ASTM F 855, where needed) will be used in the process.
14. The appropriate PPE will be used until the system has been verified as de-energized.
15. The appropriate shock and flash hazard boundaries have been established and are in place.
16. Methods and controls for testing of the system before and during partial or full re-energization.
17. Methods and controls for re-energization, including verification that all workers are clear of potential electrical hazards, visual inspection and testing to verify that all

tools and equipment have been removed from the work areas. This includes coordination with other trades, workers and crafts as needed.

L. Training – The lockout/tagout procedure shall be provided to all employees working with electrical systems. UC Santa Cruz Physical Plant Electric Shop shall conduct training and retraining as required to ensure workers understanding of the lockout/tagout requirements, procedures and duties.

M. Lockout/Tagout Devices – UC Santa Cruz Physical Plant Electric Shop shall supply the lockout/tagout devices and equipment necessary to execute the requirements. Lockout/tagout devices shall be installed on all disconnecting means. Control devices (i.e. pushbuttons, selector switches, etc.) shall not be used as the primary isolation device. Lockout/tagout device requirements are outlined below:

1. Lockout Device - A lockout device used for control of exposure to energy hazards shall:
    a. Include a keyed or combination lock that is visually unique and easily recognizable. This lock shall not be used for any other purpose.
    b. Provide a method for identifying the individual that installed the device on the tagout means, including name and phone/pager number (note: pictures can be helpful). Contractors shall also provide their company name and phone number.
    c. Be attached to prevent operation of the disconnecting means without resorting to undue force or the use of tools.
    d. Include a tag meeting the requirements outlined in Tagout Device (see below).
    e. Be suitable for the environment for the duration of the lockout period.
    f. Have a specific key or combination that will remain in possession of the individual installing the lock or the person in charge (based on the procedure implemented).

2. Tagout Device - a tagout device shall:
    a. Include a tag with an attachment means.
    b. Be readily identifiable as a tagout device.
    c. Be suitable for the environment to which it will be exposed for the duration of exposure.
    d. Utilize an attachment means capable of withstanding 50 lbs of force exerted at right angles to the surface of the disconnecting means. The attachment means shall be attachable by hand, self locking and non-releasable (i.e. cable tie). The attachment means shall not be reusable.

e. Contain a statement prohibiting unauthorized operation of the disconnecting means or removal of the tag (i.e. Do Not Start, Do Not Open, Do Not Close, Do Not Energized, Do Not Operate, etc.).

N. Annual Periodic Inspection of Lockout/Tagout - An inspection shall be conducted at least annually by a qualified person and shall cover at least one lockout/tagout in progress and the procedure details. The audit shall be designed to correct deficiencies in the procedure or in employee understanding.

The UC Santa Cruz Physical Plant Electric shop Supervisor shall certify that the periodic inspection has been performed. The certification shall identify the machine or equipment on which the energy control procedure was being utilized, the date of the inspection, the employee included in the inspection (Authorized Employee Observed), and the person performing the inspection (Periodic Inspector). The Authorized Employee Observed and the Periodic Inspector shall sign the Lockout/Tagout Periodic Inspection Form.

5.7 Energized Electrical Work Requirements (EEW)

If the live parts operating at 50 volts or more are not placed in an electrically safe work condition, other safety-related work practices shall be used to protect employees who might be exposed to the electrical hazards involved.

This section is intended to establish the minimum requirements and performance expectations for all electricians that have been specifically trained performing energized electrical work and have obtained a certification as a qualified electrician by their company, union, or government agency. Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.

All employees shall comply with procedures outlined and where necessary, shall supplement requirements as needed to minimize risks and exposure to hazards.

A. Energized Electrical Work/Justification for live work – Live parts shall be put into an electrically safe work condition (following lockout/tagout procedures) before an employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operation limitations (see section 5.1).

Examples of increased or additional hazards:

- Interruption of life support equipment.
- Deactivation of emergency alarm systems.
- Shutdown of hazardous location ventilation equipment.

Examples of infeasibility due to equipment design or operational limitation:

- Diagnostics and testing/troubleshooting that can only be successfully performed with circuit energized.

- Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

Live parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs. For voltages of less than 50 volts, the decision to de-energize should include consideration of the capacity of the source and any overcurrent protection between the energy source and the worker.

If live parts are not placed in an electrically safe work condition (i.e. for the reasons of increased or additional hazards or infeasibility), work to be performed shall be considered energized electrical work and shall be performed by written permit only.

B. Job Hazard Analysis, Energized Electrical Work (EEW) Permit and Job Briefing Required – Energized Electrical Work requires a thorough Job Hazard Analysis, a written Energized Electrical Work Permit, Job Briefing(s), worker approval and written management / supervisory personnel approval. The energized electrical work permit shall meet the requirements of NFPA 70E 130.1(B)(2).

C. EEW Permit Approver - The employer is responsible for ensuring that a Job Hazard Analysis has been completed prior to approval of EEW Permit. A UC Santa Cruz Physical Plant Electrical Safety Officer or Knowledgeable Assigned Representative shall be responsible for documenting and/or validating the justification of the Energized Electrical Work (EEW) Permit. The permit approver is responsible for documenting and/or validating the compelling reason for EEW. The person documenting the compelling reason shall have the authority and responsibility to make judgments that affect the lives of those doing work when deciding "Infeasibility". The approver should understand the overall business process or production flow so that educated decisions can be made to schedule the work during times where the systems can be de-energized. The authorized permit approver must have read and understood this document.

D. Permit Posting - The "Qualified" worker shall post the EEW Permit at the location where the EEW will be performed. If work is being performed in an electrical room and the EEW Permit is posted on the door, no person shall enter the area unless they receive permission from the person performing EEW.

E. Codes and Standards Requirements - All EEW performed must meet or exceed all applicable local, state and federal laws, rules and regulations including, but not limited to OSHA, CA-DOSH, NFPA, ANSI, ASTM, CEC and California Building Code Requirements. (See section 13 for references)

F. Potential Equipment Failure - When there is evidence that electric equipment could fail and injure employees, the electric equipment shall be de-energized unless the employer can demonstrate that de energizing introduces additional or increased hazards or is infeasible because of equipment design or operational limitation. Until the equipment is

de-energized or repaired, employees shall be protected from hazards associated with the impending failure of the equipment.

G. Deleted

H. EEW Review Committee - The EEW Review Committee shall meet at least annually to review trends in the EEW Permitting and to identify opportunities for reduction of EEW performed. The EEW Review Committee shall be comprised of the UC Santa Cruz Physical Plant Electrical Safety Officer, a UC Santa Cruz Physical Planning and Construction Building Official, UC Santa Cruz Electrical Engineer, UC Santa Cruz Supervising Building Inspector and UC Santa Cruz EH&S Representative. EEW Permit Log should be kept for a period of one year and this information can be used to evaluate future reduction of EEW Permits.

I. Electric Shop Supervisor - Ensures that an EEW Review Committee meets to review, at least yearly, to identify opportunities for reduction/engineering controls. Ensures that resources are allocated to support this program and works to eliminate or reduce the need for EEW.

J. Energized Electrical Work Permit Minimum Requirements - If live parts are not placed in an electrically safe work condition (i.e. for reasons of increased or additional hazards or infeasibility per OSHA or NFPA 70E), work to be performed shall be considered energized electrical work and shall be performed by written permission only by the authorized UC Santa Cruz EEW Permit Approver. The Energized Electrical Work Permit, as a minimum shall include the following:

1. **Justification for Live Work –** The employer shall provide written justification of energized electrical work based on a justification that describes how de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operation limitations.

2. **Job Hazard Analysis** – the job hazard analysis shall include:
   a. **Shock Hazard Analysis** - shall determine the voltages to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electrical shock to personnel. The shock hazard boundaries as indicated in NFPA 70E Table 130.2(C) include:
      - Limited Approach Boundary – An approach limit at a distance from an exposed live part within which a shock hazard exists.
      - Restricted Approach Boundary – An approach limit at a distance from an exposed live part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the live part.
      - Prohibited Approach Boundary – An approach limit at a distance from an exposed live part within which work is considered the same as making live contact with the live part.

Shock Hazard Boundaries (from NFPA 70E)					
	Limited Approach Boundary[1,5]				
Nominal System Phase to Phase Voltage Range	Exposed Movable Conductor[2]	Exposed Fixed Circuit Part	Restricted Approach Boundary[3, 4, 5]	Prohibited Approach Boundary[4, 5]	
Less than 50	Not Specified	Not Specified	Not Specified	Not Specified	
50 to 300	10 ft	3 ft 6 in	Avoid Contact	Avoid Contact	
301 to 750	10 ft	3 ft 6 in	1 ft	1 in	
751 to 15 kV	*10 ft	*5 ft	*2 ft 2 in	*7 in	
Above 15 kV	*N/A for Safe day Personnel				
1. – Should a need arise for an "unqualified" person to cross the Limited Approach Boundary, a "qualified" person shall advise them of the possible hazards and continuously escort this person while inside the boundary.					
2. – Examples of when Exposed Movable Conductor requirement is applicable can include work on or near overhead lines or when the worker is on a movable platform such as a man lift.					
3. – Includes Inadvertent Movement Adder.					
4 – Under no circumstances shall an "unqualified" person cross the Restricted or the Prohibited Approach Boundary.					
5- Personnel shall not approach or take any conductive items into the Limited approach boundary. These items include, but are not limited to watches, bracelets, rings, conductive framed glasses, earrings, badge clips and clothing with metal snaps and buttons.					

b. **Flash Hazard Analysis** - A flash hazard analysis shall be performed in order to provide information that can help protect personnel from the possibility of being seriously or fatally injured by an arc flash. The analysis shall determine the Flash Protection Boundary, estimated arc flash energy levels and the PPE requirements for workers within the Flash Protection Boundary. This can be performed with commercially available software that uses industry standard formulas such as Institute of Electrical and Electronics Engineers (IEEE)-1584 for the calculations.

Important Note: A flash hazard analysis does not provide any guarantees that the worker will not be injured should a flash hazard event occur. Flash Hazards levels are based on many variables, including anticipated short circuit current, estimated protective device clearing time, equipment design and estimated worker clearance (typically at the chest area – 18" or 24" away from the potential flash point). The industry standard IEEE formulas and industry standard American Society for Testing and Materials (ASTM) personal protective equipment (FR Clothing) allow for the possibility of a recoverable injury. It is the responsibility of the

worker to take the adequate precautions to help minimize the risk, hazards and exposure to injury.

Hazard Boundary - for locations where an arc flash hazard analysis has not been completed, the Flash Hazard Boundary can be calculated by the formula outlined in NFPA 70E Annex D. NFPA 70E, 130.3(A)(1) also offers the following option: *For systems that are 600 volts or less, the Flash Protection Boundary shall be 4', based on the product of clearing times of 2 cycles (0.033 second) and the available bolted fault current of 50 kA or any combination not exceeding 100kA cycles (1667 ampere seconds).*

Note: the above 4.0 ft. option should be only used until Flash Hazard calculations (such as described in IEEE-1584) can be performed. Expanding the Flash Protection Boundary beyond the NFPA 70E required 4.0 ft value is recommended.

Hazard/Risk Category Classifications - for locations where an arc flash hazard analysis has not been completed for incident energy levels, a hazard/risk category can be obtained in NFPA 70E Table 130.7(C)(9).

It is vitally important that the notes to the table be read, understood and taken into consideration when using this table. The notes include limitations on available short circuit current and fault clearing times (i.e. breaker or fuse clearing time) that need to be considered if the table is to be used. If the system does not provide short circuit or fault clearing times within the limits provided in the notes, a flash hazard must be performed.

It is also important to note that this table includes reductions in the Hazard/Risk Category values for certain tasks that may be considered "low risk". This is the risk element of the equation that the NFPA 70E committee used for the Hazard/Risk Categories. Referring to the table below, you can see that for the same type of location, the Hazard/Risk Category changes for the task performed. This does not mean that the incident energy exposure level will be any lower should an incident occur.

Should the tables be used for locations where a Flash Hazard Analysis has not been performed, it is recommended that the worker carefully consider the Hazard/Risk Category, and select a conservative value that provides for the higher level of protection. Example: you are going to operate the CB with the covers off and the table calls for a Hazard/Risk Category 1 for this operation. You notice that voltage testing provides a 2* Hazard Risk Category. You should consider going with a 2* for the breaker operation for a more conservative approach.

Excerpt from NFPA 70E Table 130.7(C)(9) – Hazard/Risk Category Classifications			
Task	**Hazard/Risk Category**	**V-rated Gloves**	**V-rated Tools**
Panelboards or Switchboards Rated>240V and			

up to 600V (with molded case or insulated case circuit breakers – Notes 1 and 3			
CB or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	1	N	N
Work on energized parts, including voltage testing	2*	Y	Y
Note 1: 25kA short circuit current available, 0.03 second (2 cycle) fault clearing time.			
Note 3: For < 10kA short circuit current available, the hazard/risk category required may be reduced by one number.			
2* means that a double-layer switching hood and hearing protection are required for this task in addition to the other Hazard/Risk Category requirements of Table 130.7(C)(10).			

c. Any Additional Hazards – including, but not limited to the following:

1. Under-rated circuit breakers, electrical disconnects and electrical equipment.
2. Inadequate housekeeping.
3. The introduction of a hazard by others performing work in the area energized electrical work is to take place (i.e. wash down of an area with water, metal flying's from a grinder, excessive dust from drywall being sanded).
4. Water leakage.
5. Uncovered and improperly covered openings in electrical gear.
6. Improper storage of materials/equipment in electrical rooms.
7. Mechanical support.
8. Physical integrity.
9. Equipment degradation.
10. Suspicious equipment noises or performance.
11. Improper or inadequate maintenance and testing.
12. Out of date one-line drawings.
13. Improper installations.
14. Lack of equipment operation and maintenance manuals.
15. Inability of workers to see equipment and systems due to poor illumination or obstructions or installation (no blind reaching is allowed).
16. Impaired ability of employees due to fatigue, lack of sleep, illness, medication, etc.
17. Lack of proper equipment information or special tools required.
18. Conductive tools, equipment, dust and hazardous locations (i.e. chemicals, metal objects, piping, etc.).
19. Lack of proper ventilation to the room / high room and / or equipment temperatures.
20. Excavation is being performed near other underground conduits next to the conduit/circuit(s) that EEW is taking place.
21. Circuit is on a photocell and has not been verified that it is off.

22. Heavy congestion of others in the area where work is to be performed.

Note: any of these hazards may prevent energized electrical work from being performed without unnecessary risk or exposure to hazards.

d. **Personal Protective Equipment Requirements** – including, but not limited to the following equipment (rating based on application requirements):

1. Hard Hat.
2. Safety Glasses.
3. Face Shields and Socks or Hoods (rated in Calories per cm^2).
4. Non-melting or FR undergarments.
5. Rubber Insulating Gloves.
6. Leather Gloves.
7. Hearing Protection.
8. FR Clothing and Suits (rated by NFPA 70E Hazard Risk Category and in Calories per cm^2).
9. FR Rated Safety Vest (if required).
10. Leather and/or insulated work boots (SEMC Certified Construction for HRC 2 and above).
11. Insulating Blankets and Mats.
12. Arc Suppression Blankets.
13. FR Rated fall protection (where deemed necessary).
14. Rescue equipment.

e. **Tools and Equipment -** including, but not limited to the following equipment (rating based on application requirements):

1. Insulated Tools.
2. Test and Measurement Equipment.
3. Ground Fault Circuit Interrupters.
4. Lighting (normal and emergency), including non-conductive flash lights.
5. Non-conductive rope.
6. Communications (i.e two way radio).

f. **Job Hazard Analysis Checklist -** A JHA Checklist shall be completed after the EEW Permit has been approved and prior to any energized electrical work being performed.

g. **Proper Planning and Communication -** No live (energized) electrical work shall take place without a well thought out and communicated plan. All contingencies must be discussed prior to beginning work and the work will not proceed until all workers are comfortable with the plan and agree that the work can be performed safely.

h. **Boundary Requirements and Barriers -** Areas around exposed/energized equipment shall be properly barricaded with non-conductive material and/or secured to prevent accidental contact and maintain a safe work environment. Barricades shall be used in conjunction with safety signs where it is necessary to prevent and/or limit employee access to work areas containing live parts. If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn employees. The EEW permit shall describe the Boundary / Barricade requirements for shock and flash hazards.

i. **Additional Considerations** - including, but not limited to the following equipment (rating based on application requirements):

1. Local Hospital (Dominican) and Nearest Burn Center (Burn Center is located at Santa Clara Valley Medical Center).
2. Fire Alarm Pull Station.
3. Fire Extinguisher.
4. Communications (phone, radio, cell phone, etc.). Note: metallic communication equipment (i.e. metallic cell phones or holders) shall not be allowed within the limited, restricted or prohibited shock hazard boundaries.
5. Emergency Contact.
6. Exits (including Emergency exits).

j. **Grounding Straps/Cables -** Grounding cables must be installed whenever any work is to be performed on the exposed parts of any electrical component that may become energized by inductive coupling or by accidental means. PPE must be worn, commensurate to the hazard, for application and removal of grounds. Prior to the application of ground straps, the bus/system shall be verified as de-energized.

