

 <b>CITY OF TUCSON</b>	<b>City of Tucson</b> Central Safety Services  Number: S-019  Subject: <b>Electrical Work Practices</b>	Page 1 of 72
		Effective Date: October 10, 2002
		Reviewed/ Revised: January 1, 2013

## 1.0 PURPOSE

To prevent electrically-related injuries to employees and property damages to city of Tucson facilities. To provide employees with proper training and requisite knowledge and understanding of safe electrical work practices and procedures.

The intent of this program is not to replace industry standards such as Occupational Safety and Health Administration (OSHA), National Electrical Code (NEC) or National Fire Protection Association (NFPA), but is to be used in conjunction with industry standards.

Any department having electricians on staff may develop their own site-specific electrical safety program using this program as a guideline.

Users of this Procedure may find it useful to consult the index found in Appendix D to locate reference specific sections or Tables.

## 2.0 SCOPE

This program addresses electrical safety requirements for employees performing installation, operation, maintenance, repair and demolition of systems, including camera imaging and data logging assessments on or near energized equipment over 50 volts. It is the responsibility of the Qualified Electrician or Authorized Personnel to recognize hazards associated with exposed, energized equipment by potential amperage output and review the approach distance to energized equipment and to assess the potential hazards from arc flash, direct contact, and indirect contact from energized equipment, by reviewing labeled electrical equipment or to perform a hazard/risk evaluation supplemented by the Hazard Risk Tables found in this procedure and to wear the appropriate Personal Protective Equipment during exposed energized work.

This program will also apply to any and all contractors working under the scope of a City of Tucson contract.

## 3.0 DEFINITIONS

**Accepted:** An installation/device is "accepted" if it has been inspected and found by a nationally recognized testing laboratory to conform to specified plans or to procedures of applicable codes.

**Approved for the Purpose:** Means the equipment or practice is approved for a specific purpose, environment, or application described in a particular standard or requirement.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	2 of 72

**Arc Flash:** A dangerous condition associated with the release of energy caused by an electric arc, producing intense heat, sound blast and pressure waves resulting in high temperatures and radiant heat that will cause severe to fatal skin burns, debilitating eye injuries and ignite non-fire retardant clothing.

**Arc Flash Hazard Analysis:** A 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, arc flash protection boundary, and the appropriate levels of PPE.

**Arc Flash Suit:** A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet. This may include pants or overalls, or a jacket and coveralls, and rated hood fitted with a face shield.

**Arc Rating:** The maximum incident energy resistance demonstrated by a material (or layered systems of materials) prior to break open or at the onset of a second degree skin burn. Arc Rating is normally expressed in calories per centimeter squared (cal/cm<sup>2</sup>).

**Authorized Personnel:** An employee, other than a Qualified Electrician authorized by position, title and training to perform diagnostic testing and troubleshooting associated with the energized operation of electrically powered equipment and to perform installation, maintenance or demolition on electrically powered equipment or systems, in a de-energized state.

**Balaclava (Sock Hood):** An arc-rated hood that protects the neck and head except for the facial area around the eyes and nose.

**Barricade:** A physical obstruction such as tape, cones, or other warning device intended to provide a warning about and to limit access to a hazardous area.

**Bonding:** The permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

**Boundary, Arc Flash Protection:** When an arc flash hazard exists, an approach limit at a distance from a prospective arc source within which a person could receive a second degree burn if electrical arc flash were to occur.

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

**Boundary, Prohibited Approach:** An approach limit at a distance from an exposed, energized electrical conductor or circuit part within which work is considered the same as making contact with the electrical conductor or circuit part.

**Boundary, Restricted Approach:** An approach limit at a distance from an exposed, energized electrical conductor or circuit part within which there is an increased risk of

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	3 of 72

shock, due to electrical arc over combined with inadvertent movement, for personnel working in close proximity to the energized electrical conductor or circuit part.

**Cabinet:** An enclosure designed either for surface or flush mounting, and provided with a frame, mat, or trim in which a swinging door or doors are or may be hung.

**Cable tray system:** A cable tray system is a unit or assembly of units or sections, and associated fittings, made of metal or other noncombustible materials forming a rigid structural system used to support cables. Cable tray systems include ladders, troughs, channels, solid bottom trays, and other similar structures.

**Certified:** Equipment is "certified" if it:

1. Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner, or
2. Is of a kind whose production is periodically inspected by a nationally recognized testing laboratory, and
3. It bears a label, tag, or other record of certification.

**Circuit breaker:** A device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined over current.

**Competent Person:** One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate the condition.

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

**Dead front:** Without live parts exposed to a person on the operating side of the equipment.

**De-energized:** Free from any electrical connection to a source of potential difference and from electrical charge.

**Disconnecting means:** A device, or group of devices, by which the conductors of a circuit can be disconnected from their source of energy supply.

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

**Electrical Safety Coordinator:** A qualified person, designated by management to develop, implement, administer, and oversee electrical work practices, policies and procedures within a specific department/division.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	4 of 72

**Enclosed:** Surrounded by a case, housing, fence or walls which will prevent persons from accidentally contacting energized parts.

