ORANGE COUNTY SANITATION DISTRICT	SOP-205 (Ver. 8) Electrical Safety
Standard Operating Procedure (SOP)	Effective: 1/25/2022 Supersedes: 11/02/2020
Approved By: James D. Herberg General Manager	

I. Purpose

The purpose of this procedure is to protect the Orange County Sanitation District (OC San) staff and contractors exposed to electrical hazards such as electric shock, electrocution, arc flash, arc blasts and fires during the operation, servicing and maintenance of electrical equipment and systems. This plan provides minimum safety requirements and assists in the elimination of accidents which may result from the operation, installation, removal, use and maintenance of electrical equipment and tools.

II. Background

It is the policy of the OC San to protect its employees from occupational injuries by implementing and enforcing safe work practices, including the appointment of qualified persons to manage this program.

OC San has developed this program in accordance with the state of California and Federal Occupational Safety and Health Administration (Cal/OSHA) *Electrical Safety Orders* and the NFPA 70E (National Fire Protection Agency 2018), *Standard for Electrical Safety in the Workplace,* and the California Fire Code (CFC).

III. Applicability

This procedure applies to all work performed at the OC San treatment plants, pump stations and the collection system.

This procedure covers electrical safety related work practices and procedures to protect workers who are exposed to electrical hazards.

This procedure does not address the design and installation of electrical systems and equipment.

This procedure does not apply to equipment that operates at less than 50 volts where it is determined that there will be no increased risk of exposure to electrical burns or explosions due to electric arcs.

IV. Definitions

Approach Boundary, Limited – an approach limit at a distance from an exposed live part within which a shock hazard exists.

Approach Boundary, Restricted – 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 near the live part.

Arc Flash – a release of energy caused by an electric arc. An arc flash hazard may exist when energized electrical conductors are exposed or interacted within a manner that could cause an electric ar. Under normal operating conditions, enclosed energized equipment that has been proper installed and maintained is not likely to pose an arc flash hazard.

Arc Flash Boundary – when an arc flash hazard exists, an approach limit from an arc source at which incident energy equals 1.2 calories per centimeter squared (cal/cm^2), where a person could receive a second degree burn on unprotected skin from one second of exposure.

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

Arc Flash Suit – a complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet. This includes pants, jacket, and a beekeeper type hood fitted with a face shield.

Arc Rating – the value attributed to materials that describes their performance to exposure to an electrical arc discharge. The arc rating is expressed in calories per square centimeter (cal/cm^2).

Authorized Person – a qualified person delegated to perform specific duties under existing conditions.

Balaclava (sock hood) – an arc-rated hood that protects the neck and head except for the facial area of the eyes and nose.

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

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

De-energized – free from any electrical connection to a source of potential difference and from electrical charge (voltage), and not having a potential difference from that of earth (grounded or equal to ground).

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

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

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

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

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

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.

High Voltage – a sustained voltage of more than 600 volts.

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

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

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

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

Normal Operating Condition – a normal operating condition exists when the equipment is properly installed, maintained, and used in accordance with manufacturer's instructions, as well as equipment doors are closed and secured, equipment covers are in place and secured, and there is no evidence of impending failure.

Overcurrent – any current more than the rated current of equipment or the ampacity of a conductor. It may result in an overload, short circuit, or ground fault.

Overload – operation of equipment more than normal, full-load rating, or of a conductor more than rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a circuit or ground fault is not an overload.

Qualified Person – a person, designated by the employer, who has demonstrated skills, experience and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to identify and avoid the hazards involved. Whether an employee is a qualified person will depend upon various circumstances in the workplace. An employee who is undergoing on the job training, and who during such training has demonstrated an ability to perform duties safely at his or her level of training, and who is

under the direct supervision of a qualified person is qualified for the performance of those duties.

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

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

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

Switchgear, Metal-Enclosed – a switchgear assembly completely enclosed on all sides and to with sheet metal, containing primary power circuit switching, interrupting devices, or both, with buses and connections. The assembly may include control and auxiliary devices. Access to the interior is provided by doors, removeable covers or both.

Working Near (live parts) – any activity inside a Limited Approach Boundary.

Working On (live parts) – any activity with contact with live parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment a person is wearing.

V. Responsibilities

A. Risk Management

- Responsible for the development of this program, which on an annual basis, shall be reviewed and updated, as necessary.
- Provide and coordinate initial training and refresher training.
- Provide technical assistance regarding electrical safety hazards.
- Work with the Division managers and supervisors to select appropriate PPE to be worn by employees based on identified hazards of specific electrical work.
- Ensure managers and supervisors are trained on the safety and health hazards to which employees under their direction or supervision may be exposed.
- Conduct periodic regulatory audits of electrical operations and equipment to ensure compliance with this procedure.
- Communicate procedure inclusion/changes in a timely manner to all staff.

B. Supervision

- Ensure that each employee participating in electrical work participates in appropriate electrical training, which should include NFPA-70E training. Only Qualified and Authorized Electricians shall perform electrical work. Employees shall be current in

equipment-specific training before requesting they perform a required task under this procedure.
- Ensure that employees conduct operations in compliance with this procedure.
- Ensure energized electrical work is approved by the Electrical Maintenance Supervisor.
- Verify a risk assessment has been completed prior to any work performed on or adjacent to exposed live electrical parts.
- Monitor and enforce employee compliance with electrical safety during job operations.
- Evaluate the work location periodically for any change in hazards that may require a modification to this procedure.
- Notify employees of new and existing hazards in the workplace and provide the appropriate electrically rated PPE and insulated tools for those hazards.
- Ensure that all equipment and PPE required by this procedure is available to employees always.
- Verify panel schedules, equipment labels, single-line diagrams (SLDs), and lockout/tagout procedures are provided for employee use.
- Ensure contractors do not use OC San-supplied, electrically rated PPE and insulated tools, and instead provide their own electrically rated PPE and insulated tools appropriate for the job.

C. Qualified Persons

A qualified person is one who has demonstrated skills and knowledge in the construction and operation of equipment or a specific work method and is trained to identify and avoid the electrical hazards that might be present with respect to that equipment or work method. Qualified persons shall also be familiar with proper use of special precautionary techniques, electrical policies and procedures, PPE, insulating and shielding materials, and insulated tools and test equipment. Employees can be considered qualified with respect to certain equipment and tasks but still unqualified for others. An employee who is undergoing on-the-job-training and who, during such training, has demonstrated an ability to perform duties safely at his or her level of training and who under the direct supervision of a qualified person is a qualified person for the performance of those duties.