All points where temporary grounds will be connected shall be inspected and cleaned to assure a good positive connection. When installing temporary grounds, the ground end shall be connected first, and then the line end shall be attached. Temporary grounds shall be removed when the employee in charge of the work and all employees performing the work are in the clear and are informed of the change in the status of the line.

When removing the grounds, the line end of the ground shall be disconnected first, and then the ground end disconnected. Grounding straps / cables shall be designed for the feeder / circuit rating and shall be of sufficiently low impedance to provide for rapid interruption of the upstream over current / short circuit device. The EEW shall describe protective ground requirements as needed for the application.

k. **Conductive Items -** personnel shall not approach or take any conductive items into the minimum approach distance for shock hazards. These items include, but are not limited to watches, bracelets, rings, conductive framed glasses, earrings, necklaces, belt buckles, body piercing apparatus, badge clips, cell phones and clothing with metal snaps and buttons.

l. **Precautionary Techniques -** A "qualified" person shall be familiar with the proper use of the special precautionary techniques, PPE, including arc-flash, insulating and shielding materials, and insulated tools and test equipment.

m. **EEW Assistant System –** When doing EEW work, using the EEW Assistant System is a good practice, but not required.

n. **Confined or Enclosed Workspaces -** When an employee works in a confined or enclosed space that contains exposed live parts operating at 50 volts or more or an electrical hazard exists, the employer shall provide, and the employee shall use, protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed live parts operating at 50 volts or more or where an electrical hazard exits. Examples of confined or enclosed workspaces include manholes, hand holes, vaults and large sections of equipment.

   The EEW shall describe all necessary precautions, work practices, tools and equipment necessary for work in confined or enclosed spaces. UC Santa Cruz Confined Space Safety Requirements also apply.

o. **Signatures –** A UC Santa Cruz Physical Plant Electrical Safety Officer or Knowledgeable Assigned Representative shall be responsible for documenting and/or validating the justification of the Energized Electrical Work Permit. The EEW Permit must include signatures of supervisory/management personnel authorizing the EEW and signatures of the "qualified" individuals performing the EEW, indicating that they believe that the work can be completed safely. All qualified persons who will be working inside the shock hazard (limited/restricted/prohibited) approach boundary and flash hazard boundary must sign the EEW permit. The EEW Assistant shall also sign the EEW Permit.

p. **Administrative -** All electrical EEW Permits, checklists and forms shall be readily available to workers. All complete EEW Permits shall be archived with UC Santa Cruz Physical Planning and Construction Archives Office.

5.8 Supplemental Requirements for Selected Tasks

A. Live Switchgear Inspection (Infrared) - There must be at least two qualified workers to open the enclosure and to do the inspection; both must be wearing the appropriate PPE during the entire test. A minimum boundary equal to the arc flash hazard boundary or a minimum boundary of 12 feet shall be established in front of the equipment and barricaded to keep unqualified personnel out of the testing area. Under no circumstances shall the Infrared camera equipment be allowed to intrude into the area normally protected by the enclosure door or cover. If identifying marks are to be placed on the electrical equipment, the person installing the marks must be using rubber insulated gloves and leather protectors while installing the label. Once the inspection is done, an electrician will close all the electrical enclosures. Properly rated PPE is required for removing and replacing or opening and closing doors or covers on all energized electrical enclosures. An Energized Electrical Work Permit and Job Briefing shall be required.

B. Fuse Replacement – Power shall be de-energized prior to fuse replacement unless the fuse is used for control circuits, the fuse holder is of the type that is an approved disconnect that removes all power sources to the fuse and the worker is not exposed to energized systems > 50 volts. If it is necessary to pull or replace control fuses on energized devices, the Qualified Worker must make sure the necessary safeguards are in place prior to the job being performed. Rubber insulated gloves (including leather protectors where required), tools and devices must be used when replacing a fuse. The appropriate job hazard analysis shall be performed before replacing a fuse. Appropriate PPE must be used to minimize the risks associated with electrical shock and arc flash/blast hazards.

C. Re-closing electric power circuits after protective device operation - After a circuit is de-energized by a circuit protective device, it may not be manually re-energized until it has been determined the equipment and circuit can be safely energized or that a fault does not exist. Repetitive manual re-closing of circuit breakers or re-energizing circuits by replacing fuses is prohibited. (Also refer to Electric Shop circuit breaker reset procedure)

When a protective device is designed to protect a circuit from **short circuits and/or ground fault** opens a circuit, and the circuit is verified with a Megger, the following recommended levels of insulation resistance can be expected:

When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit is needed before the circuit is re-energized.

Over current protection of circuits and conductors may not be modified, even on a temporary basis, beyond that allowed by the installation and safety requirements for over current protection.

Up to 600V Circuits—1.5 Mega-Ohms phase to phase and phase to ground using a 500V Megger. These are typical values from IEEE 43-2000 "Recommended Practice for Testing Insulation Resistance for Rotating Machinery" that could be expected under ideal conditions, and are not mandated.

D. Resetting Motor Overloads 600 V and Below -An overload should be reset no more than one time. If an overload trip occurs more frequently, a "qualified" worker must be called to further diagnose the problem. This will include visual inspection of motor and load, taking current readings, and checking overloads for proper size.

E. Portable Generators - The frame of the UC Santa Cruz transportable generator shall be grounded to the facility electrical distribution system as required. The size of the conductor, the conductor lugs and the attachment points shall be of adequate capacity to provide a low impedance path necessary to facilitate timely operation of the over current / short circuit protective devices.

F. Batteries and Battery Rooms - The battery manufacturer shall be consulted regarding the sizing of the battery short-circuit protection. If information regarding the short-circuit protection of a battery is not available from the manufacturer, the prospective fault level at the battery terminals shall be considered to be twenty times the nominal battery capacity at the 3-hour rate. The battery room shall be accessible only to authorized personnel and shall be locked when unoccupied.

1. Any cable, busbar, or busway forming the connection between the battery terminal and the dc switching equipment shall be rated to withstand the prospective short-circuit current.
2. Alarms shall be provided for early warning of abnormal conditions of battery operation. The alarm system shall provide an audible alarm and visual indication at the battery location, and where applicable, at a remote manned control point.
3. Ventilation shall be provided to prevent liberated hydrogen gas from exceeding 1% concentration.
4. Ventilation shall be provided to maintain design temperature to prevent thermal runaway that can cause cell meltdown leading to a fire or explosion.
5. The battery room and enclosure doors shall open outward and shall be equipped with quick-release, quick opening hardware.
6. Battery room lighting shall provide a minimum level of illumination of 30 ft. candles. Emergency illumination shall be provided for safe egress from the battery room.

Personal Protective Equipment. The following protective equipment shall be available to employees performing battery maintenance:

1. Non-melting goggle and face shield.
2. Chemical-resistant gloves.
3. Protective aprons.
4. Protective overshoes.
5. Portable or stationary water facilities for rinsing eyes and skin in case of electrolyte spillage.

Tools and Equipment. Tools and equipment for work on batteries shall comply with the following:

1. Be of the non-sparking type.
2. Be equipped with handles listed as insulated for the maximum working voltage.

6.0 Personal Protective Equipment (PPE) and Tools

This section outlines the minimum requirements for PPE selection application, training and maintenance. Many hazards and risks can exist when doing electrical work, including cuts, falls, eye injuries, shock, burns, blast hazards, etc. The PPE selection process is based on potential and existing job hazards, risks, tasks and procedures. Once the Hazard/Risk Classification has been identified, the employee shall use the required personal protective equipment for the task to help provide worker protection from shock, arc flash and other hazards.

Employees working in areas where electrical hazards may be or are present shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body to be protected, appropriate for the work to be performed and compliant with OSHA, CA-DOSH, ANSI, ASTM, NFPA 70E and other standards and recommended practices. It is the responsibility of every worker, including contractors, to wear the appropriate PPE for the hazards / risks involved and the tasks to be performed.

It is important for the worker to note PPE that is properly designed, applied and maintained, will significantly help protect the worker, however it may not stop all forms of injury. PPE IS NOT A SUBSTITUTE FOR APPROPRIATE JOB HAZARD/RISK REDUCTION AND AVOIDANCE. PPE SHOULD BE CONSIDERED AS BACKUP PROTECTION, NOT AS THE PRIMARY METHOD TO PROTECT THE WORKER.

A. Shock protection – workers shall have appropriate PPE and voltage rated tools before crossing the appropriate "Restricted Approach Boundary" as outlined in NFPA 70E, including the following tables, the associated sections and the applicable notes to the tables:

1. Approach Boundaries to Live Parts for Shock Protection - Table 130.2(C).
2. Hazard/Risk Categories – Table 130.7(C)(9).
3. Protective Clothing and Personal Protective Equipment Matrix – Table 130.7(C)(10).
4. Protective Clothing Characteristics – Table 130.7(C)(11)

B. Flash Hazard (Arc Flash) Protection - workers shall have appropriate PPE for flash hazards to cross the "Flash Hazard Boundary" as outlined in NFPA 70E, including the following tables, the associated sections and the applicable notes to the tables:

1. Approach Boundaries to Live Parts for Shock Protection - Table 130.2(C).
2. Hazard/Risk Categories – Table 130.7(C)(9).
3. Protective Clothing and Personal Protective Equipment Matrix – Table 130.7(C)(10).
4. Protective Clothing Characteristics – Table 130.7(C)(11)

As per NFPA 70E, Table 130.7(C)(10) and Table 130.7(C)(11), workers with the potential exposure to energy levels of 2 Cal/Cm^2 and below may wear non-melting clothing described in Hazard/Risk Category 0 in Table 130.7(C)(11). Typical items listed in this table include: untreated cotton, wool, etc. with a fabric weight of at least 4.5 oz/yd^2. Where hazard/risk exposure is significant, it is recommended that the appropriate

FR clothing be utilized, even if the Hazard/Risk Category is ≤ 0 as per NFPA 70E.

Worker protection can be improved by wearing FR clothing whenever the potential exists for exposure to flash hazards. It is mandatory to use FR clothing for potential incident energy exposure above 2 Cal/Cm^2 or for NFPA 70E Hazard/Risk Categories > 0.

Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall NOT be permitted in clothing or in fabric under layers (underwear) next to the skin. Clothing made from materials that do not meet the requirement of NFPA 70E 130.7(C)(14)and(15) regarding melting, or made from materials that do not meet the flammability requirement, shall not be permitted to be worn.

C. Application - Protective equipment, including PPE for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, electrical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact. It is the responsibility of every electrician, including contractors, to wear the appropriate PPE.

The PPE selection process is based on potential and existing job hazards, risks, tasks and procedures. All PPE shall be tested and used in accordance with ANSI, ASTM, IEC, OSHA, CA-DOSH and manufacturer's requirements.

When FR clothing and equipment is worn, it shall cover all ignitable clothing, shall be sized properly and shall provide for proper movement and visibility. Precautions shall be taken to prevent oxygen deprivation when wearing switching hoods (i.e. properly designed and rated hood fan) and for heat exhaustion (i.e. application of cooling packs).

D. Employee-owned equipment - Where employees provide their own protective equipment or it is provided by UC Santa Cruz, the UC Santa Cruz Physical Plant Electrical Safety Officer in charge shall be responsible to ensure its adequacy, including proper maintenance, and sanitation of such equipment.

E. Design - All PPE shall be of safe design and construction for the work to be performed.

F. Hazard Assessment and Equipment Selection - The workplace will be assessed to determine if hazards are present, or are likely to be present, which necessitate the use of PPE. If such hazards are present, or likely to be present, UC Santa Cruz shall:

1. Select, and have each affected employee use, the types of PPE that will protect the affected employee from the hazards identified in the hazard assessment;
2. Communicate selection decisions to each affected employee; and,
3. Select PPE that properly fits each affected employee.
4. Routinely inspect equipment to help ensure that defective or damaged PPE shall not be used.

G. Typical PPE – appropriately rated PPE shall be provided to help protect the workers body. This may include, but is not limited to the following equipment (rating based on application requirements):

1. **Hard Hat (head protection) –** Type E or G ANSI approved hard hats shall be used for head protection.
2. **Safety Glasses (eye protection) -** Safety glass shall be worn at all times. Eye protection (safety glasses) shall also always be worn under face shields or hoods.

   Arc Rated Face Shields and Sock Hoods (eye, face, neck and chin protection) - Arc Rated Face Shields (rated in Calories per cm^2 per NFPA 70E requirements) shall be used for all tasks that present a danger of injury due to arc flash or flying debris from an electrical explosion. All live electrical work, verification for lockout, and work near live electrical equipment is included in this requirement. The type of face protection will be selected according to the arc flash potential incident energy rating and shall be of the wrap around design to help prevent damage to neck, chin and face areas. A balaclava (face sock) shall be worn under the face shield at all times. Safety glasses are required to be worn, in addition to all face shields.

   Face shields are not permitted when performing any tasks on overstressed breakers or equipment—a flash rated suit and hood must be used regardless of the arc flash potential.

   Double Layer Hoods with Face shields (rated in Calories per cm^2) **–** Double Layer Switching Hoods with properly rated face shields are required for incident energy levels greater than Hazard/Risk Category 2 (8 Cal/Cm^2) or for 2* locations listed in NFPA 70E Table 130.7(C)(9). Double Layer Switching Hoods shall be tested to, and comply with American Society of Testing and Materials (ASTM) F2178- latest revision. Face shields shall have an anti-scratch and anti-fog coating. Safety glasses are required to be worn in addition to all face shields.

   A compatible fresh air blower system shall be used to supply fresh air into the hood when the worker is going to wear the hood for more than a couple of minutes. The fresh air system helps prevent oxygen deprivation and higher temperatures in the hood that might be present without the system.

3. **Rubber Insulated Gloves (hand and partial arm protection) -** Employees shall wear rubber insulated gloves appropriately rated for the highest phase to phase

voltage that the worker will be exposed to where there is danger of hand and arm injury from electric shock due to contact with live parts. Where insulating rubber gloves are used for shock protection, leather protectors shall be worn over the rubber gloves.

Hand and arm protection shall be worn where there is possible exposure to arc flash burn. Rubber insulating gloves are not rated to withstand the energy in a flash incident. Flash rated gloves with the appropriate voltage rating or rubber-insulated gloves with heavy-duty leather protectors are mandatory for working on energized equipment.

Every person in the UC Santa Cruz maintenance department who works with electrical equipment will be issued a pair of insulated gloves for work. The issued rubber insulated inserts will be exchanged every three months for testing. Rubber inserts will be tested for leaks before each use. Heavy-duty protective leather gloves shall be worn over the rubber-insulated gloves for work. Protective leather covers shall also be inspected for defects. Any insert or cover showing defects should be replaced and destroyed immediately.

Rubber insulated gloves ratings (voltage rating phase to phase):

- Class 00 500 volts
- Class 0 1,000 volts
- Class 1 7,500 volts
- Class 2 17,000 volts
- Class 3 26,500 volts
- Class 4 36,000 volts

Tests of Rubber Gloves and Sleeves - Rubber gloves and sleeves shall be electrically tested at least once every 3 months after they are checked out for use, and complete records shall be kept of all such tests and date of issue. Rubber gloves and sleeves not checked out for use within 6 months shall be retested before being issued.