**Energized Electrical Work:** Any work, other than testing/troubleshooting performed on or close enough to exposed parts of electrical circuits and equipment operating at greater than 50 V to ground, or less than 50 volts to ground where the current exceeds 5mA, and the potential for injury exists. To be completed in conjunction with a Job Task Analysis.

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

**Exposed (as applied to wiring methods):** Means on or attached to the surface or behind panels designed to allow access.

**Exempted Work:** Routine work exempted from the Energized Work Permit; normally start-up testing, troubleshooting, diagnostic voltage measurement and re-energizing voltage measurement, performed utilizing insulated instruments and Personal Protective Equipment appropriate to the known voltage and hazard risk. This work also includes Thermography imaging performed with covers off by Qualified Electricians.

**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, with or without subsequent removal of the ignition source.

**Ground:** A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

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

**High Voltage:** The city of Tucson classifies high voltage work as any voltage greater than 480v to ground.

**Incident Energy:** The amount of energy impressed on a surface, a certain distance from the source, generated during an arc flash event. One of the units used to measure incident energy is calories per centimeter squared (cal/cm<sup>2</sup>).

**Incident Energy Analysis:** A component of an arc flash hazard analysis used to predict the incident energy of an arc flash for a specified set of conditions.

**Isolated:** Not readily accessible to persons unless special means for access are used.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	5 of 72

**Job Task Analysis:** A checklist of safety issues that shall be considered and addressed before work is performed on any energized, exposed electrical conductor or circuit.

**Labeled:** Equipment or materials are "labeled" if there is attached to it a label, symbol, or other identifying mark of a nationally recognized testing laboratory which, (a) makes periodic inspections of the production of such equipment, and (b) whose labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.

**Non-qualified Person:** An individual who does not meet the training, educational, and testing criteria for a Qualified Electrician or Authorized Personnel and who is not authorized to perform diagnostic testing or work on electrically powered systems or equipment.

**Qualified Electrician:** Is an individual who has a minimum of four years electrical work experience and six (6) months of formal post high school specialty training in the electrical field and who successfully passes the City Of Tucson examination for the position of electrician and who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

Note: These requirements will not affect current City Of Tucson employees in this classification, but shall affect any new hire, potential promotion, or transfer to the position of electrician or high voltage electrician.

Work performed on or near exposed, energized electrical systems, with specific exceptions noted in this procedure for diagnostic testing and troubleshooting performed by Authorized Personnel, shall only be performed by a qualified electrician.

**Readily accessible:** Capable of being reached quickly for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc.

**Shock Hazard:** A dangerous condition associated with the possible release of energy caused by contact or approach to energized electrical conductors or circuit parts.

**Short Circuit Current Rating:** The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.

**Single-Line Diagram:** A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used in the circuit or system.

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

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	6 of 72

**Switchgear, Arc Resistant:** Equipment designed to withstand the effects of an internal arcing fault and that directs the internally released energy away from the employee.

**Switchgear, Metal-clad:** A switchgear assembly completely enclosed on all sides and top with sheet metal, having drawout switching and interrupting devices and all live parts enclosed within grounded metal components.

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

**Touch Potential:** A ground potential gradient difference that can cause current flow (jump) from hand to hand, hand to foot, or another path other than foot to foot through the body.

**Two Worker Rule:** A City rule which requires that a second worker be present whenever work is performed on or near energized, exposed high voltage (>480v) electrical systems. The second worker shall be certified in CPR/First Aid response procedures and shall be present, primarily as an observer and shall be present at all times when work is performed on systems energized at high voltage, 480v to ground or greater.

**Voltage (of a circuit):** The greatest root-mean-square (effective) difference of potential between any two conductors of a circuit.

**Voltage, nominal:** A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240, 480Y/277, 600 etc.). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

**Voltage to ground:** For grounded circuits, the voltage between the given conductor and that point or conductor of the circuit that is grounded; for ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

**Watertight:** So constructed that moisture will not enter the enclosure under specified test conditions.

**Weatherproof:** (Also Rain tight, rainproof) Constructed or protected that exposure to the weather will not interfere with successful operation.

**Working On (Energized electrical conductors or circuit parts):** Intentionally coming in contact with energized electrical conductors or circuit parts with hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	7 of 72

personal protective equipment a person is wearing. There are two (2) categories of “working on”: **Diagnostic** (testing) is taking readings or measurements of electrical equipment with approved test equipment that does not require making any physical change to the equipment; and **Repair** is any physical alteration of electrical equipment such as making or tightening connections, removing or replacing components.

#### 4.0 RESPONSIBILITIES

##### A. Director or Designee

Provides and facilitates training time for Qualified Electrician, Authorized Personnel and non-qualified employees along with the necessary resources to accomplish the training. The Director shall designate a Competent Person, normally the Supervisor of the Electricians, for the department with the necessary authority to enact these procedures and to stop or alter unsafe work procedures that are in conflict with this procedure.