Qualified persons are responsible for the following:

- Shall follow all safety rules, policies, procedures, and specific requirements regarding electrical safety.
- Shall inspect electrical protective equipment before use to ensure the equipment will provide the proper protection.
- Shall place equipment into an electrically safe working condition before releasing the equipment for servicing and maintenance.
- Shall inform supervision of tasks that cannot be performed safely.
- Shall request additional safety equipment and/or other equipment from supervision as needed to ensure ongoing compliance with this procedure.
- Shall verify required training is current prior to performing any task under this procedure.
- Shall wear required PPE and/or arc flash clothing per arc flash analysis.
- Maintain, inspect, and store equipment and PPE as specified by the manufacturer.
- Shall immediately report incidents, near misses, or hazards resulting from activities related to the control of hazardous energy.

- Shall only work on electrical equipment or systems in which they are deemed qualified.

D. Operations

Trained and authorized OC San Plant Operators are considered electrically qualified for safeguarding employees from exposure to electrical hazards using lockout/tagout in accordance with the Control of Hazardous Energy Control Program (SOP-605).

Plant Operators are not to operate any electrical equipment greater than 480-volts such as equipment breakers.

Below are operational standards when working with electrical equipment:

- Do not reset overload relays on a tripped motor starter more than one time on 480-volt or below motor control equipment.
- Operations cannot reset tripped breakers on any electrical equipment.

Plant Operations can operate MCC breakers 480-volts or below on the electrical MCC for lockout/tagout purposes utilizing the following methods:

- Opening and closing a circuit breaker utilizing a remote actuator, where the operator is safely positioned outside of the arc flash boundary, and the operator has received approved training on the use and care for the actuators.
- Staff who are properly trained and issued arc flash suits can open and close circuit breakers for the purpose of lockout/tagout where calculated incident energy is less than 8 calories per centimeter squared (cal/cm2) when utilizing personal protective equipment (PPE) as listed in Section XI.

E. Unqualified Persons

- Employees who work around electrical equipment and appliances.
- Must understand the hazards of electricity and shall be trained in and be familiar with, any electrical safety related practice necessary for their safety.
- Employees are required to follow all safety rules, policies, and procedures regarding electrical safety, and are required to follow OC San policy regarding the use of approved electronic devices and appliances, flexible cords, and use of power cords and strips.

F. Contractors

- Contractors performing electrical work must have established electrical safety procedures that comply with the Cal/OSHA, NFPA, and CFC requirements and meet or exceed the requirements of this program.
- Contractors must follow their electrical safety procedures when performing any work and should only perform electrical work that has been authorized.
- Contractors must follow all applicable regulations for the control of hazardous energy, as well as the OC San Control of Hazardous Energy Program (SOP-605), where applicable.
- Contractors shall ensure that its employees are instructed per NFPA-70E Article 110.2(A) and trained in the identification of electrical hazards, work practices and safety-related work rules required by OC San. Retraining shall be provided at intervals not to

exceed 3 years. Training shall be classroom, on-the-job, or a combination of both. Contractors shall provide proof of training for qualified persons.
- A license, diploma, or certificate does not necessarily make you a qualified person under requirements of NFPA 70E.
- Contractors shall advise OC San of any unique hazards presented by their work, including any measures to correct violations reported by OC San from reoccurrence.
- Contractors shall establish and implement an assured equipment grounding conductor program to cover all cord sets and receptacles which are not part of the permanent wiring of OC San building or structures and equipment connected by cord and plug.

VI. Electrical Safety Program Principles

The electrical safety program principles, include, but are not limited to, the following:

- Protect the employee from shock, burns, blast, and other hazards due to the working environment.
- De-energize equipment and place into an electrically safe working condition before working on it, if possible.
- Plan every job and document first-time procedures.
- Anticipate unexpected events.
- Identify and minimize the hazards.
- Inspect and evaluate the condition of all electrical equipment in accordance with OSHA Assured Equipment Grounding Protection Program.
- Maintain the electrical equipment's insulation and enclosure integrity.
- Use the right tools for the job.
- Assess employee's abilities and train for deficiencies.

VII. General Requirements for Electrical Safety-Related Work Practices

A. Electrical Safety Program Controls

The electrical safety program has the following basic controls or rules for safe electrical work:

- Exposed energized electrical conductors or circuit parts above 50 volts to ground are considered electrically hazardous and requires the proper PPE and procedures.
- Energizing and deenergizing an electrical conductor or circuit part is a potentially hazardous task.
- Perform a risk assessment to identify the hazards and develop plans to eliminate or control the hazards.
- Employees are trained to be qualified to work in an environment influenced by the presence of electrical energy.
- Identify and categorize tasks to be performed on or near exposed energized electrical conductors and circuit parts.
- Use a logical approach to determine potential hazards of each task.
- Identify and use precautions appropriate to the working environment.
- Unqualified persons shall not be permitted to enter work zones where there are exposed live parts.

B. Electrical Safety Program Procedures

OC San requires safety procedures to be developed and implemented by qualified employees. It is the qualified employee's responsibility to verify the suitability of these documents for changing conditions and specific requirements of the work. The qualified employee is required to review and modify each procedure prior to starting any work. The qualified employee is also responsible for notifying OC San supervision of any required corrections to the procedures for document revision.

1. Master Electrical Safety Procedures

Electrical safety procedures have been developed for the application of protective grounding, working on high voltage switchgear, low voltage switchgear, and low voltage motor control centers, and diagnostic testing of electrical equipment. These procedures are maintained by the electrical maintenance division. The procedures contain the following information:

- Purpose of task
- Qualification and number of employees to be involved
- Nature of hazard and extent of risk
- Limits of approach
- Safe work practices to be utilized
- Personal protective equipment involved
- Insulating materials and tools involved
- Special precautionary techniques
- Electrical diagrams
- Equipment details
- Sketches/pictures of unique features
- Reference data

2. Energy Control Procedures

Energy Control Procedures (ECPs) shall be utilized for the safe de-energization of machinery, equipment and/or OC San facilities. The OC San Control of Hazardous Energy (LOTO) Program (SOP-605) shall be followed. Many specific LOTO's already exist and are stored in OC San's Maximo system. When a LOTO does not exist for a specific situation, one shall be developed before any work begins.

3. Switching Procedures

Switching procedures have been developed for each 12kV switchgear at each of the plants. These procedures provide the systematic process to safety switch the switchgears from one mode to another. These procedures are available through the Electrical Maintenance Supervisor at each plant. The qualified person must verify the accuracy of the procedure before use.

C. Risk Assessments

Risk assessments must be completed for all work on or adjacent to electrical systems to identify electrical hazards, estimate the probability and severity of injury or damage to heath, and

determine if protective measures are required to eliminate or reduce the hazards. Depending on the electrical system, the below listed risk assessments shall be completed.

1. Hazard-Based Risk Assessment

Hazard-based risk assessments are completed during the design and purchasing phase of a project. In this risk assessment, workplace hazards are identified and characterized by materials, processes, the worksite, and the environment. Activities that are affected by the hazards are identified, where the risk of the hazard is reduced by substituting or engineering controls. This risk assessment can be formal or informal.