4. **Hearing Protection** – Appropriate non melting hearing protection (ear canal inserts) shall always be worn when using a multi-layer flash hood or when exposure to Hazard/Risk Category 2 or greater exists.
5. **FR Clothing**– FR Clothing shall be used whenever potential exposure exists for a flash hazard to be present.
    a. **ASTM F1506 Requirements** – ASTM F1506 details the specifications of a textile to be used by an electrical worker as a means of electrical arc protection. A garment must include a label, which states all six of the following items to qualify as an arc protective garment.
        - Tracking Identification Code
        - Meets F1506
        - Manufacturer’s Name

- Care Instructions and Fiber Content
- Size and other associated standard labeling
- "Arc Rating" – Arc Thermal Performance Value (ATPV) or E_{BT}. Note: The ATPV is defined as the minimum incident energy that causes the onset of a second-degree burn when Stoll is reached without breakopen occurring. E_{BT} is defined as the average of the five or more highest incident exposure energy values (without breakopen) below Stoll when breakopen occurs before reaching Stoll.

b. **ASTM F1959 Requirements** – ASTM F1959 details the standard test method, which must be employed to determine the thermal protective value of a textile material in an electrical arc application. The arc rating ATPV value shall meet or exceed the potential incident energy exposure level (i.e. if the Incident Energy Exposure level is calculated at 8 Cal/Cm^2, arc flash protective clothing shall be rated a minimum of 8 Cal/Cm^2).

Additional protection may be provided and the risk of burn injury may be reduced if the protection selected exceeds the incident energy rating (i.e. 12 Cal/Cm^2 protection is selected for 8 Cal/Cm^2 exposures), although this has to be weighed against additional bulk, worker flexibility and possible worker heat stress in warm or hot locations. Some clothing manufacturers publish a burn injury reduction guide that can help determine the reduction in burn injury risk associated with higher levels of protection. The increased protection may be achieved through clothing rated at higher ATPV values or through layering of FR clothing (see below).

Note: Incident Energy Levels (Cal/Cm^2) are typically calculated at 18"-24" from the worker's chest area. This means that the workers arms and hands can be exposed to higher incident energy levels if they are closer to the point of the arc flash origination. Additional protection shall be utilized as necessary to help protect the workers hands and arms from these higher incident energy levels.

c. **Layering** – Layering can be used with some FR equipment manufacturers products to decrease risk of burn injury (i.e. a FR Coveralls with an ATPV rating of 8 Cal/Cm^2 may be worn over an FR shirt with a ATPV rating of 8 Cal/Cm^2 to achieve a rating of 16 Cal/Cm^2). It is essential that the manufacturer of the FR clothing be consulted, to confirm that the FR clothing they provide can provide this additional protection, and to obtain their guide for layering.

d. **Typical FR Clothing types**:

- **Daily Wear** – daily wear typically consists of a shirt and pants combination or coveralls typically rated 4 Cal/Cm^2 (Category 1), 8 Cal/Cm^2 (Category 2) or in a rating up to 15 Cal/Cm^2. The selection of Shirt and Pants vs. Coveralls is a personal preference and may be based on frequency of exposure to electrical hazards.

  Example 1: Worker A performs electrical work all day long and has exposure to electrical hazards. Worker A selects FR shirts and pants with the

appropriate energy (Cal/Cm^2) or hazard risk category rating for the tasks to be performed.

Example 2: Worker B performs limited electrical work and is only exposed to potential electrical hazards a couple times a day. Worker B has chosen to select FR Coveralls that can be worn over non-melting cotton clothing. Worker B will wear the appropriately rated FR coveralls along with the other required PPE before being subject to electrical hazards.

- **Arc Flash Suit** – An Arc Flash Suit (Coats and Pants or Coveralls) is usually rated between 15 to 65 Cal/Cm^2 and typically used for NFPA 70E Hazard Risk Categories 2* to 4. Arc Flash Suits are used in conjunction with a Flash Suit hood with the appropriate energy rating. Note: NFPA 70E does not provide recommendations for greater than a Category 4 exposure (up to 40 Cal/Cm^2) due to the arc blast hazards and the associated risk of personnel injury due to the pressure wave associated with the blast. UC Santa Cruz does not allow energized (live) work on systems with energy levels exceeding 40 Cal/Cm^2. PPE with energy ratings above 40 Cal/Cm^2 may help reduce the risk of 2nd degree burn for exposures of $\leq$ 40 Cal/Cm^2.

  FR coats, pants and hoods are provided by UC Santa Cruz and must be worn by electricians who are exposed to any electrical hazard beyond the level of protection provided by the daily wear flame resistant PPE.

- **Undergarments** – FR undergarments can be used to reduce the risk of burn injuries.

e. **Fit** – Flash protective clothing must be loosely fit and designed to allow easy and rapid removal after flash incident, or a means must be provided to remove the clothing.

f. **FR Clothing Requirements** - Maintenance electricians at UC Santa Cruz are provided with daily wear flame resistant (FR) clothing. It is mandatory to wear FR protective clothing for all live electrical work, including troubleshooting and testing for work on any branch circuit or feeder with an upstream protective device (fuse or circuit breaker) > 30 amps. Garments that may melt (i.e. nylon, polyester, etc.) may not be worn by electricians who are exposed to any electrical hazard.

FR suits (coats, pants and hoods) are provided and must be worn by electricians who are exposed to any electrical hazard beyond the level of protection provided by the daily wear flame resistant clothing and equipment.

6. **Leather and/or Insulated work boots** – Appropriate leather foot protection shall be worn for all electrical work. Foot protection of heavy-duty leather work shoes shall be worn in all tasks in Hazard/Risk Category 2 and higher. Toe guards and structural components shall be constructed of Structurally Engineered Moldable Composite (SEMC) Certified materials. Steel toe and component shoes are not allowed.

7. **Insulating Blankets and Mats –** Rubber Insulating Blankets and Mats can be used to help protect the worker against shock hazards and to help limit accidental contact with live surfaces. Insulating blankets and mats shall be rated for the applicable

phase-to-phase voltage. Blankets and Mats shall be inspected before each use and shall be electrically tested at least once every 3 months after they are checked out for use, and complete records shall be kept of all such tests and date of issue. Insulating Blankets and Mats not checked out for use within 6 months shall be retested before being issued.

8. **Arc Suppression Blankets** – arc suppression blankets can be used to help limit the exposure to a potential arc flash. These blankets DO NOT provide for shock protection and are meant to only help limit the exposure to arc flash. The blankets shall be rated for the potential incident energy to which they may be exposed.
9. **FR Raingear** – Where exposed to flash hazards FR rated raingear appropriate for the hazard/risk category and energy level shall be provided to the Qualified Worker who is performing live (energized) electrical work outside in the rain on electrical systems.
10. **FR Fall protection (where deemed necessary)** – fall protection devices shall be appropriate for the use and shall be constructed of suitable material to prevent shock and burn hazards when worker is exposed to such hazards.
11. **Specialty Protection Equipment** - i.e. chemical resistant gloves and aprons for battery work, etc.).

H. PPE Care and Inspection – PPE shall be maintained in a safe and reliable condition. PPE shall be inspected before each use. Should the PPE be out of certified date range (i.e. rubber insulating glove testing requirements), worn out, damaged, impaired or unsuitable for use or application, the worker has the responsibility to not use the PPE, tag the PPE with their name, a description of the problem and the date of the inspection and notify their Supervisor. Work clothing or flash suits that are contaminated, or damaged to the extent their protective qualities are impaired, shall not be used.

The garment manufacturer's instructions for care and maintenance of FR apparel shall be followed and particular care shall be taken to not wash out the FR treatment in any FR treated cotton products. Fabric wear is also of concern, especially with FR treated cotton products. FR clothing that is subject to frequent washing should be constructed of a material that has inherent FR properties in the thread and fabric used to construct the clothing.

I. Standards - Personal protective equipment shall conform to the standards given in NFPA 70E, Table 130.7(C)(8) as well as applicable OSHA, ASTM and ANSI standards. Several have been listed below for reference:

- Head Protection ANSI Z89.1-03
- Eye & Face Protection ANSI Z87.1-03
- Gloves ASTM D 120-02
- Sleeves ASTM D 1051-07
- Gloves & Sleeves ASTM F 496-06
- Leather Protectors ASTM F 696-06
- Footwear ASTM F 117-03, F2412-05, F2413-05

	ANSI Z41
• Visual Inspection	ASTM F 1236-01
• Apparel	ASTM F 1506-02a
• Raingear	ASTM F 1891-06
• Face Protective Products	ASTM F 2178-06
• Ladders	ANSI A14.5
• Safety Signs and Tags	ANSI Z535
• Blankets	ASTM D 1048
• Blankets	ASTM F 479
• Covers	ASTM D 1049
• Line Hoses	ASTM D 1050
• Line Hoses and Covers	ASTM F 478
• Fiberglass Tools/Ladders	ASTM F 711
• Plastic Guards	ASTM F 712
• Temporary Grounding	ASTM F 855
• Insulated Hand Tools	ASTM F 1505

J. Training – Training on PPE selection, application and use shall be provided to each employee. The training shall include:

1. When PPE is necessary.
2. The PPE that is necessary for the task / project.
3. How to properly don, doff, adjust, and wear PPE.
4. The limitations of the PPE.
5. The proper care, maintenance, useful life and disposal of the PPE.

K. Retraining - Each affected employee shall demonstrate an understanding of the training listed above, and the ability to use PPE properly before being allowed to perform work requiring the use of PPE. When there is reason to believe that any affected employee who has already been trained does not have the understanding and skill required by this section, the employer shall retrain each such employee. Circumstances where retraining is required include, but are not limited to, situations where:

1. Changes in the workplace render previous training obsolete; or
2. Changes in the types of PPE to be used render previous training obsolete; or
3. Inadequacies in an affected employee's knowledge or use of assigned PPE indicate that the employee has not retained the requisite understanding or skill.

L. Documentation of Training and Retraining – PPE training shall be documented in writing, including the name of each employee receiving training, the date they were trained and the subject of the training.

7.0 Electrical Maintenance Practices to Minimize Risk and Hazards

A. Electrical Maintenance Requirements – UC Santa Cruz Facilities shall have an active electrical maintenance program that helps prevent electrical failures and breakdown that could lead to increased worker risk and exposure to hazards.

B. Basis for Program - The electrical maintenance program shall be based on documents, standards and recommended practices from the following organizations:

1. National Fire Protection Association (NFPA) 70B.
2. National Electrical Manufacturers Association (NEMA).
3. National Electrical Testing Association (NETA).
4. Equipment manufacturer requirements.
5. Applicable OSHA and CA-DOSH requirements.
6. America National Standards Institute (ANSI).
7. American Society for Testing and Materials (ASTM)
8. International Electrotechnical Commission (IEC).
9. Institute of Electrical and Electronic Engineers (IEEE)
10. International Standards Organization (ISO)

C. Minimum Program Requirements – As a minimum, the electrical maintenance program shall provide for:

1. Proper housekeeping in electrical rooms.
2. Inspection for proper signage/labeling.
3. One-line drawings that are maintained and up-to-date.
4. Gear inspection and cleaning.
5. Inspection for water leaks into electrical rooms and gear.
6. Inspection for excessive dust or metal flying in electrical rooms and gear.
7. Operation and testing of circuit breakers.
8. Infrared testing.
9. Proper setting of circuit breakers as per short circuit, protective device coordination and arc flash hazard studies.

10. Insulation testing on cables where appropriate.
11. Inspection and testing of battery plant.
12. Installation deficiencies (i.e. inadequate available fault current interrupting capacity for circuit breakers) are promptly corrected.
13. System modifications will be documented in a software program capable of analyzing short circuit; protective device coordination and arc flash hazard values. New systems or system changes shall have short circuit, coordination and arc flash hazard values evaluated as part of the design.

8.0 Electrical Design Practices to Minimize Risk and Hazards

A. Design Requirements - UC Santa Cruz facilities will pursue electrical system design and installation practices that reduce the risk of exposure to electrical hazards for UC Santa Cruz facilities, including, but not limited to the following:

1. Installations that help ensure that protective device and equipment available fault current interrupting ratings are sufficient for the installation (i.e. a breaker rated 25kAIC will NOT be used in an installation with an available fault current higher than its rating).
2. Installations that limit exposure to live electrical equipment (i.e. installation of metering points and/or metering on the exterior of a cabinet or in an isolated cubicle where frequent electrical measurements are necessary).
3. Over current and short-circuit protective devices that limit available short circuit current and duration of arc.
4. New systems, system modifications and additions will be documented in a software program capable of analyzing short circuit; protective device coordination and arc flash hazard values through Physical Planning and Construction department. New systems or system changes shall have short circuit, coordination and arc flash hazard values evaluated as part of the design.

9.0 Incident Review and Electrical Safety Program Updates

A. Incident Review - A fact-finding meeting shall be scheduled within 24 hours of an incident (including a "near miss"). All persons involved in the incident shall be present in the Incident Review Meeting.

1. The purpose of the meeting is to:

    a. Thoroughly understand the sequence of events leading to the incident.
    b. Identify contributing factor(s) to the incident.
    c. Identify the root-cause of the incident.
    d. Put in place plans to correct the root-cause failure and prevent reoccurrence of the incident.

2. Documents Required – the documents required for system description and clear understanding of the sequence of events including:

    a. One-line diagrams.
    b. Panel schedules.
    c. Area maps.
    d. Applicable material safety data sheets.
    e. Photographic evidence, if obtained.

3. Incident Review Meeting Parameters:

    a) Problem Statement
    b) Chronology
    c) Contributing Factors
    d) Root Cause
    e) Action Required (AR) - AR's should be completed within a given time frame.
    f) Opens
    g) Follow Up

B. Electrical Safety Program Review and Updates – The UC Santa Cruz Electrical Safety Program shall be reviewed and updated/enhanced based on the following requirements:

1. Annually, or
2. As needed for program enhancements, or
3. As needed to incorporate changes or updates in industry mandates, standards and recommended practices including; OSHA, CA-DOSH, ANSI, ASTM, IEEE or NFPA.
4. As needed for UC Santa Cruz Policy updates.

C. Addressing Potential Conflicts – If a potential conflict or issue is noted in this Electrical Safety Program or between elements of this safety program, nationally recognized standards and practices, OSHA mandates or other elements of UC Santa Cruz's safety program, these shall be brought to the attention of a Direct Supervisor and EH&S via written communication. These issues shall be reviewed and a response given within 15 working days. Should any conflict or problem arise that could present an increased risk or exposure to hazards, the issue shall be addressed before any live work is performed.

10.0 Other UC Santa Cruz Safety Policies

Other UC Santa Cruz Safety Policies, Programs and Requirements may also apply. UC Santa Cruz employees are responsible for complying with other safety plans and programs. Where a conflict is present, the conflict will be brought to the attention of the electrical supervisor for resolution. Additional safety requirements include:

A. Fall Protection
B. Confined Spaces
C. General Lockout/Tagout
D. General PPE Requirements
E. Welding Safety
F. Voluntary Dusk Masks
G. Respirators
H. Training Requirements
I. Hazard Communication
J. Asbestos Abatement
K. Bloodborne Pathogens
L. Emergency Procedures
M. Earthquake Protection
N. Ergonomics
O. Lifting and Materials Movement
P. Fire Safety

11.0 Definitions

Arc Rating - The maximum incident energy resistance demonstrated by a material (or a layered system of materials) prior to breakopen or at the onset of a second-degree skin burn. Arc rating is normally expressed in cal/cm2.

Calorie per centimeter squared (cal/cm2) - The unit of measurement used to express the amount of thermal energy released during an arc flash event. 1 calorie is equal to the amount of thermal energy needed to raise 1 gram of water 1 degree Celsius.

Circuit Breaker Testing - Circuit breakers that interrupt faults approaching their rating shall be inspected and tested in accordance with the manufacturer's instructions. NFPA 70B and NETA Maintenance Testing Specifications can assist in understanding the specific tests and testing intervals that are required to help ensure reliability.

EEW Assistant System - A safety system used when one person is performing EEW and one person is functioning as a dedicated Qualified – EEW Assistant. A person may function as an EEW Assistant for two people if they are in a single line of sight from a single observation point. An Assistant System is a good practice, but not required, when performing EEW. The EEW Assistant should be positioned outside of the Flash Protection Boundary when possible. If the assistant must be inside the Flash Protection Boundary, he/she must be wearing equivalent PPE as the person doing the work.