##### B. Supervision

1. The direct Supervisor of electrical workers or the Competent Person shall consult with employees regarding questions, issues, conflicts. The Supervisor or Competent Person shall know and understand the delineation between a Qualified Electrician, Authorized Personnel and a Non-qualified person and shall assign work appropriately. The Supervisor shall ensure that all employees are properly trained and instructed in the safe operation of electrical equipment and aware of all hazards associated with the use of these electrical devices.
2. The Supervisor or Competent Person shall initiate any necessary administrative action required to enforce safety practices and track all electrical deficiencies and corrective action and shall coordinate with Central Safety Services for any equipment, devices or training that require a unique safety practice or instruction.

##### C. Employee

1. Employees shall follow the City of Tucson's Electrical Work Practices and instructions from their Supervisor or Competent Person. Employees shall bring to the immediate attention of the Supervisor or Competent Person, potential hazardous situations such as discrepancies between instructions, procedures, policies and manuals, faulty equipment, misapplication of device and electrical equipment known to be malfunctioning must be repaired or replaced before use.
2. Qualified Electricians shall perform diagnostic testing or repairs on energized electrical systems while wearing appropriate personal protective equipment.
3. Authorized Personnel may perform diagnostic testing, including voltage measurement (exempted work) on energized exposed electric systems up to 480v to ground while wearing appropriate personal protective equipment but

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	8 of 72

shall not perform a repair or install electrically powered equipment or components, unless the electrical source is energized at less than 50v, or unless the equipment is de-energized **and** is locked out.

4. Equipment with electrical deficiencies shall be tagged and locked out according to the procedures outlined in OSHM S-009 Control of Hazardous Energy –Lockout/Tagout/Tryout.
5. Where electrical powered equipment or electrical systems cannot be de-energized and placed in an electrically safe work condition for repair or installation of electrical components, work shall only be performed by a Qualified Electrician or under the direct supervision of a Competent Person.

## 5.0 EDUCATION and TRAINING

### A. Qualified Electrician and Authorized Personnel

1. A Qualified Electrician and Authorized Personnel shall meet the minimum employment qualifications set by the City of Tucson and shall be trained and knowledgeable of the design and operation of equipment or a specific work method and be trained to recognize and avoid the electrical hazards that might be present with respect to that equipment or work method.
2. Such person shall also be familiar with the proper use of special precautionary techniques, personal protective equipment, including arc flash, insulating and shielding materials, insulated tools and test equipment. A person may be considered qualified with respect to certain equipment methods and still be considered unqualified for others.
3. Such persons permitted to work within the Limited Approach Boundary of exposed live parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:
  - a. The skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment;
  - b. The skills and techniques necessary to determine the nominal voltage of live parts;
  - c. The approach distance specified in Table 1 – Approach Boundaries to Live Parts and the corresponding voltages to which the qualified person will be exposed;
  - d. 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.
4. Each Qualified Electrician and Authorized Personnel shall be trained in emergency response procedures including methods of release of victims from contact with exposed, energized electrical conductors or circuit parts, and shall be certified in cardiopulmonary resuscitation and first aid (CPR/FA) at least every two (2) years.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	9 of 72

## **B. Non-qualified Personnel**

1. Non-qualified personnel shall be trained in and be familiar with any of the electrical safety-related practices that are necessary for their safe work. This safety awareness training shall include but not limited to the following:
  - a. Procedures for resetting over current protective devices;
  - b. Techniques for approaching distances to overhead conductors;
  - c. The meaning of electrical safety warnings and barriers;
  - d. The proper handling of portable tools and appliance cords;
  - e. Electrical hazards associated with water;
  - f. The proper response to electric shock;
  - g. Recognition of electric shock and emergency response actions;
  - h. Emergency response notifications and basic First Aid.

## **C. Initial and Annual Training**

1. Training specific to the job tasks and reasonably anticipated hazards shall be offered to qualified, authorized and non-qualified newly-hired personnel at the department level by Supervision prior work assignment.
2. A **Qualified Electrician** and **Authorized Personnel** shall receive training as required and under any of the following conditions:
  - a. Annual refresher;
  - b. If supervision, observation, or injury, indicate that the employee is not complying with safety-related work practices;
  - c. If a new technology, new types of equipment or changes in accepted procedures in the National Electrical Code, NFPA, or OSHA necessitate a change in the use of safety-related work practices that are different from those which the employee would normally use;
  - d. For safety-related or task-related work practices, not frequently used during his or her regular job duties.
3. Tasks that are performed less often than once per year shall require retraining before the performance of the work practices involved, by supervision.
4. Qualified and Authorized employees shall be trained to select an appropriate voltage detector and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. Training shall include information that enables the employee to understand all limitations of each specific voltage detector that may be used.

## **D. Training Documentation**

The employer shall document that each employee has received the Electrical Work Practices training and specific training required for tasks that are performed less than once per year. This documentation shall be made when the employee demonstrates proficiency in the work practices involved and shall be maintained

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	10 of 72

for the duration of the employee's employment and shall include the employee's name, employee number, and date(s) of training.