2. Task-Based Risk Assessment

Task-based risk assessments are completed by analyzing all hazards (i.e., electrical, chemical, etc.) associated with the task or job, where each step is broken down with hazards and controls assigned to each step. The task-based risk assessment is also referred to as the job safety analysis (JSA). JSAs must be completed prior to each task or job.

3. Shock Risk Assessment

Shock risk assessments must be completed to identify shock hazards, estimate the likelihood of occurrence of injury or damage to health, estimate the potential severity of injury or damage to health, and determine required protective measures to be implemented.

Protective measures shall be selected and implemented according to the hierarchy of controls. When protective measures are not feasible, PPE will be implemented and the following determined:

- Voltage to which personnel will be exposed
- Boundary requirements
- Personal and other protective equipment required to protect against shock hazard

Limited approach and restricted approach boundaries will be established where personnel are required to approach exposed energized electrical conductors or circuit parts.

Shock hazard identification has been completed for Plant 1 and 2 switchgear and motor control centers (MCCs) by the OC San Electrical Engineering group (Division 760). The shock hazard identification includes calculations for the limited approach boundary and restricted approach boundary. These values have been posted in areas designated by the Electrical Supervisor, at locations adjacent to the switchgear or MCC assessed.

OC San or contractor qualified persons are required to complete the shock risk assessment, specifically to determine the likelihood of injury or damage to health and assignment of protective measures to further reduce the risk of injury. The qualified person must identify shock hazards for electrical equipment or systems not previously assessed by Division 760. Where a risk assessment has not been completed, qualified persons shall refer to Article 130 of NFPA 70E, specifically Tables 130.4(D)(a) and 130.4(D)(b).

4. Arc Flash and Arc Blast Risk Assessment

Arc flash risk assessments shall be completed in accordance with 8 CCR 3203 *Injury and Illness Prevention Program* to identify arc flash hazards, estimate the likelihood and severity for injury or damage, to determine if additional protective measure or PPE are required.

In accordance with 8 CCR 2320.11 *Protection from Flames and Electric Arcs*, for each employee exposed to hazards from electric arcs, the employer shall make a reasonable estimate of the incident heat energy to which the employee would be exposed. The probability and severity for injury or damage are calculated by assessing the design of the electrical equipment, including any overcurrent protective devices and operating time, as well as operating condition and condition of maintenance.

Protective measures shall be selected and implemented according to the hierarchy of controls. When protective measures are not feasible, PPE will be implemented and the following determined:

- Appropriate safety-related work practices.
- The arc flash boundary.
- PPE to be used within the arch flash protection boundary

The arc flash protection boundary is the distance at which the incident energy equals 1.2 calories per centimeter squared (cal/cm^2). The arc flash protection boundary will only exist when the electrical hazard is exposed. In some cases, the arc flash protection boundary may be at a greater distance than the limited approach boundary.

Arc flash hazard identification has been completed for Plant 1 and 2 switchgear and motor control centers (MCCs) by the OC San Electrical Engineering group (Division 760). The arc flash hazard identification includes calculations for the arc flash incident energy and arc flash protection boundary. These values have been posted in areas designated by the Electrical Supervisor, at locations adjacent to the switchgear or MCC assessed.

OC San or contractor qualified persons are required to complete the arc flash risk assessment, specifically to determine the likelihood of injury or damage to health and assignment of protective measures to further reduce the risk of injury. The qualified person must identify arc flash hazards for electrical equipment or systems not previously assessed by Division 760. Where a risk assessment has not been completed, qualified persons shall refer to Article 130 of NFPA 70E, specifically Tables 130.5(C), 130.7(C)(15)(a), and 130.7(C)(15)(b).

5. Battery Risk Assessment

Prior to any work on a battery system, a risk assessment must be performed to identify chemical, electrical shock, and arc flash hazards. The risk assessment shall include the risks associated with the type of tasks to be performed on the battery system. Qualified persons must complete this assessment.

D. Energized Electrical Work Permit

Qualified employees shall complete the energized work permit under the following conditions:

- Work (i.e., tightening connections, removing, or replacing) performed on exposed and energized conductors and circuit parts within the restricted approach boundary.

- When the employee interacts with the equipment, but the conductors and circuit parts are not exposed, but an increased likelihood of injury from an exposure to an arc flash hazard exists.

The energized work permit process is administered and maintained by the electrical maintenance division. OC San staff are not permitted to perform work on electrical systems when the calculated incident energy is greater than 40 cal/cm^2. OC San staff may operate equipment to establish an electrically safe working condition where the incident energy is greater than 40 cal/cm^2.

The work permit must be approved by the Electrical Supervisor, and include the following items:

- Description of the circuit and equipment to be worked on.
- Description of work to be performed.
- Justification for why the work must be performed energized.
- Description of safe work practices to be employed.
- Results of the shock/arc flash risk assessment.
- Means to restrict access of unqualified persons.
- Energized work approval.

The energized work permits are not required for the following tasks where a qualified person is provided with and uses appropriate safe work practices and PPE:

- Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed.
- Testing, troubleshooting or voltage measuring.
- when accessing an area with energized electrical equipment if no electrical work is performed and employees do not cross the restricted approach boundary.
- general housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed.

E. Job Briefing

Any work involving exposure to live parts shall be preceded by a job briefing. The briefing shall include all affected persons performing and/or supporting the work. The briefing shall cover the following topics:

- Electrical and other hazards associated with the work task.
- Specific procedures that must be followed when executing the work task.
- Any special precautions that are required by the working conditions.
- Where and how to remove the source(s) of energy.
- Emergency response and emergency communications.
- Required PPE.
- Other work in the immediate physical area.
- Other work associated with the same electrical circuits or equipment.

The job briefing level of detail can be reduced for routine work where all the participants are aware of the hazards or if the task is relatively simple. If new staff or outside contractors are involved a complete briefing should be conducted.

VIII. Electrically Safe Work Conditions

Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition before an employee performs work within the limited approach boundary or the employee interacts with equipment where conductors or circuit parts are not exposed but an increased likelihood of being burnt from an exposure to an arc flash hazard exists.

Energized electrical work or exposure to open energized panels shall be prohibited without authorization and precautions in accordance with this program.

De-energizing electrical conductors and circuit parts to which an employee may be exposed will be performed by de-energizing and locking out the sources of electrical energy in accordance with the OC San Control of Hazardous Energy Program (SOP-605).