EEW Assistant:

- A person who observes the work without interfering with the person performing EEW.
- Determines the best emergency procedures prior to beginning work.
- Review scope of work with the Qualified Person performing EEW.
- Reviews and signs the EEW Permit if used.

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

Electrically Safe Work Condition - A state in which the conductor or circuit part to be worked on or near has been disconnected from energized (live) parts, locked and tagged in accordance with established standards, tested to ensure the absence of voltage with an approved voltage testing device and grounded if determined necessary.

Energized Electrical Work (EEW) - Working on or near exposed energized parts 50 volts or greater and/or within the shock hazard and flash protection boundary.

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

Flame-Resistant (FR) - The property of a material whereby combustion is prevented, terminated, or inhibited following the application of a flaming or non-flaming source of ignition. Note: Flame resistance can be an inherent property of a material, or it can be imparted by a specific treatment applied to the material.

Flash Hazard Analysis - Study investigating a worker's potential exposure to arc-flash energy, conducted for the purpose of injury prevention and the determination of safe work practices and the appropriate levels of PPE.

Calculation that determines the distance or Flash Protection boundary that a person may be exposed to an electrical arc and receive a second degree burn. Work or standing within this boundary requires the wearing of properly rated PPE based on the risk as per the NFPA 70E.

Flash Protection Boundary - An approach limit at a distance from exposed live parts within which a person could receive a second-degree burn if an electrical arc flash were to occur. Only qualified persons are allowed inside the Flash Protection Boundary.

Incident Energy - The amount of energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. One of the units used to measure incident energy is calories per centimeter squared (Cal/cm^2)

California Contractors – All Contractors performing work in the state of California shall be licensed by the Contractors State License Board. (WWW.CSLB.CA.GOV)

California Electrical Code (CEC) - Interrupting Rating. Equipment intended to interrupt current at fault levels shall have an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment. Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

California Electrical Code (CEC) - Circuit Impedance and Other Characteristics. The overcurrent protective devices, the total impedance, the component short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit-protective devices used to clear a fault to do so without extensive damage to the electrical components of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors or between any circuit conductor and the grounding conductor or enclosing metal raceway. Listed products applied in accordance with their listing shall be considered to meet the requirements of this section.

California Electrical Code (CEC) - Flash Protection. Switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that is in other than dwelling occupancies and are likely to require examination, adjustment, servicing, or maintenance while energized shall be field marked to warn qualified persons of potential electric arc flash hazards. The marking shall be located in such a way to be clearly visible to qualified person before examination, adjustment, servicing, or maintenance of the equipment.

OSHA Standard for General Industry 1910.303(b) - Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees.

Qualified Electrical Person - A person who is trained, has the skills, and is knowledgeable of the construction and operation of equipment or a specific work method and is trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.

This person shall have and successfully demonstrate the skills and understand and apply the knowledge and techniques necessary to:

- Distinguish exposed energized parts from other parts of electrical equipment.
- Determine the nominal voltage of exposed live parts.
- Determine the shock hazard and arc flash hazard approach distances specified in the NFPA 70E Tables or from any arc flash study conducted.
- Perform the decision-making processes necessary to determine the degree and extent of the hazard.
- Determine the appropriate personal protective equipment.
- Determine the proper tools and equipment for safely carrying out the task.
- Perform the job planning necessary to perform the task safely.
- Be competent in the proper operation of the equipment.

A person can be considered qualified with respect to certain equipment and methods but still are unqualified for others.

Unqualified Electrical Persons – Someone that does not meet the qualifications above. Unqualified persons shall be trained in and be familiar with any of the electrical safety related practices that are necessary to help ensure their safety related to electrical hazards when potential exposure exists to electrical hazards.

Working Near Live (Energized) Parts – Any activity inside the Limited Approach Boundary. The limited approach boundary is the outermost shock protection boundary. Refer to NFPA 70E for additional information.

Working On Live (Energized) Parts – Coming in contact with live (electrically energized) parts with any body part, tools, test probes, test equipment, etc. regardless of PPE involved.

UC Santa Cruz Physical Planning and Construction (PP&C) - Acts as the local permitting agency. PPC requires plan reviews and building inspections be scheduled and coordinated with the UC Santa Cruz Building Official and UC Santa Cruz Project Manager. UC Santa Cruz Physical Planning and Construction is not under the jurisdiction the City of Santa Cruz.

12.0 Appendices

- **Appendix A (ESP)** – Electrical Safety Program Action Item Summary
- **Appendix B (CP)** – Outside Contractors and the Electrical Safety Program
- **Appendix C (EAESP)**-Employee Acknowledgement of Electrical Safety Program
- **Appendix D –** NFPA 70E 2009 Tables
- **Appendix E (SB) -** Safety Briefs (SB1-13)
- **Appendix F (JB1) -** Job Briefing Checklist for Electrical Work
- **Appendix G (EEW)** – EEW Check List
- **Appendix H (EEWP**1) – Energized Electrical Work Permit
- **Appendix I (PPE1) -** PPE Checklist
- **Appendix J (PPE2)** – PPE and Protective Clothing Characteristics HRC
- **Appendix K** – Breaker Reset Procedure for Electrical Safety Program

13.0 References

A. Specific References

- NFPA 70E Table 130.2(C) - Approach Boundaries to Live Parts for Shock Protection
- NFPA 70E Table 130.7(C)(8) - Standards on Protective Equipment
- NFPA 70E Table 130.7(C)(9) - Hazard/Risk Category Classifications
- NFPA 70E Table 130.7(C)(10) - Protective Clothing and Personal Protective Equipment (PPE).
- NFPA 70E Table 130.7 (C)(11)- Protective Clothing Characteristics

B. Referenced Publications

- NFPA National Fire Protection Agency (70B and 70E)
- CEC - California Electrical Code
- ANSI - American National Standards Institute
- ASTM - American Society for Testing and Materials
- IEEE - Institute of Electrical and Electronic Engineers
- IEC - International Electrical Commission
- OSHA CFR - Occupational Safety Health Administration Code of Federal Regulations
- CAL DOSH – California Division of Occupational Health and Safety

C. Resources

- http://www.osha.gov
- http://www.cdc.gov/niosh/homepage.html
- http://www.nfpa.org
- http://www.ieee.org
- http://www.fluke.com
- http://www.dir.ca.gov/samples/search/query.htm

OSHA - 29 CFR 1910 Subpart S 331 –335 and 399 Electrical

- http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10135

OSHA - 29 CFR 1910 Subpart R 269 Electric Power Generation, Transmission, and Distribution.

- http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9868

CAL DOSH - CCR Title 8 Division1 Chapter 4 SubChapter 5 Electrical safety Orders

- http://government.westlaw.com/linkedslice/default.asp?Action=TOC&RS=GVT1.0&VR=2.0&SP=CCR-1000

14.0 Facilities Safety Team

Name	Phone	Pager	Email

15.0 Summary of Electrical Safety Program Updates

Date	Sections	Summary of Change	Person Responsible	Implemented

End of Electrical Safety Program Document

UCSC Electrical Safety Program Review and Update Schedule APPENDIX A

Section	Section Topic(s) for Review	Review Target Dates	Responsibility	Update Completion Date(s)
	Section 1			
1.0	**Introduction**			
	1.1 UCSC Electrical Safety Program			
	1.2 Electrical Hazards			
	1.3 Electrical Safety			
	Section 2			
2.0	**Responsibilities**			
	Section 3			
3.0	**Training**			
	3.1 Safety Training for Electrical Work			
	3.2 Safety Brief/Toolbox Topic			
	3.3 Competency			
	Section 4			
4.0	**Outside Personnel/Contractor Requirements**			
	Section 5			
5.0	**Requirements for Electrical Work**			
	5.1 Energized Electrical Work			
	5.2 Facility Electrical Hazard/Risk Review			
	5.3 General Electrical Safety Requirements			
	5.4 Job Hazard Analysis, Work Permits and Job Briefing			
	Requirements for Electrical Work			
	5.5 Job Hazard/Risk Evaluation & Briefing Procedures			
	5.6 Safe Work Condition-Lockout/Tagout			
	5.7 Energized Electrical Work Requirements (EEW)			
	5.8 Supplemental Requirements for Selected Tasks			
	Section 6			
6.0	**Personal Protective Equipment (PPE) and Tools**			
	Section 7			
7.0	**Electrical Maintenance Practices to Minimize Risks**			

Section	Section Topic(s) for Review	Review Target Dates	Responsibility	Update Completion Date(s)
	and Hazards			
	Section 8			
8.0	Electrical Design Practices to Minimize Risks and			
	Hazards			
	Section 9			
9.0	Incident Review and Electrical Safety Program Updates			
	Section 10			
10.0	Other UCSC Safety Policies			
	Section 11			
11.0	Definitions			
	Section 12			
12.0	Appendices			
	Section 13			
13.0	References			
	Section 14			
14.0	UCSC Facilities Safety Team			
	Section 15			
15.0	Summary of Electrical Safety Program Updates			

APPENDIX B

UCSC Electrical Safety Program
Outside Contractors and the Electrical Safety Program

UCSC Electrical Safety Program and Outside Contractors

UCSC recognizes that a successful accident prevention program and safety program are essential to the well-being of UCSC employees.

UCSC requires that all outside personnel, that work with or in/around the area of exposed electrical distribution equipment shall have developed and implemented an electrical safety plan/program that complies with the requirements of local, state and federal rules and nationally recognized standards including OSHA, CA-DOSH and NFPA-70E (or equivalent).

While the UCSC Electrical Safety Program contains requirements for employees to follow, it is not to be used as the primary safety plan/program for outside contractors.

UCSC employees are not responsible for determining the suitability of the contractor's safety plan/program, however if it is observed that the contractor personnel fail to meet UCSC requirements for electrical safety, the UCSC employee shall notify the University Representative (Project Manager), Physical Plant Supervisor and EH&S and where deemed necessary recommend stopping the work until corrected.

APPENDIX C

Employee Acknowledgement of UCSC Electrical Safety Program

Each UCSC Employee and contracted worker will study the UCSC Electrical Safety Program, receive relevant Electrical Safety Training and acknowledge the following items:

1. Electrical hazards may include dangerous conditions such as electric shock, arc flash burn (including possible shrapnel injury from molten metal and other associated injuries), arc blast injury (including internal organ and other bodily injuries from blast pressure waves) and hazards from catastrophic equipment failure that can result from contact with equipment or equipment failure.

2. The Electrical Safety Program was developed to minimize hazardous electrical exposures to UCSC personnel and ensure compliance with regulatory requirements applicable to electrical systems. It is the UCSC Electrical Safety Program requirement and priority to work equipment de-energized wherever possible.

3. The Electrical Safety Program outlines requirements for working on or near live parts operating at 50 volts or more or where an electrical hazard may exist before work is started, based on OSHA, CA-DOSH and NFPA 70E requirements. UCSC's Electrical Safety Program is the basis of the minimum performance expectations for all UCSC employees involved with Energized Electrical Work. This Electrical Safety Program covers electrical safety related work requirements for employees who work on or near exposed energized electrical conductors and circuit parts in the workplace rated 600 volts and below and is congruent with OSHA, CA-DOSH and NFPA 70E requirements.

4. It is the UCSC Electrical Safety Program requirement to provide safety-related work practices, personal protective equipment and safety-related training for their employees, who shall then implement them. Safety-related work practices, personal protective equipment and worker skill and knowledge gathered from training shall be used to help protect employees who might be exposed to electrical hazards.

5. UCSC recognizes that safety is achieved through an ongoing process of UCSC employees and management, working together daily to help reduce hazards and improve worker safety. This includes the evaluation of the hazards and risks, proper training, development and revision of work practices and procedures, and use of the proper Personal Protective Equipment necessary to safely perform electrical work within these facilities. UCSC employees will update, enhance and supplement the requirements, practices and procedures outlined in the electrical safety plan to continue to strive for a workplace that is incident free.

6. It is the responsibility of UCSC Employees to implement the safety-related work practices and training and to work with management and supervisory personnel to help evaluate the hazards, risks, work procedures, training and Personal Protective Equipment necessary to safely perform electrical work within these facilities and to update, enhance and supplement the requirements, practices and procedures outlined in the Electrical Safety Program as necessary to provide for a safe workplace.

APPENDIX C

Employee Acknowledgement of UCSC Electrical Safety Program

7. All electrical incidents and "near misses" shall be documented, reported to supervisory personnel and investigated as per UCSC policies and procedures. A fact-finding meeting shall be scheduled within 24 hours of an incident (including a "near miss"). All persons involved in the incident shall be present in the Incident Review Meeting.

8. Where necessary to improve worker safety and reduce the risk and exposure to hazards, the safety plan, policies, procedures, practices, protective equipment, etc. shall be reviewed and updated as deemed necessary by the safety committee. Workers shall receive training as necessary for any updates.

9. Following the requirements outlined in the Electrical Safety Program will help limit, but not prevent possible exposure to hazards and / or worker injury. While this safety plan is comprehensive, following all of the elements in this plan does not guarantee worker safety. It is the employee's responsibility to evaluate potential/existing risks and hazards, the potential exposure to these hazards and to develop a work plan specific to the job task and the job hazard/risk analysis.

10. It is the employee's responsibility to review this safety plan, to ask any questions, address any concerns and to commit to be responsible for a safe work place. The applicable UCSC employee will study and become intimately familiar with the elements of this safety plan and any applicable OSHA, CA-DOSH and NFPA 70E requirements. UCSC employees shall demonstrate knowledge of the plan and the practices outlined in the plan and will acknowledge responsibilities and knowledge of the Electrical Safety Program by signing this document.

11. Should the employee not be prepared to sign this document, employee shall document issues or concerns that they feel would prevent them from signing this acknowledgement, which shall be then reviewed with their supervisor and/or safety committee.

Acknowledgment and Acceptance of UCSC Electrical Safety Program and Requirements, including Items above.	
Employee Signature:	Date:
Printed Name of Employee:	Phone:
Employee ID:	Email:
Print Name of Supervisor:	Supervisor Signature:
Documentation of any Employee Concerns:	
Reviewed by:	

(9) Selection of Personal Protective Equipment When Required for Various Tasks. Where selected in lieu of the incident energy analysis of 130.3(B)(1), Table 130.7(C)(9) shall be used to determine the hazard/risk category and requirements for use of rubber insulating gloves and insulated and insulating hand tools for a task. The assumed maximum short-circuit current capacities and maximum fault clearing times for various tasks are listed in the notes to Table 130.7(C)(9). For tasks not listed, or for power systems with greater than the assumed maximum short-circuit current capacity or with longer than the assumed maximum fault clearing times, an arc flash hazard analysis shall be required in accordance with 130.3.

FPN No. 1: The work tasks and protective equipment identified in Table 130.7(C)(9) were identified by a task group and the protective clothing and equipment selected was based on the collective experience of the task group. The protective clothing and equipment is generally based on determination of estimated exposure levels.

In several cases where the risk of an arc flash incident is considered low, very low, or extremely low by the task group, the hazard/risk category number has been reduced by 1, 2, or 3 numbers, respectively. The collective experience of the task group is that in most cases closed doors do not provide enough protection to eliminate the need for PPE for instances where the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out). The premise used by the Task Group is considered to be reasonable, based on the consensus judgment of the full NFPA 70E Technical Committee.

FPN No. 2: Both larger and smaller available short-circuit currents could result in higher available arc flash energies. If the available short-circuit current increases without a decrease in the opening time of the overcurrent protective device, the arc flash energy will increase. If the available short-circuit current decreases, resulting in a longer opening time for the overcurrent protective device, arc flash energies could also increase.

FPN No. 3: Energized electrical conductors or circuit parts that operate at less than 50 volts may need to be de-energized to satisfy an "electrically safe work condition." Consideration should be given to the capacity of the source, any overcurrent protection between the energy source and the worker, and whether the work task related to the source operating at less than 50 volts increases exposure to electrical burns or to explosion from an electric arc.

FPN No. 4: See 130.1(B)(2)(6) for requirements on documenting the available short-circuit current and fault clearing time.