## 6.0 GENERAL

### A. Establishing an Electrically Safe Work Condition

1. Energized electrical conductors and circuit parts to which an employee might be exposed shall be placed into an electrically safe work condition (reference OSHA 1910.333 (a)) before an employee works within the Limited Approach Boundary of those conductors or parts, by the following:

- a. Determine all possible sources of electrical supply, including emergency generators, battery backup and/or solar power, to specific equipment by checking applicable up-to-date single-line drawings, diagrams and identification tags;
- b. After properly interrupting the load current, open the disconnect device(s) for each source;
- c. Whenever possible, visually verify that all blades of the disconnecting devices are fully open or that draw-out type circuit breakers are withdrawn to the fully disconnected position;
- d. Apply lockout/tagout devices in accordance with the documented and established policy (OSHM S-009);
- e. Affirm the voltage tester is operating correctly on a known voltage source. Use adequately rated voltage detector to test each phase conductor or circuit path to verify they are de-energized. Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the voltage detector is operating satisfactorily;
- f. 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 energized could contact other exposed energized conductors or circuit parts, apply ground connecting devices rated for the available fault duty.
- g. Where the availability exists; physically attempt to start de-energized equipment by activating a start-up control, switch or device to verify absence of electrical energy.

### B. Principles of Lockout/Tagout/Tryout

A detailed procedure for Lockout/Tagout of energized equipment is referenced in the **Occupational Safety and Health Manual S-009**. Listed below are brief definitions of the principles of Lockout/Tagout/Tryout.

**Complex Lockout/tagout/Tryout:** Lockout/tagout/Tryout procedures will involve a written plan where one or more of the following exist:

- Multiple energy sources
- Multiple crews
- Multiple crafts
- Multiple locations

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	11 of 72

- Multiple employers
- Multiple means of disconnect
- Specific disconnect sequence
- A job or task that continues for more than one job shift

A qualified electrician shall coordinate a complex lockout/tagout/tryout procedure and plan. Such person shall be appointed with overall responsibility and identified as the person-in-charge (Competent Person), and shall be able to account for all persons working on the job/task and the safe execution of the complex lockout/tagout/tryout procedure.

**Control of Energy:** All sources of electrical energy shall be controlled in such a way as to minimize or eliminate employee exposure to electrical hazards.

**Coordination:** The established electrical lockout/tagout/tryout procedure shall be coordinated with all City equipment lockout/tagout /tryout procedures and shall be annually audited for execution and completeness.

**Employee:** Every employee who could be exposed directly or indirectly to a source of electrical energy shall be involved in Lockout/Tagout/Tryout training.

**Equipment:** The department shall supply and employees shall use lockout/tagout devices and equipment necessary to execute of the lockout/tagout/tryout as delineated in OSHM S-009. Lock as and tags used for the control of energy hazards shall be unique and readily identifiable as lockout/tagout devices and shall be used for no other purpose.

**Identification:** The lockout/tagout device shall be unique and readily identifiable as a lockout/tagout device.

**Lockout Device:** A lockout device shall be permitted only to be a lock, unique to the individual applying the lockout device and readily identifiable as a lockout device. The lockout device shall be attached and secured in a manner that would prevent unauthorized or accidental removal, or circumvention of the device. The tag used in conjunction with a lockout device shall contain a statement prohibiting unauthorized operation of the disconnecting means or unauthorized removal of the lockout device.

**Plan:** A plan shall be developed on the basis of the existing electrical equipment and system and shall utilize up-to-date diagrams, drawings or schematics.

**Procedures:** The City shall establish written lockout/tagout/tryout procedures and provide annual training to employees and shall provide equipment necessary to execute the details of the lockout/tagout procedure.

**Simple Lockout/Tagout/Tryout:** Lockout/Tagout/Tryout procedures that involve a qualified electrician or authorized person de-energizing one set of conductors or

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	12 of 72

circuit as part of the energy source for the sole purpose of performing work on or near the electrical equipment. Each worker is responsible for their lockout/tagout.

**Tagout Device:** A Tagout Device shall be a tag together with a means of attachment, suitable for the environment and the duration of the tagout. The tagout device shall be capable of withstanding a 50lb force exerted at a right angle to the disconnecting surface. The tagout shall contain a statement prohibiting unauthorized operation of the disconnecting means and prohibiting removal of the tagout device. The tagout device shall be signed by the qualified electrician or authorized person and dated.

**Training:** Every employee who could be exposed shall be trained annually to understand the established procedure to control the energy and their responsibility in executing the procedure.

**Tryout:** The employee performing the work shall attempt to start the equipment that is locked out by activating the on/off device or shall verify a zero energy state by use of a voltage meter.