When the possibility of induced voltages or stored electrical energy exists, the phase conductors or circuit parts shall be grounded 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, temporary protective grounding equipment shall be installed and meet the following requirements:

- Be installed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard. The location, sizing and application of temporary grounding equipment shall be identifying during job planning.
- Shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.
- Shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

Documentation, including facility drawings, shall be reviewed to ensure that no electrical circuit interlock operation can result in reenergizing the circuit being worked on.

Locks and tags shall only be installed on circuit disconnecting means. Control devices such as pushbuttons or selector switches shall not be used as the primary isolating device.

Arc flash personal protective equipment and special safety training may be waived if the following is achieved:

- An electrically safe working condition is achieved,
- No electrical energy is in the immediate vicinity of the work task, and
- All danger of injury from an electrical hazard has been removed.

Unqualified employees may perform work on equipment after an electrically safe work condition has been established, however, they must understand technical aspects of the work task to not create an electrical hazard when the equipment is re-energized.

IX. Energized Work

Working on energized equipment is permitted only if performed by qualified persons, where approved by the Electrical Supervisor, and where it can be demonstrated that de-energizing equipment introduces additional hazards or increased risk.

Energized work is permitted where the task is infeasible in a de-energized state due to equipment design or operational limitations, for equipment operating at less than 50 volts, or under normal operating conditions.

Employees working with exposed electrical hazards shall implement safety-related work practices consistent with the electrical hazard and associated risk. The safety-related work practices shall be determined before any person is exposed to the energized equipment using shock and arc flash risk assessments. The shock risk assessment will determine the limited approach boundary and the restricted approach boundary. The arc flash risk assessment will determine the arc flash boundary, including the level of personal protective equipment to protect against arc flash hazards. OC San will perform these risk assessments for all electrical systems.

Energized work is not permitted when the calculated incident energy exceeds 40 cal/cm^2.

A. General Requirements

Where lack of illumination or an obstruction prevents observation of the work to be performed, employees are prohibited from blindly reaching into areas that might contain exposed energized electrical conductors or circuit parts.

Conductive articles of jewelry and clothing (watches, bracelets, rings, key chains, necklaces, metal framed glasses) shall not be worn within restricted approach boundaries or where they present an electrical contact hazard. Additionally, any conductive materials and equipment that are in contact with any part of an employee's body shall be handled in a manner that will prevent contact with exposed energized conductors or circuit parts.

When working within a confined or enclosed space that contains exposed energized electrical conductors or circuit parts operating at 50 volts or more, protective shields, protective barriers or insulating materials shall be used to avoid inadvertent contact with these parts.

B. Normal Operating Conditions

Normal operating conditions exist when the following conditions are satisfied:

- The equipment is properly installed.
- The equipment is maintained.
- The equipment is used in accordance with the manufacturer’s instructions.
- The equipment doors are closed and secured.
- All equipment covers are in place and secured.
- There is no evidence of impending failure.

When equipment is in a normal operating condition, arc flash incidents are not likely to occur and therefore normal operation of the equipment is permitted. Designated clear spaces around equipment shall be maintained and not used for storage.

Employees performing housekeeping within the limited approach boundary shall not use electrically conductive cleaning materials (steel wool, liquid solutions, silicon carbide), except where adequate safeguards are in place.

C. 50 Volts or Less

Electrical conductors and circuits operating at 50 volts or less (nominal) may not present an electrical shock hazard under normal operating conditions. Since thermal hazards can exist in low voltage circuits, it shall be determined that there is no increased exposure to electrical burns or to explosion due to electric arcs. De-energization is not required where there is no potential for electrical burns and explosions.

Electrical systems operating at 50 volts or less may still present additional hazards that should be controlled. For example, an open circuit or short circuit could produce a toxic gas, ejection of materials, or damage to hearing and eyesight.

D. Limited Approach Boundary

The limited approach boundary is the established safe distance for unqualified persons. The limited approach boundary is a calculated distance from an exposed live part where a shock hazard may exist. Only qualified persons are permitted to cross this boundary, if needed.

Where there is a need for unqualified persons to cross the limited approach boundary, qualified persons shall advise the unqualified person of the hazards and continuously escort the unqualified person while inside the boundary limit. Unqualified persons shall never cross the restricted approach boundary.

E. Restricted Approach Boundary

The restricted approach boundary is closer to live parts and may only be crossed by qualified persons. The restricted approach boundary is a calculated distance from an exposed live part where there is an increased risk of shock due to electrical arc combined with inadvertent movement for personnel working near the live part. Energized electrical permits are required when crossing this boundary to perform work on the energized conductor or circuit.

No qualified person shall approach or take any conductive object closer to exposed energized electrical parts within the restricted approach boundary, except where one of the following conditions exists:

- The qualified person is insulated or guarded from energized conductors and circuits.
- The energized conductors or circuits are insulated from the qualified person and from any other conductive object at a different potential.

Unqualified persons are prohibited from working within the restricted approach boundary.

F. Arc Flash Boundary

The arc flash boundary is the calculated distance at which the incident energy equals 1.2 cal/cm^2 (energy capable of causing a curable second-degree burn). In theory, persons working outside of the arc flash boundary would only sustain a curable second degree burn or less should an arc flash occur. Work performed inside of the arc flash boundary requires a level of PPE to reduce the incident energy on the human body to quantities lower than 1.2 cal/cm^2.

The incident energy analysis is based on the working distance of the employee's face and chest from a prospective arc source for the specific tasks to be performed. The analysis is performed

as part of the arc flash risk assessment, which considers overcurrent protective devices, fault clearing time, and condition of maintenance.

The incident energy analysis shall be evaluated when changes occur in the electrical system or every five years, whichever occurs first.

The arc flash boundary does not apply when the electrical equipment or systems is in a normal operating condition. When energized electrical conductors and circuit parts are exposed, protective measure and PPE for arc flash protection shall apply. Where the arc flash boundary is greater than the limited approach boundary, barricaded shall not be placed any closer than the arc flash boundary.

X. Equipment Labels or Markings

Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures, motor control centers, likely to require examination, adjustment, servicing, or maintenance while energized shall be marked with the following information, as determined by the incident energy analysis:

- Nominal system voltage,
- Limited approach boundary (in feet),
- Restricted approach boundary (in feet),
- Incident energy and corresponding working distance,
- Arc flash protection boundary (in feet).

Switchgear and MCC's will have the above information posted directly on the enclosure or available in an equivalent manner for reference. If information is not provided directly at the disconnect switch, staff must refer to the switchgear and/or MCC in which the device is fed.

Systems enclosures containing multiple energy sources are required to be appropriately labeled with a label warning of multiple energy sources and directing operation personnel to the procedure for eliminating all alternate sources of energy.

XI. Personal Protective Equipment (PPE)

Arc flash PPE shall be worn by qualified persons where exposed to energized conductors and circuit parts within the arc flash protection boundary. Qualified persons shall complete an arc flash risk assessment to determine appropriate protective measures and required level of PPE.