Table 130.7(C)(9) Hazard/Risk Category Classifications and Use of Rubber Insulating Gloves and Insulated and Insulating Hand Tools

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Panelboards or Other Equipment Rated 240 V and Below — Note 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	0	N	N
Circuit breaker (CB) or fused switch operation with covers on	0	N	N
CB or fused switch operation with covers off	0	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	1	Y	Y
Remove/install CBs or fused switches	1	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	0	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard	1	Y	Y
Panelboards or Switchboards Rated >240 V and up to 600 V (with molded case or insulated case circuit breakers) — Note 1			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch operation with covers on	0	N	N

Table 130.7(C)(9) ***Continued***

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
CB or fused switch operation with covers off	1	Y	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panelboard or switchboard	2*	Y	Y
600 V Class Motor Control Centers (MCCs) — Note 2 (except as indicated)			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	1	N	N
CB or fused switch or starter operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch or starter operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2*	Y	Y
Insertion or removal of individual starter "buckets" from MCC — Note 3	4	Y	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts) — Note 3	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts) — Note 3	1	N	N
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the motor control center	2*	Y	Y
600 V Class Switchgear (with power circuit breakers or fused switches) — Note 4			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	2	N	N
CB or fused switch operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB or fused switch operation with enclosure doors open	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	2*	Y	Y

(continues)

Table 130.7(C)(9) ***Continued***

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	2*	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	2	N	N
Other 600 V Class (277 V through 600 V, nominal) Equipment — Note 2 (except as indicated)			
Lighting or small power transformers (600 V, maximum)			
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	2*	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Revenue meters (kW-hour, at primary voltage and current) Insertion or removal	2*	Y	N
Cable trough or tray cover removal or installation	1	N	N
Miscellaneous equipment cover removal or installation	1	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	2*	Y	Y
Application of safety grounds, after voltage test	2*	Y	N
Insertion or removal of plug-in devices into or from busways	2*	Y	N
NEMA E2 (fused contactor) Motor Starters, 2.3 kV Through 7.2 kV			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
Contactor operation with enclosure doors closed	0	N	N
Reading a panel meter while operating a meter switch	0	N	N
Contactor operation with enclosure doors open	2*	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	0	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	3	Y	Y
Insertion or removal (racking) of starters from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	3	Y	N

Table 130.7(C)(9) ***Continued***

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Metal Clad Switchgear, 1 kV Through 38 kV			
Perform infrared thermography and other non-contact inspections outside the restricted approach boundary	3	N	N
CB operation with enclosure doors closed	2	N	N
Reading a panel meter while operating a meter switch	0	N	N
CB operation with enclosure doors open	4	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Work on control circuits with energized electrical conductors and circuit parts >120 V, exposed	4	Y	Y
Insertion or removal (racking) of CBs from cubicles, doors open or closed	4	N	N
Application of safety grounds, after voltage test	4	Y	N
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Opening voltage transformer or control power transformer compartments	4	N	N
Arc-Resistant Switchgear Type 1 or 2 (for clearing times of <0.5 sec with a perspective fault current not to exceed the arc resistant rating of the equipment)			
CB operation with enclosure door closed	0	N	N
Insertion or removal (racking) of CBs from cubicles, doors closed	0	N	N
Insertion or removal of CBs from cubicles with door open	4	N	N
Work on control circuits with energized electrical conductors and circuit parts 120 V or below, exposed	2	Y	Y
Insertion or removal (racking) of ground and test device with door closed	0	N	N
Insertion or removal (racking) of voltage transformers on or off the bus door closed	0	N	N

(continues)

Table 130.7(C)(9) ***Continued***

Tasks Performed on Energized Equipment	Hazard/Risk Category	Rubber Insulating Gloves	Insulated and Insulating Hand Tools
Other Equipment 1 kV Through 38 kV			
Metal-enclosed interrupter switchgear, fused or unfused			
Switch operation of arc-resistant-type construction, tested in accordance with IEEE C37.20.7, doors closed only	0	N	N
Switch operation, doors closed	2	N	N
Work on energized electrical conductors and circuit parts, including voltage testing	4	Y	Y
Removal of bolted covers (to expose bare, energized electrical conductors and circuit parts)	4	N	N
Opening hinged covers (to expose bare, energized electrical conductors and circuit parts)	3	N	N
Outdoor disconnect switch operation (hookstick operated)	3	Y	Y
Outdoor disconnect switch operation (gang-operated, from grade)	2	Y	N
Insulated cable examination, in manhole or other confined space	4	Y	N
Insulated cable examination, in open area	2	Y	N

General Notes (applicable to the entire table):
(a) Rubber insulating gloves are gloves rated for the maximum line-to-line voltage upon which work will be done.
(b) Insulated and insulating hand tools are tools rated and tested for the maximum line-to-line voltage upon which work will be done, and are manufactured and tested in accordance with ASTM F 1505, *Standard Specification for Insulated and Insulating Hand Tools*.
(c) Y = yes (required), N = no (not required).
(d) For systems rated less than 1000 volts, the fault currents and upstream protective device clearing times are based on an 18 in. working distance.
(e) For systems rated 1 kV and greater, the Hazard/Risk Categories are based on a 36 in. working distance.
(f) For equipment protected by upstream current limiting fuses with arcing fault current in their current limiting range (½ cycle fault clearing time or less), the hazard/risk category required may be reduced by one number.
Specific Notes (as referenced in the table):
1. Maximum of 25 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.
2. Maximum of 65 kA short circuit current available; maximum of 0.03 sec (2 cycle) fault clearing time.
3. Maximum of 42 kA short circuit current available; maximum of 0.33 sec (20 cycle) fault clearing time.
4. Maximum of 35 kA short circuit current available; maximum of up to 0.5 sec (30 cycle) fault clearing time.

(10) Protective Clothing and Personal Protective Equipment Matrix. Once the Hazard/Risk Category has been identified from Table 130.7(C)(9) (including associated notes) and the requirements of 130.7(C)(9), Table 130.7(C)(10) shall be used to determine the required PPE for the task. Table 130.7(C)(10) lists the requirements for protective clothing and other protective equipment based on Hazard/Risk Category numbers 0 through 4. This clothing and equipment shall be used when working within the Arc Flash Protection Boundary.

FPN No. 1: See Annex H for a suggested simplified approach to ensure adequate PPE for electrical workers within facilities with large and diverse electrical systems.

FPN No. 2: The PPE requirements of this section are intended to protect a person from arc flash and shock hazards. While some situations could result in burns to the skin, even with the protection described in Table 130.7(C)(10), burn injury should be reduced and survivable. Due to the explosive effect of some arc events, physical trauma injuries could occur. The PPE requirements of this section do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

Table 130.7(C)(10) Protective Clothing and Personal Protective Equipment (PPE)

Hazard/Risk Category	Protective Clothing and PPE
Hazard/Risk Category 0	
Protective Clothing, Nonmelting (according to ASTM F 1506-00) or Untreated Natural Fiber	Shirt (long sleeve) Pants (long)
FR Protective Equipment	Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (AN) (Note 2)
Hazard/Risk Category 1	
FR Clothing, Minimum Arc Rating of 4 (Note 1)	Arc-rated long-sleeve shirt (Note 3) Arc-rated pants (Note 3) Arc-rated coverall (Note 4) Arc-rated face shield or arc flash suit hood (Note 7) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes (AN)
Hazard/Risk Category 2	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated face shield or arc flash suit hood (Note 7) Arc rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 2*	
FR Clothing, Minimum Arc Rating of 8 (Note 1)	Arc-rated long-sleeve shirt (Note 5) Arc-rated pants (Note 5) Arc-rated coverall (Note 6) Arc-rated arc flash suit hood (Note 10) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Leather gloves (Note 2) Leather work shoes
Hazard/Risk Category 3	
FR Clothing, Minimum Arc Rating of 25 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 8) Arc-rated pants (AR) (Note 8) Arc-rated coverall (AR) (Note 8) Arc-rated arc flash suit jacket (AR) (Note 8) Arc-rated arc flash suit pants (AR) (Note 8) Arc-rated arc flash suit hood (Note 8) Arc-rated jacket, parka, or rainwear (AN)

(continues)

Table 130.7(C)(10) ***Continued***

Hazard/Risk Category	Protective Clothing and PPE
FR Protective Equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes
Hazard/Risk Category 4	
FR Clothing, Minimum Arc Rating of 40 (Note 1)	Arc-rated long-sleeve shirt (AR) (Note 9) Arc-rated pants (AR) (Note 9) Arc-rated coverall (AR) (Note 9) Arc-rated arc flash suit jacket (AR) (Note 9) Arc-rated arc flash suit pants (AR) (Note 9) Arc-rated arc flash suit hood (Note 9) Arc-rated jacket, parka, or rainwear (AN)
FR Protective Equipment	Hard hat FR hard hat liner (AR) Safety glasses or safety goggles (SR) Hearing protection (ear canal inserts) Arc-rated gloves (Note 2) Leather work shoes

AN = As needed (optional)
AR = As required
SR = Selection required
Notes:
1. See Table 130.7(C)(11). Arc rating for a garment or system of garments is expressed in cal/cm^2.
2. If rubber insulating gloves with leather protectors are required by Table 130.7(C)(9), additional leather or arc-rated gloves are not required. The combination of rubber insulating gloves with leather protectors satisfies the arc flash protection requirement.
3. The FR shirt and pants used for Hazard/ Risk Category 1 shall have a minimum arc rating of 4.
4. Alternate is to use FR coveralls (minimum arc rating of 4) instead of FR shirt and FR pants.
5. FR shirt and FR pants used for Hazard/ Risk Category 2 shall have a minimum arc rating of 8.
6. Alternate is to use FR coveralls (minimum arc rating of 8) instead of FR shirt and FR pants.
7. A face shield with a minimum arc rating of 4 for Hazard/Risk Category 1 or a minimum arc rating of 8 for Hazard/Risk Category 2, with wrap-around guarding to protect not only the face, but also the forehead, ears, and neck (or, alternatively, an arc-rated arc flash suit hood), is required.
8. An alternate is to use a total FR clothing system and hood, which shall have a minimum arc rating of 25 for Hazard/Risk Category 3.
9. The total clothing system consisting of FR shirt and pants and/or FR coveralls and/or arc flash coat and pants and hood shall have a minimum arc rating of 40 for Hazard/Risk Category 4.
10. Alternate is to use a face shield with a minimum arc rating of 8 and a balaclava (sock hood) with a minimum arc rating of 8 and which covers the face, head and neck except for the eye and nose areas.

(11) Protective Clothing Characteristics. Table 130.7(C)(11) lists examples of protective clothing systems and typical characteristics, including the degree of protection, for various clothing. The protective clothing selected for the corresponding Hazard/Risk Category number determined from Table 130.7(C)(9) (including associated notes) and the requirements of 130.7(C)(9) shall have an arc rating of at least the value listed in the last column of Table 130.7(C)(11).

FPN: The arc rating for a particular clothing system can be obtained from the FR clothing manufacturer.

Table 130.7(C)(11) Protective Clothing Characteristics

Hazard/Risk Category	Clothing Description	Required Minimum Arc Rating of PPE [J/cm^2(cal/cm^2)]
0	Nonmelting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd^2	N/A
1	Arc-rated FR shirt and FR pants or FR coverall	16.74 (4)
2	Arc-rated FR shirt and FR pants or FR coverall	33.47 (8)
3	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	104.6 (25)
4	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	167.36 (40)

Note: Arc rating is defined in Article 100 and can be either ATPV or E_{BT}. ATPV is defined in ASTM F 1959, ***Standard Test Method for Determining the Arc Thermal Performance Value of Materials for Clothing***, as the incident energy on a material or a multilayer system of materials that results in a 50% 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, cal/cm^2. E_{BT} is defined in ASTM F 1959 as the incident energy on a material or material system that results in a 50% probability of breakopen. Arc rating is reported as either ATPV or E_{BT}, whichever is the lower value.

(12) Factors in Selection of Protective Clothing. Clothing and equipment that provide worker protection from shock and arc flash hazards shall be utilized. Clothing and equipment required for the degree of exposure shall be permitted to be worn alone or integrated with flammable, nonmelting apparel. If FR clothing is required, it shall cover associated parts of the body as well as all flammable apparel while allowing movement and visibility. All personal protective equipment shall be maintained in a sanitary and functionally effective condition. Personal protective equipment items will normally be used in conjunction with one another as a system to provide the appropriate level of protection.

FPN: Protective clothing includes shirts, pants, coveralls, jackets, and parkas worn routinely by workers who, under normal working conditions, are exposed to momentary electric arc and related thermal hazards. Flame-resistant rainwear worn in inclement weather is included in this category of clothing.

(a) Layering. Nonmelting, flammable fiber garments shall be permitted to be used as underlayers in conjunction with FR garments in a layered system for added protection. If nonmelting, flammable fiber garments are used as underlayers, the system arc rating shall be sufficient to prevent breakopen of the innermost FR layer at the expected arc exposure incident energy level to prevent ignition of flammable underlayers.

FPN: A typical layering system might include cotton underwear, a cotton shirt and trouser, and a FR coverall. Specific tasks might call for additional FR layers to achieve the required protection level.

(b) Outer Layers. Garments worn as outer layers over FR clothing, such as jackets or rainwear, shall also be made from FR material.

(c) Underlayers. Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers (underwear) next to the skin.

Exception: An incidental amount of elastic used on nonmelting fabric underwear or socks shall be permitted.

FPN No. 1: FR garments (e.g., shirts, trousers, and coveralls) worn as underlayers that neither ignite nor melt and drip in the course of an exposure to electric arc and related thermal hazards generally provide a higher system arc rating than nonmelting, flammable fiber underlayers.

FPN No. 2: FR underwear or undergarments used as underlayers generally provide a higher system arc rating than nonmelting, flammable fiber underwear or undergarments used as underlayers.

(d) Coverage. Clothing shall cover potentially exposed areas as completely as possible. Shirt sleeves shall be fastened at the wrists, and shirts and jackets shall be closed at the neck.

(e) Fit. Tight-fitting clothing shall be avoided. Loose-fitting clothing provides additional thermal insulation because of air spaces. FR apparel shall fit properly such that it does not interfere with the work task.

SB1 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Electrical Safety Program and OSHA, CA-DOSH & NFPA 70E

- The UCSC Electrical Safety Program:
  - Was developed to minimize hazardous electrical exposures to UCSC personnel and ensure compliance with regulatory requirements applicable to electrical systems. It is the UCSC policy to work equipment de-energized wherever possible.
  - Outlines the procedures for working on or near live parts operating at 50 volts or more or where an electrical hazard may exist before work is started, based on OSHA, CA-DOSH, ANSI, ASTM and NFPA 70E. This program is the basis of the minimum performance expectations for all UCSC employees involved with Energized Electrical Work.
  - Covers electrical safety related work practices and procedures for employees who work on or near exposed energized electrical conductors and circuit parts in the workplace rated 600 volts and below.
  - Contains minimum requirements for UCSC contractors to follow. It is not to be used as a safety program for contractors. Contractors are responsible for providing and implementing their own safety program that meet or exceed the minimum requirements of OSHA, CA-DOSH, NFPA-70E and the UCSC electrical safety program.

- It is the responsibility of UCSC Employees to implement the safety-related work practices and training and to work with management and supervisory personnel to help evaluate the hazards, risks, work procedures, training and Personal Protective Equipment necessary to safely perform electrical work within these facilities and to update, enhance and supplement the requirements, practices and procedures outlined in the electrical safety program as necessary to provide for a safe workplace.

- While this safety program is comprehensive, following all of the elements in this program does not guarantee worker safety. It is the employee's responsibility to evaluate potential/existing risks and hazards, the potential exposure to these hazards and to develop a work plan specific to the job task and the job hazard/risk analysis.

- It is the employee's responsibility to review this safety program, to ask any questions, address any concerns and to commit to be responsible for a safe work place. The

applicable UCSC employee will study and become intimately familiar with the element of this safety program and any applicable OSHA and NFPA 70E requirements. UCSC Employees shall demonstrate knowledge of the program and the practices outlined in the program and will sign form acknowledging responsibilities and knowledge of the program.

- All electrical incidents and "near misses" shall be documented, reported to supervisory personnel and investigated as per UCSC policies and procedures. Where necessary to improve worker safety and reduce the risk and exposure to hazards, the safety program, policies, procedures, practices, protective equipment, etc. shall be reviewed and updated as deemed necessary by the safety committee. Workers shall receive training as necessary for any updates.