**Voltage:** Voltage shall be removed and the absence of voltage verified.

#### **C. Working within the Limited Approach Boundary – Energized Equipment**

1. Live parts (above 50 volts to ground) to which an employee may be exposed, with the exception of testing/troubleshooting, shall be put into an electrically safe work condition before an employee works on or near them, unless the employer can demonstrate the de-energizing introduces additional or increased hazards, or is unfeasible due to equipment design or operation.
2. With the appropriate PPE in place, a Qualified Electrician or Authorized Personnel may perform start-up, testing, and circuit testing, or troubleshooting on energized electrical systems or equipment without an energized Electrical Work Permit (refer notation in following section).

#### **D. Job Task Analysis**

1. A Job Task Analysis (similar to a Job Hazard Analysis) shall be performed by the Qualified Electricians prior to completing the Energized Electrical Work Permit to identify the specific or anticipated electrical hazards expected to be encountered when performing work on exposed, energized electrical systems.
2. The Qualified Electricians shall reference any electrical drawing or blue-prints, including one-line drawings or diagrams of the electrical systems, prior to work being performed.
3. The Job Task Analysis template is located in Appendix B.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	13 of 72

### **E. Two (2) Person Rule**

1. If the equipment cannot be de-energized or placed in an electrically safe work condition, then two (2) qualified electricians are required to perform work on any exposed, energized system or equipment above 50v to 480v.

**Exception:** Routine work involving outlet, switch, ballast, or breaker replacement energized at 50v to ground up to 480v to ground may be performed by one Qualified Electrician, provided work is performed:

- With the specific and direct knowledge of Supervision and as defined by department electrical work practices to prevent routine interruption of electrical service; **and**
- Utilizing the appropriate Personal Protective Equipment as defined by the use of the Hazard /Risk Analysis and PPE Matrix (Page 20).

**Note:** Exception includes diagnostic testing, troubleshooting and voltage measurement by Authorized Personnel in order to determine repair or replacement work to be performed in a de-energized state, followed by start-up testing after repairs are performed.

2. If live parts are energized, (not placed in an electrically-safe operating condition), outside the scope of the routine work exemption, work to be performed shall be considered energized electrical work and shall be performed by Qualified Electricians (2) under written permit only or de-energized and scheduled during off hours to prevent interruption of electrical service.
3. If the equipment cannot be de-energized or placed in an electrically safe work condition, then two (2) Qualified Electricians are required to perform work on any exposed, energized system or equipment above 50v - 480v to ground, utilizing the appropriate Personal Protective Equipment as defined by either and Electrical Hazard Analysis which includes a Shock Hazard Analysis *and* an Arc Flash Analysis *or* the use of the hazard /Risk Analysis and PPE Matrix (Page 20) and completing the energized Electrical Work Permit and under the following conditions:
  - a. Installation, removal, or repair of lines that are energized at more than 240 volts to ground or 400 volts phase to phase;
  - b. Installation, removal, or repair of de-energized lines if an employee is exposed to contact with other parts energized at more than 200 volts to ground or 400 volts phase to phase;
  - c. Installation, removal, or repair of equipment, such as transformers, capacitors, and regulators, if an employee is exposed to contact with parts energized at more than 200 volts to ground or 400 volts phase to phase;

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	14 of 72

- d. At the request of the qualified electrician performing the work, a second employee may also be assigned to be present while performing work on energized circuits less than 200 volts to ground or 400 volts phase to phase;
- e. Data logging;
- f. Infrared thermography;
- g. Other work that exposes an employee to electrical hazards greater than or equal to those listed above.

**F. Energized Electrical Work Permit**

1. The Energized Electrical Work Permit (Appendix C) shall include, but not be limited to, the following elements:
  - a. A description of the circuit and equipment to be worked on and location;
  - b. Justification for why work must be performed in energized condition;
  - c. A description of safe work practices to be employed;
  - d. Results of Shock Hazard Analysis;
  - e. Determination of Shock Protection Boundaries (Table 1)
  - f. Results of Flash Hazard Analysis;
  - g. Determination of the Flash Hazard Protection Boundary (4.0 Feet) or calculated - Reference Table 2;
  - h. The necessary Personal Protective Equipment required to perform the work safely;
  - i. Means/method to restrict the access of unqualified employees to the work area;
  - j. Evidence of completion of the job briefing, including specific anticipated hazards;
  - k. Energized work authorization (Supervisor, Safety Officer, Qualified Electricians (2)).

**Note:** Work performed on or near live parts, by a Qualified Electrician or Authorized Person that is limited to start-up, circuit testing, troubleshooting, and voltage measurement, can be performed by a single individual and shall not require the completion of an Electrical Work Permit, provided appropriate safe work practices and Personal Protective Equipment applicable to working within the Prohibited Approach Boundary is followed by the employee. (Refer Table 1).

2. If the purpose of crossing the Limited Approach Boundary is only for visual inspection and the Restricted Approach Boundary will not be crossed, then an Energized Electrical Work Permit shall not be required.
3. The Energized Electrical Work Permit shall reference and select:
  - a. Shock Protection Boundary Table 1 (Page 14)
  - b. Hazard/Risk Category Classification Table 2 (Page 19)
  - c. Arc Flash Hazard/Risk Category Table 2 (Page 20)
  - d. PPE Selection by Arc Rating Table 3 (Page 23)

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	15 of 72

## **G. Approach Boundaries - Live Parts**

### **1. Shock Hazard Analysis**

A shock hazard analysis performed by a Qualified Electrician by consulting Table 1, shall determine the voltage to which personnel will be exposed, boundary requirements, and the personal protective equipment necessary in order to minimize the possibility of electric shock to personnel.