The required level of PPE can be determined using the incident energy analysis method or arc flash PPE category method.

A. Incident Energy Analysis Method

The incident energy analysis method is the OC San preferred selection method. This method is based on the working distance of the employee's face and chest from the prospective arc source for the specific task to be performed. This method recognizes that as the distance from the arc flash decreases, the required level of PPE increases. This method accounts for characteristics of overcurrent protective devices and its fault clearing time.

Incident energy analysis has been completed for most switchgears and MCCs located in the OC San process areas. Refer to Section X for additional details.

If an incident energy analysis has not been completed, the qualified person may perform one of the following:

- Calculate the incident energy using the incident energy analysis method.
- Use the incident energy calculated for the electrical source that feeds the specific equipment or system.
- Use the arc flash PPE category method.

When using the incident energy analysis method, the following table shall be used as part of the risk assessment to determine the required level of PPE based on incident energy calculated.

Calculated Arc Flash Incident Energy	Required PPE When Working in Restricted Approach and Arc Flash Protection Boundaries	Qualified Persons by Division	Minimum Qualified Persons Present	Work Activity Permitted
≤ 1.2 cal/cm^2	• Uniform • Hardhat • Safety glasses • Leather gloves • Leather work boots	• Electrical • Instrumentation • Operations • Mechanical • Collections	• One	• All Energized Work
> 1.2 to 8 cal/cm^2	Arc Suit Rated for 12 cal/cm^2 • Arc-rated flash suit • Arc-rated face shield and balaclava or arc-rated flash suit hood • Arc-rated outwear (as needed) • Arc-rated gloves or rubber insulating gloves with leather protectors, heavy-duty leather gloves accepted (0.7 mm thick) • Safety glasses or goggles • Leather work boots • Uniform • Ear plugs	• Electrical • Instrumentation • Operations • Mechanical • Collections	• One	• All Energized Work
> 8.1 to 40 cal/cm^2	Arc Suit Rated for 65 cal/cm^2 • Arc-rated flash suit • Arc-rated flash suit hood • Arc-rated outwear (as needed) • Arc-rated gloves or rubber insulating gloves with leather protectors • Safety glasses or goggles • Leather work boots • Uniform • Ear plugs	• Electrical • Instrumentation	• Two	• All Energized Work

Calculated Arc Flash Incident Energy	Required PPE When Working in Restricted Approach and Arc Flash Protection Boundaries	Qualified Persons by Division	Minimum Qualified Persons Present	Work Activity Permitted
>40.1	Arc-Rated rated for 65 cal/cm^2 • Arc-rated flash suit • Arc-rated flash suit hood • Arc-rated outwear (as needed) • Arc-rated gloves or rubber insulating gloves with leather protectors • Safety glasses or goggles • Leather work boots • Uniform • Ear plugs	• Electrical • Instrumentation	• Two	• De-Energization Only; Energized Work Prohibited

Note: Outwear includes a jacket, parka, rainwear, or hard hat liner that is arc-rated. Outerwear that is not arc-rated shall be removed prior to performing energized work. Arc suits must be rated for incident energy calculated at equipment.

B. Arc Flash PPE Category Method

Where the incident energy has not been calculated, the arc flash PPE category method listed in NFPA 70E, Article 130 may be used. Arc flash PPE is listed in Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b), and Table 130.7(C)(15)(c) for the task and system type listed.

C. PPE Requirements

Personal protective equipment for electrical work shall be nonconductive wherever there is a danger from electric arcs or shocks due to contact with energized systems or from flying objects resulting in an electrical explosion. The protective equipment shall cover all parts of the body, including the head, face, neck, chin, eyes, body, and ears.

Employees shall wear arc-rated clothing wherever there is possible exposure to an electric arc flash above the threshold incident energy level of 1.2 cal/cm^2. Electrical and Instrumentation technicians are issued arc-rated uniforms with an arc flash rating of 8 cal/cm^2.

Arc rated clothing shall be worn as the outer most layer and cover ignitable clothing and allow for movement and visibility. Non-melting garments are permitted to be used in a layered system to achieve the required level of PPE. The overall rating of the layered system must be determined by the manufacturer. If non-melting fiber garments are used as underlayers, the system arc rating shall be sufficient to prevent break-open of the innermost arc-rated layer at the expected arc exposure incident energy level to prevent ignition of underlayers. The non-melting fiber garments will not add to the level of protection against arc injuries. Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers next to the skin, unless the garment is flame resistant. An incidental amount of elastic used in non-melting fabric underwear or socks is permitted.

All jewelry and conductive articles worn, such as watch chains, belt buckles, rings, wristwatches, metal framed eyeglasses, or bands shall be removed prior to working on energized parts.

D. Body Protection

Shirt and coverall sleeves shall be fastened at the wrists. Shirts shall be tucked into pants, and shirts, coveralls, and jackets shall be closed at the neck.

Tight-fitting clothing shall be avoided. Loose-fitted clothing provides additional thermal insulation. The clothing shall fit properly as to not interfere with the work.

Clothing with drawstrings shall have drawstrings tied back or tucked away as to minimize potential of being snagged on equipment or moving parts.

E. Head and Eye Protection

Arc-rated hoods or balaclava with an arc-rated face shield shall be used when the back of the head is within the arc flash boundary. Arc-rated hoods are required when incident energy exceeds 8 cal/cm^2.

Face shields shall have an arc rating suitable for the arc flash exposure. Face shields without an arc rating shall not be used. Face shields may only be used for incident energies less than 8 cal/cm^2. Eye protection (safety glasses or goggles) shall always be worn under a hood or face shield.

Hard hat liners and hair nets are prohibited from use, except where they are designed for use at industrial electrical or utility applications.

F. Hand and Arm Protection

Employees shall wear rubber insulating gloves with leather protectors (gloves) for protection against shocks and arc flash for incident energies greater than 1.2 cal/cm^2. Rubber insulating sleeves shall be worn where there is potential for injury to the arm from contact with exposed energized conductors and parts.

Insulating rubber gloves are among the most important articles of personal protection for electrical workers. Rubber gloves must be used with leather gloves to keep the soft rubber glove from being damaged. Since the protector does not add any significant insulation value, the length of the protector must be less than the length of the rubber glove. The standard ASTM F496 requires Class 00 and 0 gloves to be ½ “longer than the protector and Class 2 gloves to be 2 inches longer. When it is required to reach into equipment beyond the length of the glove, insulating rubber sleeves must be used. Gloves are rated by voltage as shown below.