- Workers should review, become familiar with and follow industry regulations, mandates, standards and recommended practices including OSHA, CA-DOSH, ANSI, ASTM and NFPA-70E Standard for Electrical Safety in the Workplace. Note to leader: review key NFPA 70E sections and tables, OSHA and CA-DOSH website.

QUESTIONS

1. Electrical work covered under the UCSC Electrical Safety Program shall be performed de-energized unless proper justification is provided, authorization is received and proper plans and procedures are developed and implemented.
   True _____ False _____

2. Following the requirements of the Electrical Safety Program will guarantee my safety.
   True _____ False _____

3. It is the employee's responsibility to evaluate potential/existing risks and hazards, the potential exposure to these hazards and to develop a work plan specific to the job task and the job hazard/risk analysis.
   True _____ False _____

4. The Electrical Safety Program covers work on or near live systems 600V and below.
   True _____ False _____

5. All near misses and incidents need to be documented and reported to supervisory immediately.
   True _____ False _____

SB2 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Electrical Safety

The Occupational Safety and Health Administration (OSHA) and the National Fire Protection Agency (NFPA) has established electrical safety standards and work practices that will help reduce electrically induced injuries.

These standards include wiring design, writing methods and work practice requirements. They apply to "qualified" as well as un-qualified" workers.

PROTECTIVE MEASURES

Personal Protective Equipment should be used whenever a worker may come in contact with or go near electricity. The equipment requirements are as follows:

1. All parts of the body should be covered by personal protective equipment (PPE) appropriate to the work performed. This includes non-conductive head hat, safety glasses, goggles, face shields, hearing protection, rubber insulated gloves, leather protectors, heavy duty leather work shoes, and Flame-Resistant (FR) clothing. Rubber Insulated gloves and leather protectors should be worn when using equipment such as jackhammers, or other hand tools that may contact energized lines.

2. Insulated tools shall be rated for the voltages on which they are used and be designed and constructed for the environment to which they are exposed and the manner in which they are used. Insulated tools shall be protected from damage to the insulating material. When working with energized fuses, the fuse holder handling equipment shall be insulated for the circuit voltage. Ropes and hand lines used near exposed live parts, or where an electrical hazards exists, shall be non-conductive. Portable ladders shall have non-conductive side rails if they are used where the employee could contact exposed live parts.

3. FR apparel shall be inspected before each use. Protective items that become contaminated with grease, oil, or flammable liquids or combustible materials shall not be used. Conductive articles of jewelry and clothing shall not be worn when performing energized electrical work.

4. Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock and burns. When normally enclosed live parts are exposed for maintenance or repair, they shall be guarded to protect un-qualified persons from contact with the live parts.

5. Maintain clearance distances for shock and flash protection boundaries. In certain instances, the Flash Protection Boundary might be a greater distance from the exposed live parts than the approach boundary to live parts for shock protection. Consult your Job Hazard Analysis (JHA) for these distances.

ALERTING TECHNIQUES

Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing live parts. If signs and barricades do not provide sufficient warning and protection from electrical hazards, and attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant to keep unqualified employees outside a work area where the employee might be exposed to electrical hazards.

Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards that might endanger them.

QUESTIONS

1. A non-conductive hard hat may be worn when performing energized electrical work.
   True _____ False _____

2. If a qualified person is performing energized electrical work, guarding may be accomplished by using barriers and shields.
   True _____ False _____

3. Ropes or hand lines may be conductive.
   True _____ False _____

4. Leather protectors should always be worn over rubber insulated gloves when performing energized electrical work.
   True _____ False _____

5. The Flash Protection Boundary is always a greater distance than the Shock Protection Boundary.
   True _____ False _____

SB3 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Electricity and the Body

Never assume that electricians are the only workers exposed to electrical hazards. As an employee in the electrical industry you can be faced with a job that requires you to work near live electrical parts of equipment. Employees shall be trained in and familiar with the safety-related work practices that pertain to their respective job assignment. Other employees who also may reasonably be expected to face a comparable risk of injury due to electric shock or other electrical hazards must also be trained. Only qualified persons may work on electric circuit parts or equipment that have not been de-energized. Qualified persons shall be familiar with special precautionary techniques, personal protective equipment (PPE), insulating and shielding materials, and insulated tools.

ELECTRICITY

Electricity is the flow of electrons through a conductor. This flow is called current, which is measured in amps.

The material through which the electricity flows opposes the flow. This opposition to current flow is call resistance, which is measure in ohms. Resistance is determined by the type of material, its thickness and length. A copper conductor offers little resistance, therefore it is a good conductor. Some materials like air, porcelain and dry wood offer great resistance, which are called insulators.

All three factors, voltage current and resistance are related. A large voltage may cause a great current, but a matching resistance will reduce the current or prevent it. When selecting protective devices or equipment, the resistance of the material must be appropriate for the voltage used or worked on.

THE BODY AS A CONDUCTOR

The human body may become a conductor or part of the electrical path when:

- Contacting wires of an electric circuit;
- Contacting one wire of an energized circuit and the ground;
- A metallic part becomes energized while the person is in contact with that part and the ground.

SB3 - SAFETY BRIEF/TOOL BOX TOPIC

ELECTRICAL SHOCK AND INJURY

The body's resistance to electricity varies. If a person's electrical resistance is low, a large current may flow through their body even at a low voltage. For example, moisture lowers resistance. If their skin is wet or a cut exposes body tissue, even 12 volts will push enough current through to cause an uncomfortable shock. At 120 volts, enough current will pass through the body to cause death. Extreme caution must be used with working in or near wet areas. Workers should not be misled by low voltage. Low voltage does not mean low hazard. The amount of current through a person's body can cause injury or death.

Three factors determine the injury:

1. The amount of current traveling through the body.
2. The path the electricity takes through the body.
3. The length of time the body is part of the current.

Electric shock affects muscle reaction. If a shock victim is unable to quickly force themselves from a circuit, the increased exposure will increase the injury. Muscle and even bone damage can result. If the heart muscle or nerves controlling the heart are affected, heart fibrillation or cardiac arrest may occur. Fall, collisions and other accident may also result.

QUESTIONS

1. Three factors that determine the degree of electrical shock injury are the amount of current traveling through the body, the path and the length of time.
   True _____ False _____

2. A copper conductor is a good insulator.
   True _____ False _____

3. A person may become a conductor or part of the electrical path when contacting one wire of an energized circuit and the ground.
   True _____ False _____

4. Low voltage does not mean low hazard.
   True _____ False _____

5. If the heart muscle or nerves controlling the heart are affected, heart fibrillation or cardiac arrest may occur.
   True _____ False _____

SB4 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Working On Or Near Live Parts

Deciding to work on or near live parts should be a last resort, after all other opportunities for establishing an electrically safe work condition (LOTO) have been exhausted.

Justification for live work – Live parts shall be locked out/tagged out before an employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operation limitations.

Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.

Examples of increased or additional hazards:

- Interruption of life support equipment.
- Deactivation of emergency alarm systems.
- Shutdown of hazardous location ventilation equipment.

Examples of infeasibility due to equipment design or operational limitation:

- Diagnostics and testing/troubleshooting.
- Circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

Energized parts that operate at less than 50 volts to ground shall not be required to be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs. The decision to de-energized should include consideration of the capacity of the source and any overcurrent protection between the energy source and the worker.

SB4 - SAFETY BRIEF/TOOL BOX TOPIC

Examples of working on or near live parts:

- Taking meter measurements.
- Opening and closing disconnects and breakers.
- Removing panels & dead fronts.
- Opening equipment doors for inspection.
- System cleaning.
- Infrared testing.
- Installing safety grounds.
- Verifying a physical break in the power conductors.
- Replacing an electronic ballast.
- Replacing a circuit breaker in a live panel.
- Tightening connections.

Every job will be planned and properly documented. Considerations include:

- Hazards need to be identified and minimized.
- Worker training and qualifications need to be evaluated.
- The risks need to be assessed.
- Proper PPE needs to be utilized for the potential hazards involved.
- The proper tools will be utilized for the job.

QUESTIONS

1. Energized parts that operate at less than 50volts to ground shall not be required to be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.
   True _____ False _____

2. Replacing a circuit breaker in a energized panel would be an example of working on or near live parts.
   True _____ False _____

3. The term “inconvenient” is an example of infeasibility due to equipment design or operational limitation.
   True _____ False _____

4. Deactivation of emergency alarm systems would be an example of “increased or additional hazard”.
   True _____ False _____

5. A non-qualified person may work on or near live parts.
   True _____ False _____

SB5 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Arc Flash/Blast

The safe installation, maintenance, and operation of electrical equipment is essential for a safe workplace. As a worker, you have a vested interest in working safely around electricity.

The shock hazard has historically been the most understood and addressed hazard of electricity. However, studies on the causes of electrical injuries in the workplace today show that more than half of serious electrical injuries involve burns from arc flash and arc blasts.

ARC FAULTS
Arc fault currents travel through the air, which differs from the bolted fault current that flows through conductors, bus bars, or other equipment optimally designed to withstand its effects. These arcs may be caused by worker error, equipment malfunction, lack of maintenance, improper equipment and contamination of the circuit housings.

ARC FLASH/BLAST
Arc burns are the result of high temperatures in close proximity to the body produced by arc flash or by explosions (arc blasts). Arc flash injuries are mostly in the form of burns, but can also include:

- Physical injuries from a fall
- Shrapnel injuries,
- Hearing loss
- Damage to eyesight
- Lung damage
- Broken bones
- Nerve damage
- Internal organ damage

The principal factors that determine the severity of arc burns are:

- The fault current
- The distance from the arc
- The duration of the arc

SB5 - SAFETY BRIEF/TOOL BOX TOPIC

Anytime a short circuit is initiated, an uncontrolled arc can develop. An arc flash occurs when an electric current passes through air between ungrounded conductors or between ungrounded conductors and grounded conductors. A relatively small arc that develops by a worker's tool shorting between an energized component and a grounded surface can grow into an arc that consumes the entire work area by superheating the air and following the now-conductive paths to other conductive system components. This arc will continue to burn until either a protective device (circuit breaker/current limiting fuse) opens or the conductors supplying the circuit burn in the clear.

ARC BLAST

This occurs from high-amperage current arcing through air. An arc blast is initiated by contact between two energized points. This contact can be caused by persons who have an accident while working on energized components, or by equipment failure. Temperatures as high as 35,000 F have been recorded in arc-blast research.

QUESTIONS

1. The principal factors that determine the severity of arc burns are the fault current, the distance from the arc and the duration of the arc.
   True _____ False _____

2. Anytime a short circuit is initiated, an uncontrolled arc will develop.
   True _____ False _____

3. Arc flash injuries may include hearing loss, damage to eyesight and physical injuries from a fall.
   True _____ False _____

4. Electrical injuries in the workplace today show that more than half of serious electrical injuries involve burns from arc flash and arc blasts.
   True _____ False _____

5. The installation of a current limiting fuse will not help in the event of an arc flash.
   True _____ False _____

SB6 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Flash Hazard Analysis

A flash hazard analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Flash Protection Boundary and the personal protective equipment that people with the Flash Protection Boundary shall use. Only qualified persons are allowed inside the Flash Protection Boundary.

Barricades (red danger tape) shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing live parts. Conductive barricades shall not be used where it might cause an electrical hazard. Barricades shall be placed no closer than the limited approach boundary.

The EEW Assistant System shall be used when performing energized electrical work on $\geq$ 208 volts.

FLASH PROTECTION BOUNDARY

The flash protection boundary is an approach limit at a distance from exposed live parts within which a person could receive a second degree burn if an electrical arc flash were to occur.

For systems that are 600 volts or less, the Flash Protection Boundary shall be 4' based on the product of clearing times of 2 cycles and the available bolted fault current of 50kVA or any combination not exceeding 100kA cycles.

The formula for calculating the Flash Protection Boundary is:
Dt = [2.65 x MVAbf x t] 1/3

Where arc flash hazard calculations have been performed, these values will be used for determining arc flash hazard energy categories and energy levels. Since arc flash hazard values can be significantly impacted by short circuit current, duration of arcing fault and worker distance from the arc point to the workers chest (location used to calculate arc flash hazard energy), it is imperative that the worker understand the arc flash hazard calculations and how they were derived, utilize the appropriate work practices for the project and the proper PPE.

SB6 - SAFETY BRIEF/TOOL BOX TOPIC

Note: When selected in lieu of the flash hazard analysis, the NFPA 70E Table 130.7(C)(9) shall be used to determine the hazard/risk category for a task.

QUALIFIED PERSON

- A person who is trained and knowledgeable of the construction and operation of equipment or a specific work method and is trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.
- Such persons shall also be familiar with the proper use of special precautionary techniques, personal protective equipment, including arc-flash, insulating and shielding materials, and insulated tools and test equipment. A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others.
- The skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.
- The skills and techniques necessary to determine the nominal voltage of exposed live parts.
- The decision-making process necessary to determine the degree and extent of the hazard and the personal protective equipment and job planning necessary to perform the task safely.

QUESTIONS

1. Arc fault currents travel through the air, which differs from the bolted fault current that flows through conductors or bus bars.
   True _____ False _____

2. Employees can wear polyester or nylon clothing under FR clothing.
   True _____ False _____

3. A Flash Hazard Analysis shall be done in order to protect personnel from the possibility of being injured by an arc flash.
   True _____ False _____

4. PPE is the last line of defense – not a replacement - for safe work practices or engineering controls when performing energized electrical work.
   True _____ False _____

5. A non-qualified person may work in the Flash Protection Boundary.
   True _____ False _____

SB7 - SAFETY MEETING/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Protective Clothing Characteristics

Experienced electrical personnel are being severely burned and killed due to arc flash and blast hazards due to accidents, improper work practices, and improper PPE.

If an arc flash hazard is present, or likely to be present, then the employer must select and require employees to the employees to use the protective apparel. Personal protective equipment (PPE) must be worn when working on energized electrical systems. PPE is a last line of defense – not a replacement – for safe work practices or engineering controls that can reduce a worker's exposure to arc flash hazards.

Employers are required to supply, and employees are required to wear, PPE that is selected on the basis of the hazards associated with the overall job. The PPE to be used must be inspected before each use to ensure the integrity of the equipment and that it has been maintained in usable condition.

Maintenance electricians at UCSC are provided with daily wear flame resistant clothing. It is mandatory to wear FR protective clothing for all live electrical work, including troubleshooting and testing for work on any branch circuit or feeder with an upstream protective device (fuse or circuit breaker) > 30 amps.

FR suits (coats, pants and hoods) are provided and must be worn by electricians who are exposed to any electrical hazard beyond the level of protection provided by the daily wear flame resistant clothing & equipment. Garments that may melt (i.e. nylon, polyester, etc.) may not be worn by electricians who are exposed to any electrical hazard.

Typical PPE:

- **Hard Hat (head protection) –** Type E or G ANSI approved hard hats shall be used for head protection.
- **Safety Glasses (eye protection) -** Safety glass shall be worn at all times. Eye protection (safety glasses) shall also always be worn under face shields or hoods.
- **Arc Rated Face Shields & Socks Hoods (eye, face, neck and chin protection) -** Arc Rated Face Shields shall be used for all tasks which present a danger of injury due to arc flash or flying debris from an electrical explosion. The type of face protection will be selected according to the arc flash potential incident energy rating and shall be of the wrap around design to help prevent damage to neck, chin and face areas. A balaclava (face sock) shall be worn under the face shield at all times.

SB7 - SAFETY MEETING/TOOL BOX TOPIC

- **Double Layer Hoods with Face shields** (rated in Calories per cm^2) **–** Double Layer Switching Hoods with properly rated face shields are required for incident energy levels greater than Hazard/Risk Category 2 (8 Cal/Cm^2) or for 2* locations listed in NFPA 70E Table 130.7(C)(9).
- **Rubber Insulated Gloves (hand and partial arm protection) -** Employees shall wear rubber insulated gloves appropriately rated for the highest phase to phase voltage that the worker will be exposed to where there is danger of hand and arm injury from electric shock due to contact with live parts. Where insulating rubber gloves are used for shock protection, leather protectors shall be worn over the rubber gloves.