#### **a. Shock Protection Boundaries**

The shock protection boundaries identified as Limited, Restricted and Prohibited Approach Boundaries are applicable to the situation for which approaching personnel are exposed to live parts.

**Table 1 – Approach Boundaries to Live Parts for Shock Protection**

	LIMITED APPROACH BOUNDARY		RESTRICTED APPROACH BOUNDARY	PROHIBITED APPROACH BOUNDARY
Nominal System Voltage Range Phase-to-phase	Exposed Moveable Conductor	Exposed Fixed Part Circuit	(Includes inadvertent movement)	
Less than 50	Not Specified	Not Specified	Not Specified	Not Specified
50 to 300	10 feet 0 inch	3 feet 6 inch	Avoid Contact	Avoid Contact
301 to 750	10 feet 0 inch	3 feet 6 inch	1 foot	1 inch
751 to 15 kV	10 feet 0 inch	5 feet 0 inch	2 feet 2 inch	7 inches
15.1 kV to 36 kV	10 feet 0 inch	6 feet 0 inch	2 feet 7 inch	10 inches
36.1 kV to 46 kV	10 feet 0 inch	8 feet 0 inch	2 feet 9 inch	1 feet 5 inch
46.1 kV to 72.5 kV	10 feet 0 inch	8 feet 0 inch	3 feet 3 inch	2 feet 2 inch
72.6 kV to 121 kV	10 feet 8 inch	8 feet 0 inch	3 feet 4inch	2 feet 9 inch
138 kV to 145 kV	11 feet 0 inch	10 feet 0 inch	3 feet 10 inch	3 feet 4 inch
161 kV to 169 kV	11 feet 8 inch	11 feet 8 inch	4 feet 3 inch	3 feet 9 inch
230 kV to 242 kV	13 feet 0 inch	13 feet 0 inch	5 feet 8 inch	5 feet 2 inch
345 kV to 362 kV	15 feet 4 inch	15 feet 4 inch	9 feet 2 inch	8 feet 8 inch
500 kV to 550 kV	19 feet 0 inch	19 feet 0 inch	11 feet 10 inch	11 feet 4 inch
765 kV to 800 kV	23 feet 9 inch	23 feet 9 inch	15 feet 11 inch	15 feet 5 inch
Usual voltages encountered				

### **2. Detailed Arc Flash Hazard Analysis – New Equipment (30 September 2011)**

- a. On all electrical equipment installed after 30 September 2011, a detailed Arc Flash Hazard Analysis shall be performed by Installing Contractor, Certified Electrical Engineer or Qualified Electrician and shall be completed in order to protect personnel from the possibility of being injured by an arc flash. The analysis shall determine the Arc Flash Protection Boundary and the incident energy at the working distance and the personal protective

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	16 of 72

equipment that Qualified Electrician and Authorized Personnel within the Arc Flash Protection Boundary shall use. The results of the Arc Flash Analysis shall be posted in the equipment in the form of an accepted label (Section H).

- b. The Arc Flash Hazard Analysis shall be updated when a major modification or renovation takes place. It shall be reviewed periodically, not to exceed five (5) years, to account for changes in the electrical distribution system that could affect the results of the Arc Flash Analysis.
- c. The Arc Flash Hazard Analysis shall take into consideration the design of the overcurrent protective device and its opening time, including its condition of maintenance.
- d. In the absence of a Detailed Arc Flash Hazard Analysis and labeling, the requirements of Table 2 (Pages 19-23) shall be permitted to be used in lieu of a detailed Arc Flash Analysis or incident energy analysis performed by Qualified Electrician.

### 3. Arc Flash Protection Boundary

- a. For energized systems that are between 50 volts and 480 volts the Flash Protection Boundary shall be **4.0 feet**. For greater clearing times and bolted fault current over 100 kA cycles the formula referenced in NFPA 70E Section 130.3, Section A shall be utilized.
- b. Where it has been determined that work will be performed on energized equipment within the Flash Protection Boundary, the Flash Hazard Analysis shall determine and the employer shall document energy exposure of the workers in calories per centimeter squared. The incident energy exposure shall be based on a working distance of the employee's face and chest from the areas of prospective arc source for the specific task to be performed. Arc-rated clothing and personal protective equipment (PPE) shall be used by the employee based on the incident energy exposure related to the specific task.