Voltage Class / Color	Maximum Use Voltage AC / DC
00 – Beige	500 / 750
0 – Red	1,000 / 1,500
1 – White	7,500 / 11,250
2 – Yellow	17,000 / 25,500
3 – Green	26,500 / 39,750

Voltage Class / Color	Maximum Use Voltage AC / DC
4 - Orange	36,000 / 54,000

Rubber insulating gloves are permitted to be used without leather protectors under the following conditions:

- The activity performed does not risk cutting or damaging the glove.
- The rubber insulating gloves are electrical retested before reuse.
- When rubber gloves are used without leather protectors, the voltage rating of the rubber insulating gloves, when reduced by 50 percent for Class 00 and by one whole class for Class 0 through 4, still achieve the required rating.

G. Foot Protection

Insulated footwear (heavy-duty leather or dielectric footwear) may be used to protect against step and touch potential where exposures are greater than 4 cal/cm^2.

H. Hearing Protection

Hearing protection is required when working within the arc flash boundary where electrical circuits and parts are exposed or where posted in compliance with the OC San Hearing Conservation Program (SOP-106).

I. Care and Maintenance

Protective equipment must be maintained in a safe, reliable condition and in accordance with the manufacturer's instructions. Protective equipment shall be stored in a manner to prevent damage from physically damaging conditions, moisture, dust, and other deteriorating agents (i.e., grease, oil, flammable liquids). Equipment that is contaminated or damaged to the extent that their protective qualities are impaired shall not be used.

Arc-rated clothing must be cleaned and maintained in accordance with the clothing manufacturer's instructions. Certain arc-rated materials cannot be washed with bleach or other cleaning additives.

J. Inspection and Testing

Arc-rated equipment shall be marked with the name of the manufacturer, product performance, arc rating, serial number or model number, and care instructions. Equipment shall conform to industry standards. Equipment with illegible markings shall not be used. Under rated equipment shall not be used.

A visual inspection shall be performed prior to each use. In addition, protective equipment shall be inspected immediately following any incident that could reasonably be suspected of having caused damage.

Rubber insulating equipment, which includes blankets, covers, gloves, line hose and sleeves, shall be electrically tested in accordance with applicable state and federal regulations. Test intervals shall not exceed the following:

Rubber Insulating Equipment	Test Interval
Blankets	Before first use; every 12 months thereafter
Covers	If insulating value is suspect
Gloves	Before first use; every 6 months thereafter
Line Hose	If insulating value is suspect
Sleeves	Before first use; every 12 months thereafter

Note: new insulating equipment is not permitted to be placed into service unless if it has been electrical tested within the previous 12 months.

Insulating gloves shall be given an air test prior to each reuse. Any leaks or damage to gloves shall be marked and the gloves shall not be used and removed from service.

Grounding equipment, such as grounding cable shall be inspected for cuts in the protective sheath and damage to the conductors prior to each use. Clamps and connector strain relief devices shall be checked for tightness.

XII. Other Protective Equipment

A. Insulated Tools and Equipment

Employees shall use insulated tools or handling equipment when working inside of a restricted approach boundary with exposed energized conductors or circuit parts. Insulated tools shall be protected from damage. Insulated tools shall be:

- Rated for the voltage on which they are used.
- Inspected prior to each use.
- Designed and constructed for the environment in which they are used.

Fuse and fuse holder handling equipment shall be insulated for the voltage.

Ropes and handlines used within the limited approach boundary shall be nonconductive.

Fiberglass-reinforced plastic rod and tube for live-line tools shall conform to applicable standards.

Portable ladders shall have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact energized equipment.

Protective shields, barriers or insulating materials shall be used to protect employees while working in the limited approach boundary where unintentional contact or arcing could occur.

B. Live-Line Tools (Hot Stick)

Testing of live-line tool rods, tubes, and poles shall meet ASTM F711-89, Standard Specifications.

Each live-line tool shall be wiped clean and visually inspected for defects before use each day. If the live-line tool is found to have any defect or contamination, the tool shall be repaired before being returned to service or permanently remove. If the tool is not found to have any defect, it

should be cleaned and waxed. The live-line tool shall be removed from service every 2 years for examination, cleaning, and repair.

C. Signage and Barricades

Signs, symbols, or tags shall be used where necessary to warn employees about electrical hazards that could endanger them. Warning signs shall be visible, securely attached and maintained in legible condition.

Barricades or equivalent devices shall be used to prevent or limit employee access to work areas containing energized and exposed conductors or circuit parts. Where signs or barricades do not provide sufficient warning or protection, an attendant may be positioned outside of the work area to notify unqualified persons of the electrical hazards.

D. Remote Actuators

Remote actuators are an acceptable engineering control to reduce the probability of injury. Remote actuators are equipment that allows the worker to open and close a circuit breaker or switch from a safe distance, such as outside of the arc flash protection boundary. Qualified persons operating remote actuators will receive training on use, storage, and security.

E. Minimum Approach Distance

The employer shall ensure that no employee takes a conductive object closer to exposed energized parts than the established minimum approach distances unless:

Minimum Approach Distances		
Voltage (V)	Phase to Ground	Phase to Phase
0-300	Avoid contact	Avoid contact
301-600	1 foot 1 inch	1 foot 1 inch

Note: for voltages greater than 600 Volts, see Section 2940.2.
(1) The qualified employee is insulated or guarded from the energized part (rubber insulating gloves or gloves with sleeves rated for the voltage involved shall be considered insulation of the employee from the energized part upon which the qualified employee is working provided that the qualified employee has control of the part in a manner sufficient to prevent exposure to uninsulated portions of the employee's body), or
(2) The energized part is insulated or guarded from the employee and any other conductive object at a different potential.

XIII. Over Head Electrical Lines

Where work is performed in locations containing uninsulated energized overhead lines that are not guarded or isolated, precautions shall be taken to prevent employees from contact with their body, conductive materials, tools, or equipment. When work is performed and contact with such lines is possible, the lines shall be de-energized and visibly grounded at the point of work or suitably guarded.

The following general approach distances shall be maintained when working adjacent to or driving equipment under high-voltage power lines:

Power Line Voltage (kV)	Minimum Safe Distance (feet)	
	Operation Near High-Voltage Lines	In Transit Near High-Voltage Lines
<50	10	6
>50 – 200	15	10
>200 – 350	20	12
>350 – 500	25	16
>500 to 750	35	16
>750 to 1,000	45	20
ANSI B30.5-2004, 5-3.4.5.2		

For heavy equipment that is extendable or telescoping (e.g., excavator, dump truck), it should be evaluated if a spotter is necessary prior to operating the equipment near the overhead utility.

XIV. Battery Room and Enclosures

Battery risk assessments should be completed prior to any work on a battery enclosure or system. The assessment shall consider chemical, electrical shock and arc flash hazards, as well as types of tasks to be performed on the system.

Unauthorized persons shall be prohibited from entering battery rooms or enclosures with exposed and energized batteries. Authorized persons are individuals who have specific duties associated with such exposed and energized systems. Warning signs or labels must be posted with warnings for the electrical and chemical hazards, personal protective equipment, and prohibiting access to unauthorized personnel.