  Rubber insulated gloves ratings (voltage rating phase to phase):

  - Class 00 - 500 volts
  - Class 0 - 1,000 volts
  - Class 1 - 7,500 volts
  - Class 2 - 17,000 volts
  - Class 3 - 26,500 volts
  - Class 4 - 36,000 volts

  Tests of Rubber Gloves and Sleeves - Rubber gloves and sleeves shall be electrically tested at least once every 3 months after they are checked out for use, and complete records shall be kept of all such tests and date of issue. Rubber gloves and sleeves not checked out for use within 6 months shall be retested before being issued.

- **Hearing Protection** – Hearing protection shall always be worn when using a multi-layer flash hood or when exposure to Hazard/Risk Category 2 or greater exists.
- **Daily Wear** – daily wear typically consists of a shirt and pants combination or Coveralls typically rated 4 Cal/Cm^2 (Category 1), 8 Cal/Cm^2 (Category 2) or in a rating up to 15 Cal/Cm^2. The selection of Shirt and Pants vs. Coveralls is a personal preference and may be based on frequency of exposure to electrical hazards.
- **Arc Flash Suit** – An Arc Flash Suit (Coats and Pants or Coveralls) is usually rated between 15 to 65 Cal/Cm^2 and are typically used for NFPA 70E-2009 Hazard Risk Categories 2* to 4. FR coats, pants and hoods are provided by Safeday and must be worn by electricians who are exposed to any electrical hazard beyond the level of protection provided by the daily wear flame resistant PPE.
- **Leather and/or Insulated work boots** – Foot protection of heavy-duty leather work shoes shall be worn in all tasks in Hazard/Risk Category 2 and higher. Toe guards and structural components shall be constructed of Structurally Engineered Moldable Composite (SEMC) Certified materials.

SB7 - SAFETY MEETING/TOOL BOX TOPIC

QUESTIONS

1. A Type C hard hat shall be worn when performing energized electrical work.
   True _____ False _____

2. Class 00 rubber insulated gloves are rated for 500 volts.
   True _____ False _____

4. Employees can wear polyester or nylon clothing under FR clothing.
   True _____ False _____

5. It is mandatory to wear this protective clothing for all live electrical work, including troubleshooting and testing.
   True _____ False _____

SB8 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Shock Hazard Analysis

A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the PPE necessary in order to minimize the possibility of electric shock.

SHOCK PROTECTION BOUNDARIES:

The shock protection boundaries are applicable to the situation in which approaching personnel are exposed to live parts. A shock hazard is a dangerous condition associated with the possible release of energy caused by contact or approach to live parts.

Shock Hazard Analysis - shall determine the voltages to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electrical shock to personnel. The shock hazard boundaries as indicated in NFPA 70E Table 130.2(C) include:

- **Limited Approach Boundary** – An approach limit at a distance from an exposed live part within which a shock hazard exists.
  Defines a boundary around exposed live parts that may not be crossed by unqualified persons unless accompanied by qualified persons.

- **Restricted Approach Boundary** – An approach limit at a distance from an exposed live part within which there is an increased risk of shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the live part.
  Defines a boundary near exposed live parts that may be crossed only by qualified persons using appropriate shock prevention techniques and equipment.

- **Prohibited Approach Boundary** – An approach limit at a distance from an exposed live part within which work is considered the same as making live contact with the live part.
- Defines a boundary to be crossed by only qualified persons using same protection as if direct contact with live part is planned.

SB8 - SAFETY BRIEF/TOOL BOX TOPIC

Shock Hazard Boundaries					
	Limited Approach Boundary[1,5]				
Nominal System Phase to Phase Voltage Range	Exposed Movable Conductor[2]	Exposed Fixed Circuit Part	Restricted Approach Boundary[3, 4, 5]	Prohibited Approach Boundary[4, 5]	
Less than 50	Not Specified	Not Specified	Not Specified	Not Specified	
50 to 300	10 ft	3 ft 6 in	Avoid Contact	Avoid Contact	
301 to 750	10 ft	3 ft 6 in	1 ft	1 in	
751 to 15 kV	10 ft	5 ft	2 ft 2 in	7 in	
Above 15 kV	N/A for UCSC Personnel				

Barricades (red danger tape) shall be used in conjunction with safety sign where it is necessary to prevent or limit employee access to work areas containing live parts. Barricades shall be placed no closer than the limited approach boundary. The EEW Assistant System shall be used when performing energized electrical work on $\geq$ 208 volts.

QUESTIONS

1. A shock hazard is a dangerous condition associated with the possible release of energy caused by contact or approach to live parts.
   True _____ False _____

2. The limited approach boundary for a 120/240 volts panel would be 3’6”.
   True _____ False _____

3. Barricades and safety signs do not have to be used limit employees to work areas containing live parts.
   True _____ False _____

4. A shock hazard analysis shall determine the voltage to which personnel will be exposed, boundary requirements, and the PPE necessary in order to minimize the possibility of electric shock.
   True _____ False _____

5. Unqualified persons may cross the prohibited approach boundary.
   True _____ False _____

SB-9 SAFETY MEETING/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Energized Electrical Work Permit

If live parts are not placed in an electrically safe work condition (LOTO), work to be performed shall be considered energized electrical work and shall be performed by written permit only.

Arc flash incidents involving workers who are not properly protected results in workers being admitted to burn centers each year. The best protection from the arc flash hazard is to establish and electrically safe work condition (Lockout/Tagout). If LO/TO is not feasible, the alternative is to conduct a shock hazard analysis, flash hazard analysis, job hazard analysis, job briefing and obtain an Energized Electrical Work Permit.

Use of the Energized Electrical Work Permit is required prior to breaking (making repair to) an energized circuit or removing or installing (that is replacing) any parts in an energized electrical system over 50Volts. All electrically qualified persons who will be working inside the limited/restricted/prohibited approach boundary must sign the EEW permit.

Work performed on or near live parts by qualified persons related to tasks such as testing, troubleshooting, voltage or amperage measuring, shall be allowed to be performed without an energized electrical work permit, provided appropriate safe work practices and personal protective equipment are provided and used.

JUSTIFICATION FOR ENERGIZED ELECTRICAL WORK

- De-energizing introduces additional or increased hazards
- Infeasible due to equipment design or operational limitations.

Examples of increased or additional hazards include:

- Interruption of life support equipment
- Deactivation of emergency alarm systems
- Shutdown of hazardous location ventilation equipment.

Example of operational limitation:

- Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.

SB-9 SAFETY MEETING/TOOL BOX TOPIC

EEW BUDDY

An EEW Assistant System must be used when performing EEW work on ≥ 208 volts. The EEW Buddy:

- Reviews scope of work with the Qualified Person performing the work
- Determines best emergency procedures prior to beginning work.
- Keeps non-qualified personnel out of the Flash Protection Boundary.

QUESTIONS

1. Testing, troubleshooting, voltage or amperage measuring does not require an EEW Permit.
   True _____ False _____

2. Live switchgear inspection (Infrared) requires an EEW Permit.
   True _____ False _____

3. Work on circuits that form an integral part of a continuous process that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment require an EEW Permit.
   True _____ False _____

4. All electrically qualified persons who will be working inside the limited/restricted/prohibited approach boundary must sign the EEW permit.
   True _____ False _____

5. An EEW Assistant System must be used when performing EEW work on 120 volts.
   True _____ False _____

SB10 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Lockout/Tagout

OSHA and the NFPA 70E require electrical equipment and systems operating at 50 volts or greater to be de-energized to provide employees primary protection from exposure to energized electrical hazards unless certain conditions exist. All equipment shall be locked and tagged out to protect against accidental release of any type of hazardous energy that could cause injury to personnel.

ACHIEVING AN ELECTRICALLY SAFE WORK CONDITION

All electrical circuit conductors and parts shall not be considered to be in an electrically safe work condition until all sources of energy are removed, the disconnecting means is under lockout/tagout, the absence of voltage is verified by an approved voltage testing device, and where exposure to energized facilities exists, are temporarily grounded.

SEQUENCE OF LOCOUT/TAGOUT PROCEDURE

1. Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams and identification tags. Check for possible back up power supplies, tiebreakers and back feeds.
2. Notify all affected employees that a lockout/tagout procedure is required and the reason for its use.
3. After properly interrupting the load current, open the disconnecting devices for each source.
4. Wherever possible, visually verify that all blades of the disconnecting devise are fully open or that drawout type circuit breakers are withdrawn to the fully disconnected position.
5. Lockout/tagout all energy isolating devices with an assigned individual lock according to this policy.
6. Use an adequately rated voltage detector to teach each conductor or circuit part to verify they are de-energized. Test each phase conductor or circuit part both phase-to-ground and then phase-to-phase. Before and after each test, determine that the voltage detector is operating satisfactorily.
7. Where the possibility of induced voltages or stored electrical energy exists, ground the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.

SB10 - SAFETY BRIEF/TOOL BOX TOPIC

RESTORING THE EQUIPMENT TO SERVICE

1. When the task is complete and before electric circuits or equipment is reenergized, appropriate tests and visual inspections shall be conducted to verify all tools, mechanical restraints and electrical jumpers, shorts and grounds have been removed and accounted for, so that the circuits and equipment are in a condition to be safely energized.

2. After circuits and equipment have been checked, lockout/tagout devices shall be removed only by the authorized employees who applied them.

QUESTIONS

1. All electrical circuit conductors and parts are not considered to be in an electrically safe work condition until all sources of energy are removed and the absence of voltage is verified by an approved voltage testing device.
   True _____ False _____

2. A safe work practice would be to test each phase conductor phase-to-phase and then phase-to-ground.
   True _____ False _____

3. Where the possibility of induced voltages or stored electrical energy exists, a safe work practice would be to ground the phase conductors or circuit parts before touching them.
   True _____ False _____

4. Temporary grounds are never required if the circuit is locked and tagged out.
   True _____ False _____

5. When the task is complete and before electric circuits are re-energized, shorts and ground have to be removed and accounted for.
   True _____ False _____

SB11 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Job Briefing

Before starting each job, the employee in charge shall conduct a job briefing with the workers involved. The briefing shall include, but not be limited to the following subjects:

- Electrical hazards & risks associated with the work task.
- Procedures that must be followed when executing the work task.
- Any special precautions that are required by the working conditions.
- When and how to remove the source of energy.
- Required PPE.
- Contractors involved with the project, their role and coordination.
- Emergency response and emergency communications.
- Other work in the immediate physical area.
- Other work associated with the same electrical circuits or equipment.
- Tool and equipment requirements.
- Barriers & signage.
- EEW Assistant if >208 volts.

Repetitive or Similar Tasks.
If the work or operations to be performed during the work day or shift are repetitive and similar, at least one job briefing shall be conducted before the start of the first job of the day or shift. Additional job briefings shall be held if significant changes that might affect the safety of employees occur during the course of the work.

Job Briefing and Planning Checklist

Identify:
- The hazards
- The voltage levels involved
- Skills required
- Any “foreign” voltage source
- Number of people needed to do the job

SB11 - SAFETY BRIEF/TOOL BOX TOPIC

Ask:

- Can the equipment be de-energized?
- Are back feeds of the circuits to be worked on possible?
- EEW Assistant System to be used?

Check:

- Job plans
- Single line diagrams
- Individuals are familiar with the facility

Know:

- What the job is
- Who else “needs to know”
- Who is in charge

Think:

- About the unexpected event.
- Lock-tag-try
- Use the right tools and equipment, including PPE
- Install and remove ground(s)
- Install barriers and barricades

Prepare for an emergency:

- The EEW Buddy is CPR/AED trained.
- Know how to call for emergency help.
- Fire control methodology.
- Methods of release of victims.

QUESTIONS

1. Before starting each job, the employee in charge shall conduct a job briefing with the employees involved.
   True _____ False _____

2. Additional job briefings shall be held if significant changes that might affect the safety of employees occur during the course of the work.
   True _____ False _____

3. A brief discussion shall be satisfactory if the work involved is routine, even if the employee might not recognize a few hazards involved in the job.
   True _____ False _____

4. Considerations for a job briefing and planning checklist might include the following: Identify-Ask-Check-Know-Think-Preparing for an emergency.
   True _____ False _____

5. If the work or operations to be performed during the work day or shift are repetitive and similar, at least one job briefing shall be conducted before the start of the first job of the day or shift.
   True _____ False _____

SB12 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Batteries and Battery Rooms

- Enter all battery room with caution. Batteries are to be in properly ventilated rooms or enclosures to ensure the diffusion of gases from the batteries and to prevent accumulation of an explosive mixture. If you detect a strange or unusual odor, do not enter.
- When acid batteries are being charged, hydrogen gas may be released. Hydrogen is very explosive. Never have an open flame or cause a spark in the vicinity of a battery room or batteries.
- The battery manufacturer shall be consulted regarding the sizing of the battery short-circuit protection. **Exception**: If information regarding the short-circuit protection of a battery is not available from the manufacturer, the prospective fault level at the battery terminals shall be considered to be twenty times the nominal battery capacity at the 3-hour rate.
- There should be facilities for flushing and neutralizing spilled electrolyte.
- In the event of fire involving acidic materials, evacuate the area immediately.
- Any cable, busbar, or busway forming the connection between the battery terminal and the dc switching equipment shall be rated to withstand the prospective short-circuit current.
- Alarms shall be provided for early warning of abnormal conditions of battery operation. The alarm system shall provide an audible alarm and visual indication at the battery location, and where applicable, at a remote manned control point.
- Ventilation shall be provided so as to prevent liberated hydrogen gas from exceeding 1% concentration.
- Ventilation shall be provided to maintain design temperature to prevent thermal runaway that can cause cell meltdown leading to a fire or explosion.
- The battery room and enclosure doors shall open outward and shall be equipped with quick-release, quick opening hardware.
- Battery room lighting shall be installed to provide a minimum level of illumination of 30ft. candles. Emergency illumination shall be provided for safe egress from the battery room.

SB12 - SAFETY BRIEF/TOOL BOX TOPIC

PERSONAL PROTECTIVE EQUIPMENT (PPE)

The following PPE shall be available to employees performing battery maintenance:

1. Goggles and face shield.
2. Chemical-resistant gloves.
3. Protective aprons.
4. Protective overshoes.

TOOLS AND EQUIPMENT

Tools and equipment for work on batteries shall comply with the following:

1. Be of the non-sparking type.
2. Be equipped with handles listed as insulated for the maximum working voltage.

EYE AND BODY WASH APPARATUS.

Eye and body wash apparatus shall be maintained in operable condition. Before starting any work involving batteries, look around. Portable or stationary water facilities for rinsing eyes and skin in case of electrolyte spillage

BATTERY MANUFACTURER

The battery manufacturer shall be consulted regarding the sizing of the battery short-circuit protection. If information regarding the short-circuit protection of a battery is not available from the manufacturer, the prospective fault level at the battery terminals shall be considered to be twenty times the nominal battery capacity at the 3-hour rate. The battery room shall be accessible only to authorized personnel and shall be locked when unoccupied.

QUESTIONS

1. Goggle, face shield, chemical-resistant glove, protective aprons and overshoes should be worn when working in a battery room.
   True _____ False _____

2. There should be facilities for flushing and neutralizing spilled electrolyte.
   True _____ False _____

3. If you detect a strange or unusual odor, it is safe to enter the battery room.
   True _____ False _____

4. Eye and body wash apparatus shall be maintained in operable condition.
   True _____ False _____

5. In the event of fire involving acidic materials, evacuate the area immediately.
   True _____ False _____

SB13 - SAFETY BRIEF/TOOL BOX TOPIC

This form shall be completed and kept on file

Job Name _____Location_____

Meeting Leader _____Title _____

Date Held _____ Place _____ Time_____

Subject of Meeting: Portable Powered Tools

Portable and stationary cord and plug equipment must be suitable for the application and workers shall understand equipment operation and be able to safely operate the equipment. The following requirements apply**:**

Portable electric equipment - Shall be handled in a manner that will not cause damage. Portable electric equipment shall be visually inspected before use and shall be removed from service if there is evidence of defects or physical damage that might expose an employee to injury.

Electric Hand Tool Repair - All repairs to electric hand tools (such as replacement of a cord on a drill motor) must meet UL and CEC requirements and be accomplished by qualified electrical personnel.