### 4. Restricted Approach Boundary

- a. No Qualified Electrician or Authorized Personnel shall approach or take any conductive object closer to exposed energized parts operating a 50 volts or more in the **Restricted Approach Boundary** unless;
  - The Qualified Electrician or Authorized Personnel is insulated or guarded from the live parts operating at 50 volts or more (insulating gloves or insulating gloves and sleeves, Flash Suit and Flash Hood), from the energized parts upon which work is being performed and no un-insulated part of the qualified or authorized person's body crosses the Prohibited Approach Boundary.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	17 of 72

- The part operating at 50 volts or more is insulated from the qualified or authorized person and from any other conductive objects at a different potential.
  - The qualified or authorized person is insulated from any other conductive object as during live-line bare hand work.
- b. A Qualified Electrician or Authorized Personnel shall not reach blindly into any space containing live, energized electrical components or circuits.
- c. Non-qualified persons shall not be permitted to enter spaces where unguarded equipment is energized unless the equipment is considered placed in an electrically safe work condition as specified in Section 6.0, Paragraph A.
- d. Where one or more unqualified persons are working at or close to the **Limited Approach Boundary**, qualified or authorized personnel in charge of the work space shall advise the unqualified employee(s) of the electrical hazard and warn the employee(s) to stay outside of the Limited Approach Boundary.

#### **H. Equipment Labeling (After September 30, 2011)**

1. Electrical equipment likely to require examination, adjustment servicing or maintenance while energized shall be field marked with a label containing all the following information:
  - A. At least one (1) of the following:
    1. Available incident energy and the corresponding working distance, *or*
    2. Minimum arc rating of protective clothing, *or*
    3. Required level of PPE, *or*
    4. Highest Hazard/Risk Category (HRC) for the equipment, *and*
  - B. Nominal system voltage
  - C. Arc flash boundary
2. Labels applied prior to September 30, 2011 are acceptable *only* if they contain the available incident energy or required level of PPE. The method of calculating the data to support the label shall be documented.
3. Absent a warning label on the electrical equipment, the Qualified Electrician or Authorized Personnel shall reference the Hazard Risk Tables (Pages 19-23) in order to determine the Hazard Risk Category for the task to be performed on exposed, energized electrical equipment and selection of appropriate personal protective equipment or shall de-energize and Lockout the equipment prior to repair, maintenance or replacement.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	18 of 72

## **I. Protective Clothing and Personal Protective Equipment**

1. Employees working in areas where exposed, energized electrical hazards are present according to Table 2 – Hazard/Risk Category Classifications, shall be provided with and shall use protective equipment that is designed and constructed for a specific part of the body to be protected and the work to be performed, as per Table 3 – Protective Clothing and PPE Matrix.
2. Protective Clothing includes arc-rated shirts, pants, coveralls, overalls, and jackets worn routinely (uniform) or donned (outer wear) as Personal Protective Equipment when the employee is exposed to energized and exposed electrical hazards
3. Protective equipment shall be maintained in a safe, reliable condition according to manufacturer's direction. The personal protective equipment shall be visually inspected before each use. Specialized protective equipment shall be tested in accordance with the requirements set forth by the testing laboratories. In addition:
  - a. Head, Face Neck and Chin Protection  
Employees shall wear non-conductive head protection wherever there is a danger of head injury or electric shock or burns due to contact with energized electrical conductors or circuit parts or from flying debris resulting from electrical explosion. Employees shall wear protective equipment for the face, neck and chin whenever there is danger of injury from exposure to electric arcs or flashes or flying objects resulting from electrical explosion.
  - b. Eye Protection  
Employees shall wear non-conductive protective equipment for the eyes whenever there is danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion.
  - c. Hearing Protection  
Employees shall wear hearing protection whenever working within the arc flash boundary.
  - d. Body Protection  
Employees shall wear arc-rated clothing wherever there is a possible exposure to an electric arc flash above the threshold incident-energy level referenced in Table 4 – Protective Clothing Characteristics, for a second degree burn (1.2 calories/centimeter squared).
  - e. Hand and Arm protection  
Hand and arm protection shall be provided in accordance with I, II, and III, below.

### **I. Shock Protection**

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	19 of 72

Employees shall wear rubber insulating gloves with leather protectors where there is a danger of hand injury from electric shock due to contact with energized electrical conductors or circuit parts. Employees shall wear rubber insulating gloves with leather protectors *and* rubber insulating sleeves when there is a danger of hand and arm injury from electric shock due to contact with energized electrical conductors or circuit parts. Rubber insulating gloves shall be rated for the voltage for which the gloves will be exposed.

## II. Arc Flash Protection

Employees shall wear rubber insulating gloves where there is a danger of hand and arm injury from electric shock due to contact with live electric parts. Hand and arm protection shall be worn when there is a possible exposure to arc flash burn.

## III. Maintenance and Use

Electrical protective equipment shall be maintained in a safe, reliable condition. Insulating equipment shall be inspected for damage before use and immediately following any incident that can be reasonably suspected of having caused damage. Insulated gloves shall be given an air test, along with the inspection. Electrical protective equipment shall be subject to periodic electrical tests and the maximum intervals between tests shall be in accordance with Appendix A.

The Insulating Rubber Glove Program and Procedure is referenced in Appendix A of this document.