Conductive objects such as jewelry shall not be worn while working on a battery system.

Ventilation systems required by the battery system shall be examined and maintained to prevent buildup of explosive mixtures. Ventilation may be forced or natural.

Where employees are required to handle battery electrolytes, the following protective equipment shall be worn in addition to any arc flash equipment required to remove the battery from service: goggles and face shield, chemical resistant gloves, and chemical splash apron.

Insulated non-sparking tools and insulated equipment is required for working on batteries. Caution shall be used if wiping plexiglass enclosures with cloth and cleaner, which can leave the surface positively charged resulting in a fire or explosion hazard.

Spill control and acid neutralization kits shall be readily available.

XV. General Maintenance Requirements

All electrical equipment must be listed by a national testing laboratory for specific application for which it is used, as well maintained in accordance with manufacturers' instructions.

All electrical equipment that are likely to require examination, adjustment, servicing, or maintenance while energized, must be labeled to warn qualified persons and others of the potential electrical shock and arc flash hazards. The labels shall be legible and updated as needed.

A. Guarding of Live Parts

Live parts of the electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets, enclosures or by the following:

- By location in a room, vault or similar enclosure that is accessible only to qualified persons.
- By suitable permanent, substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the energized parts.
- Cabinets, cutout boxes, fittings, boxes, and panel board enclosures in damp or wet locations shall be installed to prevent moisture or water from entering and accumulating within the enclosures and shall be mounted so there is at least 0.25 in. (6.35 mm) airspace between the enclosure and the wall or other supporting surface.
- By location on a suitable balcony, gallery, or platform so elevated and otherwise located to prevent access by unqualified persons.
- Elevations greater than 8 feet or more above a floor or working level.

Enclosures shall be maintained to guard against unintentional contact with exposed energized conductors and circuit parts and other electrical hazards. Covers and doors shall be in place with all associated fasteners and latches secured. Electrical panels shall be free from recognized hazards (e.g., flammable material, loose objects, etc.) to ensure the safety of employees.

Covers for wiring systems shall be in place with all associated hardware, and there shall be no unprotected openings. All pull boxes, junction boxes, and fittings shall be covered. If metal covers are used, they shall be grounded.

B. Clear Spaces

Access to working space and escape passages shall be kept clear and unobstructed. The working space may not be used for storage. The width of the working space should be the width of the electrical panel or 30 inches, whichever is greater. The minimum clear working space in front of electric equipment such as switchboards, control panels, switches, circuit breakers, and similar equipment must maintain the following distance with the following voltage:

Nominal Voltage to Ground	Minimum Clear Distance (Feet)		
	Condition 1	Condition 2	Condition 3
0 to 150	3	3	3
151 to 600	3	3.5	4
601 to 2,500	3	4	5
2,501 to 9,000	4	5	6
9,001 to 25,000	5	6	9
25,001 to 75 kV	6	8	10
Above 75 kV	8	10	12

Notes:
Condition 1: Exposed live parts on one side and no live or grounded parts on the other side of the working space or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts.
Condition 2: Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile surfaces shall be considered as grounded surfaces.
Condition 3: Exposed live parts on both sides of the workspace (not guarded as provided in Condition (1)] with the operator between.

XVI. Test Instruments and Equipment

Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measure on electrical equipment operating at voltages equal to or greater than 50 volts.

Instruments and equipment shall be rated, approved, and used in accordance with the manufacturer, as well as designed for the environment to which they will be exposed and for the manner in which they will be utilized.

Instruments shall be visually inspected for external defects and damage before each use.

When test instruments are used for testing the absence of voltage on conductors or circuits operated at 50 volts or more, the instrument shall be verified on any known voltage surface before and after an absence of voltage test is performed.

XVII. Portable Cord and Plug-Connected Equipment

A. Extension Cords

All extension cords shall be listed by the Underwriters' Laboratory (U.L.) and bear the U.L. label.

The size of the wire in the extension cord must be compatible with the amount of current the extension cord will be expected to carry. The amount of current will depend on the equipment plugged into the extension cord. Current ratings are typically printed on the nameplate or specification sheet for equipment. Since voltage drops over the length of the cord, the length will also determine the selection of wire size. Homemade extension cords assembled with a metal box shall not be made or be used.

Extension cords shall be used only in continuous lengths without splice or tap. The terminals and insulation shall be free of defects such as cracked, split, or nicked insulation; exposed wires; knots; burn marks; loose connectors; or other damage that may present a fire or an electrocution hazard. The ground prong shall not be removed. Destroy any extension cords showing defects.

Each extension cords shall be visually inspected before each day's use for external and internal defects. Use of electrical tape is not allowed for repairs.

Extension cords shall be handled and stored in a manner that will not cause damage. It is recommended that extension cords be coiled or hung when in storage. The cord shall not be used for raising or lowering equipment. The cord shall not be fastened with staples or hung in such a fashion as could damage the outer jacket or insulation.

Extension cords shall be used in conjunction with a tested GFCI to prevent unintentional electrical shocks.

B. Flexible Cords

Each flexible cord shall be equipped with an attachment plug and shall be energized from an approved receptacle outlet. In addition, flexible cords shall be used for:

- Pendants (a lamp holder or cord-connector body suspended by a length of cord properly secured and terminated directly above the suspended device).
- Wiring of fixtures.
- Connection of portable lamps or appliances.
- Elevator cables.
- Wiring of cranes or hoists (where flexibility is necessary).
- Connection of stationary equipment to facilitate their interchange, (equipment, which is not normally moved from place to place, but might be on occasion).
- Prevention of the transmission of noise or vibration.
- Temporary wiring as permitted.

Flexible cords shall not be used as a substitute for the fixed wiring of a structure, and shall not:

- Exceed 90 days of use in one application.
- Run through holes in walls, ceilings, floors, doorways, windows, or similar openings.
- Be attached to building surfaces.
- Be concealed behind building walls, ceilings, or floors.

C. Power Strips

Power strips are devices designed to provide multiple outlets from one-power source. Power strips must be Underwriters' Laboratory (U.L.) approved or approved by a similar nationally recognized testing laboratory and they must contain an integral circuit breaker.

Each power strip shall be plugged into a permanent wall receptacle. Power strips may not be plugged into another power strip or into an extension cord.

D. Portable Electric Tools and Equipment

Tools and equipment shall be inspected prior to use and maintained per manufacturer instructions. No damaged tool or equipment shall be used. Equipment shall be tagged out of service and not used until repairs are made.