Highly Conductive Work Locations - Portable electric equipment used in highly conductive work locations (such as areas saturated with water or other conductive liquids), shall be approved for those locations. Portable and stationary grounded cord and plug attached equipment other than hand tools shall have its ground continuity tested annually (example, arc welders, personal heaters, fans, pipe threading machines, bearing heaters, sump pumps, etc.)

Ground Fault Circuit Interrupter's (GFCI's) for cords and portable cord and plug devices – GFCI's shall be used with extension cords and portable cord and plug devices.

Flexible electric cords - shall not be used for raising or lowering the equipment. Flexible cords shall not be fastened with staples or hung in such a way that might damage the outer jacket or insulation.

Grounding type equipment - A flexible cord used with grounding-type equipment shall contain an equipment-grounding conductor. Plugs and receptacles may not be altered to defeat the equipment grounding conductor and adapters shall not be used to defeat the grounding conductor.

SB13 - SAFETY BRIEF/TOOL BOX TOPIC

Maintenance Requirement for Portable Electric Tools and Equipment –equipment, attachment plugs, receptacles, cover plates, and cord connectors shall be maintained such that the following apply:

A. There are no breaks, damage, or cracks exposing live parts.
B. There are no missing cover plates.
C. Terminations have no stray strands or loose terminals.
D. There are no missing, loose, altered, or damaged blades, pins, or contacts.
E. Polarity is correct.

QUESTIONS

1. GFCI's shall be used with extension cords and portable cord and plug devices.
   True _____ False _____

2. Anyone may make repairs to electric hand tools (such as replacement of a cord on a drill motor).
   True _____ False _____

3. Portable and stationary grounded cord and plug attached equipment other than hand tools shall have its ground continuity tested annually.
   True _____ False _____

4. It is a safe work practice to plus a power tool into a receptacle that is missing a cover plate.
   True _____ False _____

5. Portable electric equipment used in highly conductive work locations (such as areas saturated with water or other conductive liquids), shall be approved for those locations.
   True _____ False _____

JB1 – Job Briefing Checklist for Electrical Work APPENDIX F

Note: This document is to be used in conjunction with requirements of the electrical safety plan, including, but not limited to: Lockout/tagout requirements and equipment, PPE Plan, other safety plan requirements (i.e. confined space, fall protection, etc.). This is a checklist only to make sure that key points are discussed and/or considered prior to work occuring.

Simple Job Briefing
Project # & Description:
Voltage(s) involved _____120/240 ____120/208 ____277/480 ____Other:_____
Flash Hazards Categories _____0 ____1 ____2 ____3 ____4 or Incident Energy_____
Is lockout/tagout required for this task to be performed?
Have all lockout/tagout procedures been reviewed and understood?
Is the proposed worker "Qualified" for this project/task (NFPA 70E Definition – One who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved).
All "Qualified" personnel been briefed on the potential hazards, risks, work procedures, PPE and safety considerations for this project?
Will any Non-Qualified Personnel be involved with the project or be in the area that could potentially expose them to electrical hazards (shock, arc flash, etc.)?
Potential hazards, project requirements, safety requirements and boundaries have been discussed with non-Qualified personnel (that may be in the area of the hazards) and/or their supervisory personnel before the project is begun?
Has a job hazard analysis been performed?
Has a plan been developed & discussed to reduce/limit exposure and risk of flash and shock hazards?
Has the PPE checklist been completed and requirements reviewed with all parties involved?
Have workers removed all conductive articles, jewelry, etc?
Is the test equipment appropriate for the voltage and application and has it been inspected/tested?
GFCI's used for power cords?
Do you have the proper tools and equipment and has it been inspected and tested (if testing required)?
Do you have the proper lighting for the task?
Have the procedures been reviewed for lockout/tagout and equipment re-energization been discussed (see Lockout/Tagout Checklist)?
Do you have the proper Safety Equipment to be employed (see PPE & Tools Checklist)?
Emergency Contact Person & Phone in the facility has been identified?
Emergency Exit in the facility has been identified?
Fire Extinguishers in the facility have been identified?
Fire Alarm Pull Station location(s) have been identified?
Emergency Eyewash Station in the facility has been identified?
Do the project participants agree the above-described work can be done safely?

APPENDIX G

ENERGIZED ELECTRICAL WORK CHECKLIST

Energized Electrical Work Checklist	**Y**	**N**	**NA**
Pre-work:			
System voltages identified along with proper procedures, Tools, PPE, etc.			
System Flash Hazard identified along with proper procedures, PPE, etc.			
Unusual work conditions accounted for in the work plan?			
Equipment maintenance/operations manuals and instructions readily available?			
Is the location where the work is to be performed in good order (clean, no water dripping, adequate clearance, illumination, etc.)?			
Is everyone on the team qualified for the work/tasks?			
Is everyone on the team ready mentally and physically for the tasks (i.e. not ill, not distracted, etc.)?			
Radio, telephone, or cell phone is available for emergency communications.			
First Aid and CPR trained?			
Fire control methodology and equipment in place?			
Fire alarm pull station identified?			
Confirmed location of all sources of power if needed to de-energize power?			
Proper Lockout/tagout process identified?			
Method of release of victim identified?			
Job Hazard Briefing Checklist Completed?			
Job Briefing conducted with all parties affected by this work?			
Over-ride of safety system (if applicable) is directed by management only.			
Energized Electrical Work Permit completed and approved?			
Energized Electrical Work Buddy/Attendant ready?			
Plan for control of other non-electrical hazardous energies?			
Confined or Enclosed Space work plan and permits?			
Fall protection and other safety plans, permits and requirements addressed?			
Barricades in Place? Danger Tape?			
Safety Watch personnel ready?			
Illumination adequate to perform the tasks?			
PPE will be utilized for this project and the hazards involved have been discussed?			
All personal conductive items have been removed?			
Non-conductive harness ready?			
Non-conductive rope is ready?			
Portable ladder(s) with non-conductive side rails ready?			
Properly rated rubber mats or insulated mats ready?			
Test instruments and associated equipment have been verified that they are rated for voltages present and have been inspected and verified to be in proper working order?			
Proper portable power equipment is available and has been inspected?			
GFCI's will be tested and used with portable cord and plug devices?			
Approved insulated tools will be inspected and utilized?			
If an approved Tic-Tracer is used, it will be supplemented by an approved meter?			

APPENDIX G

ENERGIZED ELECTRICAL WORK CHECKLIST

Energized Electrical Work Checklist	**Y**	**N**	**NA**
Post Checklist (please check each of the following as they are completed):			
All work has been successfully completed?			
All affected personnel agree that their work is complete.			
Visual inspection and tests completed to verify that all tools, jumpers, waste materials, etc. are removed and that the system is safe.			
All hardware, screws, bolts, covers, etc. have been properly installed.			
Housekeeping has been completed in the work area.			
Barriers and signage removed.			
Tools and illumination are gathered up and returned to storage location.			
Proper personnel notified that EEW is completed.			
Problems/recommendations for process, equipment, PPE, workers, etc. noted on EEW Permit.			
EEW Permit and Documentation returned to permit approver.			

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EEWP1 - ENERGIZED ELECTRICAL WORK PERMIT

APPENDIX H

Note: This document is to be used in conjunction with requirements of the electrical safety plan, including, but not limited to: Job Briefing, PPE Plan, other safety plans and requirements (i.e. confined space, fall protection, overhead line plan, etc.).

PART I: TO BE COMPLETED BY THE REQUESTER:	
Job Work Order Number:_____	
1. Description of circuit/equipment/job location:	
2. Description of work to be done:	
3. Detailed justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage and the worker should be exposed to electrical hazards: (Ref NFPA 70E Article 130, 130.1 (A) (1) and (A) (2))	
___Would interrupt life safety or support equipment. Describe:	
___Would interrupt emergency systems or alarm systems. Describe:	
___Would result in the shutdown of ventilation equipment in hazardous location(s). Describe:	
___Shutdown is infeasible due to equipment design or operational limitations. Describe:	
___The circuit forms an integral part of a continuous process that would need to be completely shut down in order to work on the circuit. Could present hazards during shutdown. Describe:	
___Increased or additional Hazards will be presented if this circuit or system is shut down. Describe:	
REQUESTED BY:	SIGNATURE:
TITLE:	DATE:
EMAIL:	PHONE:

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EEWP1 - ENERGIZED ELECTRICAL WORK PERMIT

APPENDIX H

PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSON(S) DOING THE WORK:		
Hazards, Boundaries, PPE and Tool Requirements:		
Flash Hazard Energy Level/Category:	Limited Approach Boundary:	Shock hazard Voltage:
(Table 130.7 (C) (9))	(Table 130.2 (C))	
Flash Hazard Boundary:4ft or calc distance	Restricted Approach Boundary:	V-rated Gloves:
(Section 130.3 (A) (1))	(Table 130.2 (C))	(Table 130.7 (C) (9))
Work Distance:___inches (from flash study)	Prohibited Approach Boundary:	V-rated Tools:
	(Table 130.2 (C))	(Table 130.7 (C) (9))
Flash Hazard Category: # 0 1 2 3 4 (Table 130.7 (C) (9))	**Description of PPE Necessary (or attach PPE checklist):** (Table 130.7 (C) (10))	
Equipment / Tools (also see checklist):		
Work Information:		
1. Detailed job description procedure to be used in performing the above described work:		
2. Description of the Safe Work Practices to be employed:		
3. Work location and equipment:		
4. Means employed to restrict the access of unqualified persons from the work areas:		
5. Evidence of completion of Job Hazard Analysis, PPE Review and Job Briefing including discussion of any job-specific hazards (attach associated forms):		
6. Do you agree the above-described work can be done safely?____Yes ___No (If no, return to requester) Why (brief description of why it can or can't be completed safely)?		
INDIVIDUALS ASSIGNED TO THE WORK CREW:		
I certify that I am qualified to carry out the work described above, and that I understand and will follow the electrical safety program and all safety procedures necessary to complete the job safely.		
Qualified Person(s): *Print:* _____ *Signature:* _____ *Date:* _____ *Print:* _____ *Signature:* _____ *Date:* _____ *Print:* _____ *Signature:* _____ *Date:* _____		
Nearest Hospital: Dominican Hospital *Nearest Phone to work site:*_____ *Emergency Contact Procedure: Call 911 or Dispatch C1 on Radio* *Supervisor Contact Name: Mike Hanson* *Phone Number: 459-2581 Office (Cell 212-2581)*		
EEW Buddy/Partner/Co-worker: *Print :*_____ *Signature :* _____ *Date*_____		

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EEWP1 - ENERGIZED ELECTRICAL WORK PERMIT

APPENDIX H

PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:				
Approved?	**Personnel***	**Name**	**Signature (if approved)**	**Date**
Y or N	Manager			
Y or N	Supervisor			
Y or N	EH&S Manager			
Y or N	Electrically Qualified Person			
* Note: Personnel to be included in the sign off list to be determined by Facility Owner/Management and Contractor				
If denied, please indicate reason:				

PART IV: WORK COMPLETION SUMMARY AND TASK/PROCESS IMPROVEMENTS:
Work completed successfully without incident or accident? Y N – if No, breifly describe incident and complete the incident/accident review as described in Electrical Safety Program.
Suggested modifications/improvements for future work:

PPE1 – PPE & Tools Checklist for Electrical Work APPENDIX I

Note: This document is to be used in conjunction with requirements of the electrical safety plan, including, but not limited to: Job Briefing, Lockout/tagout requirements and equipment, EEW Permit and other safety plans / requirements (i.e. confined space, fall protection, overhead line plan, etc.).

PPE and Tools Checklist - Initial in proper box	**Picture**	**Y**	**N**	**NA**
Project # and Description**:**				
Applicable Personnel:				
Date:				
Is this PPE Checklist for a single task?				
Is this PPE Checklist for multiple repetitive projects where the same task will be performed?				
Voltage(s) involved: _____120/240 ____120/208 ____277/480 ____Other:_____				
Flash Hazard Incident Energy Level(s) Cal/cm^2_____				
PPE Incident Energy Rating_____ or Category 0 1 2 3 4 Required				
PPE/Clothing				
Type E or G Hard Hat				
ANSI Rated Safety Glasses/Prescription Glasses				
Face Shield				
Balaclava				
Hearing Protection				
Non-Melting Clothing and Undergarments				
FR Clothing: ____Shirt and Pants _____Coveralls				
FR Suit (Arc Flash Suit): _____Coats and Pants _____Coveralls				
Cooling Vest				
Double Layer Switching Hood				
Fresh Air System for Switching Hood				
FR Rated Raingear				
Tested Rubber Insulated Gloves **- Class Rating:** ___00 ___0 ___1 ___2				
Leather Protectors				
Safety work shoes (EH Rated)				
Tools and Equipment				
Fire Extinguisher				
Radio or Cell Phone				
Properly Rated and Inspected Meter and Test Probes				
Non-Conductive Rope				

PPE1 – PPE & Tools Checklist for Electrical Work APPENDIX I

PPE and Tools Checklist - Initial in proper box	**Picture**	**Y**	**N**	**NA**
Non-Conductive Harness				
GFCI Adapter				
Insulating Blankets/Mats				
Non-conductive Flashlight				
Portable Lighting				
Portable Hand Powered Tools (that have been inspected)				
Insulated Tools				
Portable Ladder With Non-Conductive Side Rails				
Safety Signs				
Red Danger Tape				
Barricades				
Lockout/Tagout Kit				
Eye Wash/Shower Station				
AED				
Signatures/Approvals (where required)				
Approval of Management/Supervisory Personnel (when required): *Print :*_____ *Signature :* _____ *Date*_____Title:_____ Phone:_____ Email:_____				
Qualified Person(s): *Print:* _____*Signature:* _____ *Date:* _____ *Print:* _____*Signature:* _____ *Date:* _____				
Non-Qualified Worker(s): *Print :*_____ *Signature :* _____ *Date*_____ *Print :*_____ *Signature :* _____ *Date*_____				

APPENDIX J

PROTECTIVE CLOTHING CHARACTERISTICS

HRC 0

- Non-melting or untreated natural fiber work clothing
- Hard Hat (Type E or G)
- Safety Glasses

HRC 1

- FR Clothing: Minimum 4 cal
- Hard Hat (Type E or G)
- Safety Glasses
- Leather Gloves and Shoes

HRC 2

- FR Clothing: Minimum 8 cal
- Suggest 12 cal for 2*
- Hard Hat (Type E or G)
- Balaclava & Face Shield or Flash Suit Hood
- Safety Glasses
- Hearing Protection
- Rubber Insulated Gloves & Leather Protectors
- Heavy-duty leather work shoes

HRC 3

- FR Clothing: Minimum 25 cal
- Flash Suit Hood
- Hard Hat (Type E or G)
- Safety Glasses
- Hearing Protection
- Rubber Insulated Gloves & Leather Protectors
- Heavy-duty leather work shoes

HRC 4

- FR Clothing: Minimum 40 cal
- Flash Suit Hood
- Hard Hat (Type E or G)
- Safety Glasses
- Hearing Protection
- Rubber Insulated Gloves & Leather Protectors
- Heavy-duty leather work shoes

APPENDIX K

Circuit Breaker Resetting Procedure

1. Determine the cause of the breaker trip by talking to local power users. If none are available, perform an inspection of the area to attempt to locate the cause. If no clear cause can be found or deduced from an initial inspection, you may attempt to reset the breaker ONCE and ONLY ONCE. Skip to step 3 to continue the procedure for resetting.

2. If the breaker failure resulted from an overload situation and there are no visual signs of a short, remove part or all of the load on that circuit before attempting to reset the breaker.

3. Don the following personal protective equipment: safety glasses, leather glove, flash resistant long sleeved shirt.

4. Ensure that all panel covers are in place and secure.

5. Use your less dominant hand to activate the switch. This will require you to stand on the right side of the panel if you are right-handed, and to the left side if you are left-handed. Turn your body away from the panel, and keep your face averted from the panel box as well.

6. Close your eyes and flip the breaker switch.

7. If it kicks off again immediately, this is an indication that a short exists and you must assume that a fault condition has occurred. You must find the cause of the fault condition and repair it before repeating the attempt to reset the breaker. Do NOT activate the breaker again until the cause of the fault condition has been repaired.

8. The breaker must be locked and tagged out of service before you attempt any repairs to the wiring it serves. When the repair is complete, remove the LOTO, notify affected users, and start again from step 3 to reset the breaker.