XVIII. Ground-Fault Circuit-Interrupter Protection

Ground-fault circuit interrupters (either circuit breakers or portable ground-fault interrupting receptacles) are designed to protect personnel from serious injury, and shall be used for the following:

- All single-phase receptacles rated 150 volts to ground or less, 50 amperes or less and three-phase receptacles rated 150 volts to ground or less, 100 amperes or less installed at the following locations:
    - Bathrooms

  - Kitchens
  - Rooftops (may be readily accessible other than from the rooftop)
  - Outdoors
  - Sinks, where receptacles are installed within 6 feet from the top inside edge of the sink bowl
  - Indoor wet locations
  - Locker rooms with showering facilities
  - Garages, service bays, and similar areas
  - Crawlspaces (at or below grade level)
  - All breakroom dishwasher branch circuits
  - When an employee is operating or using extension cords or cord and plug connected tools

GFCI's are not required for the following:

- Outdoor receptacles that are part of an assured equipment grounding conductor program for only those outlets used to supply equipment that would create a greater hazard if power were interrupted or having a design that is not compatible with GFCI protection.
- An appliance which is fastened or otherwise secured at a specific location (i.e., refrigerator, water cooler).
- Laboratory areas where receptacles are required (other than on counter tops) to supply power to specific equipment (i.e., receptacles dedicated to refrigerators or other heavy equipment).
- Line filters and other power supply components in many electronic instruments. These instruments draw sufficient capacitive current to trip a GFCI and therefore are not designed to be connected to GFCI-protected circuits.
- Any double insulated power tool or appliance.

GFCI receptacles installed at work locations listed above shall be tested in accordance with the manufacturer's instructions.

Portable GFCI protection devices installed where an employee is operating or using extension cords or cord and plug connected tools shall be tested before each use.

If any GFCI device fails inspection, tag and replace the GFCI protection device. Do not use the equipment until repaired or replaced.

XIX. Assured Equipment Grounding Conductor Program

Contractors shall establish and implement an assured equipment grounding conductor program that covers all cord sets and receptacles which are not a part of the permanent wiring of the building or structure and equipment connected by cord and plug, which are available for use or used by employees. This program shall comply with requirements established in Title 8, Section 2405.4 of the California Code of Regulations.

XX. Training Requirements

Training shall be provided to employees exposed to electrical hazards. Employees shall be trained to understand the specific hazards associated with electrical energy, safety-related work practices and procedural requirements to provide protection from the electrical hazards associated with their respective job.

A. Unqualified Persons

Unqualified persons who do not work within the limited approach boundary of energized electrical conductors or circuit parts but work in the vicinity must understand the hazards of electricity. Therefore, unqualified persons shall be trained in electrical safety related practices, as well as the control of hazardous energy. Depending on job classification, OC San staff will be assigned an online electrical safety overview and control of hazardous energy (LOTO) affected persons training provided through Cornerstone. Contractors should provide its unqualified persons who may be exposed to electrical hazards with a general awareness training.

B. Qualified Persons

Qualified persons shall be trained and knowledgeable in the construction and operation of equipment or a specific work method and be trained to identify and avoid the electrical hazards that might be present with respect to the that equipment. Qualified persons shall receive the following training:

1. Control of Hazardous Energy (LOTO) – Authorized Persons

This is the detailed class for persons authorized to control hazardous energy, develop energy control procedures, and implement such procedures.

2. NFPA 70E – Electrical Safety in the Workplace Hazard Training

This training provides requirements for safe work practices to protect personnel by reducing exposure to major electrical hazards, including safety related maintenance.

Retraining for safety-related work practices and applicable changes to the NFPA 70E standard shall be performed every 3 years. Training shall consist of classroom, on-the-job, or a combination of both.

Additional training is required if any of the following conditions exists:

- Supervision or annual inspections indicate the employee is not complying with safety-related work practices.
- New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices different from those that the employee would normally use.
- The employee needs to review tasks that are performed less often than once per year.
- The employee needs to review safety-related work practices not normally used by the employee during regulator job duties.
- The employee's job duties change.

3. Emergency Response Training (Contact Release / First Aid)

Employees exposed to shock hazards and those employees responsible for acting in case of an emergency shall be trained in methods of release of victims from contact with exposed energized electrical conductors or circuit parts.

Employees responsible and designated to respond to medical emergencies shall be trained in first aid and emergency procedures.

4. Remote Actuator

Employees authorized to operate remote actuators will receive training from qualified vendor or electrical maintenance staff.

XXI. Auditing and Inspections

Annually the program shall be audited to ensure that the principles and procedures of the electrical safety program are being followed. Where the audit determines that the principles and procedures of the electrical safety program are not being followed, appropriate corrective actions/revisions shall be made. The program review shall be completed annually.

Field work audits shall also be performed to verify that the requirements contained in electrical procedures and electrical safety program are being followed. Audits shall be completed at least annually. Revisions shall be made to training, procedures, or the program to address audit findings.

Audits shall be maintained by the responsible Division for a period of three years.

XXII. Recordkeeping

All records created or generated during this procedure shall be legible and stored in a way that they are readily retrievable in facilities or electronic document/content management systems that provide a suitable environment to prevent damage, deterioration, or loss. Records may be in the form of any type of media, such as hard copy or electronic media. The OC San Records Retention Schedule is the official procedure governing the retention, retirement, and destruction of OC San records. Document owners should use these schedules to determine the item and series that best fit their records. Document owners are responsible for ensuring that documents are properly marked, indexed, and filed for their projects or area of responsibility.

XXIII. References

Injury and Illness Prevention Program

NFPA 70, National Electric Code (National Fire Protection Agency 2017)

NFPA 70E, Standard for Electrical Safety in the Workplace (National Fire Protection Agency 2018)

NFPA 2112, Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire (NFPA 2018)

SOP-102, Personal Protective Equipment

Subject: **Error! Reference source not found.**

SOP-605, Control of Hazardous Energy (LOTO)

SOP-608, Contractor Safety

Title 8, California Code of Regulations, Subchapter 5, Group 1. Low-Voltage Electrical Safety Orders, Section 2229 – 2599

Title 8, California Code of Regulations, Subchapter 5, Group 2. High-Voltage Electrical Safety Orders, Section 2700 - 2989

Title 29, Code of Federal Regulations, Standard 1910, Subpart S, Electrical

XXIV. Revision History

Version	Date	By	Reason
3.0	07/09/2009	Huynh, Cindy	Program Update
4.0	12/08/2015	Bauer, Wesley	Program Update
5.0	12/04/2018	Frattali, John	Program Update, including incorporation of SAFE Bulletin No. 77.
6.0	12/09/2019	Frattali, John	Annual program review: minor format change and remove language from Section VII for LOTO program changes
7.0	05/27/2020	Huynh, Brian	Periodic Update – Refer to Program Change Log
8.0	12/07/2021	Ventanilla, Sheri	Annual Program Review – Refer to Program Change Log