### f. Foot Protection

Where insulated footwear is used as protection against step and touch potential, dielectric overshoes shall be required. Electrically-rated footwear shall be used as primary electrical protection. In cases where safety footwear is required by Job Hazard Assessment, toe protection in the form of non-conductive, protective material shall be required at all times.

### g. Insulating Equipment

1. Electrical protective equipment shall be subjected to periodic electrical tests. Test voltages and test intervals shall be in accordance with Table A, B, C, D, and E. Gloves, sleeves and blankets shall be marked to indicate compliance with the test schedule and shall be marked with either the date tested, or the date the next test is due, or the replacement date.
2. The employer shall certify that insulating equipment has been tested and/ or replaced in accordance with the requirements of this section. The certification shall identify the equipment that passed the test and the date it was tested.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	20 of 72

**Table A - Electrical PPE Testing**

Maximum use, ac volts	Class	Color label	Proof test ac volts	Minimum distance <sup>2</sup> inches (millimeters)
1,000	0	Red	5,000	1 (25)
7,500	1	White	10,000	1 (25)
17,000	2	Yellow	20,000	2 (50)
26,500	3	Green	30,000	3 (75)
36,000	4	Orange	40,000	4 (100)

<sup>1</sup> Wear leather protectors over rubber gloves.

<sup>2</sup> Minimum length of exposed rubber glove above the leather protector

**Table B - AC Proof Test Requirements**

Class of equipment	Proof-test voltage rms V	Maximum proof-test current, mA (gloves only)			
		267-mm (10.5-in) glove	356-mm (14-in) glove	406-mm (16-in) glove	457-mm (18-in) glove
0	5,000	8	12	14	16
1	10,000		14	16	18
2	20,000		16	18	20
3	30,000		18	20	22
4	40,000			22	24

**Table C – DC Proof Test Requirements**

Class of equipment	Proof-test voltage
0	20,000
1	40,000
2	50,000
3	60,000
4	70,000

Note: The d-c voltages listed in this table are not appropriate for proof testing rubber insulating line hose or covers. For this equipment, d-c proof tests shall use a voltage high enough to indicate that the equipment can be safely used at the voltages listed in Table I-4. See ASTM D 1050-90 and ASTM D 1049-88 for further information on proof tests for rubber insulating line hose and covers.

**Table D – Glove Tests and Water Level (1) (2)**

Class of glove	AC proof test		DC proof test	
	mm.	In.	mm.	In.
0	38	1.5	38	1.5
1	38	1.5	51	2.0
2	64	2.5	76	3.0
3	89	3.5	102	4.0
4	127	5.0	153	6.0

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	21 of 72

- (1) The water level is given as the clearance from the cuff of the glove to the water line, with a tolerance of + or - 12 mm. (+ or - 0.5 in.).
- (2) If atmospheric conditions make the specified clearances impractical, the clearances may be increased by a maximum of 25 mm. (1 in.).

**Table E – Rubber Insulating Equipment Voltage Requirements**

Class of equipment	Maximum use voltage (1) a - c - rms	Retest voltage (2) a - c - rms	Retest voltage (2) d - c - avg
0	1,000	5,000	20,000
1	7,500	10,000	40,000
2	17,000	20,000	50,000
3	26,500	30,000	60,000
4	36,000	40,000	70,000

(1) The maximum use voltage is the a-c voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuit. However, the phase-to-ground potential is considered to be the nominal design voltage. If there is no multiphase exposure in a system area and if the voltage exposure is limited to the phase-to-ground potential, or

[2] if the electrical equipment and devices are insulated or isolated or both so that the multiphase exposure on a grounded wye circuit is removed. The proof-test voltage shall be applied continuously for at least 1 minute, but no more than 3 minutes.

**Table F. - Rubber Insulating Equipment Test Intervals**

Type of equipment	When to test
Rubber insulating line hose	Upon indication that insulating value suspect.
Rubber insulating covers	Upon indication that insulating value is suspect.
Rubber insulating blankets	<b>Before</b> first issue and every 12 months thereafter <b>(1)</b> . Upon indication that insulating value is suspect.
Rubber insulating gloves	<b>Before</b> first issue and every 6 months thereafter <b>(1)</b> . Upon indication that insulating value is suspect.
Rubber insulating sleeves	<b>Before</b> first issue and every 12 months thereafter <b>(1)</b> . Upon indication that insulating value is suspect.

- (1) 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.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	22 of 72

**Table 2 – Hazard/Risk Category Classifications can be utilized in lieu of conducting a Flash Hazard Analysis, when currents and clearing times have been verified**

<b>Hazard/Risk Category 0</b>	
<b>Hazard/Risk Category 1</b>	
<b>Hazard/Risk Category 2</b>	
<b>Hazard/Risk Category 3</b>	
<b>Hazard/Risk Category 4</b>	

Table 3 – Personnel Protective Clothing and Equipment Matrix will assign clothing and equipment working on energized equipment for the listed hazards found in Table 2.

**Table 2 – Hazard/Risk Category Classifications**

Panel boards (Rated 240V and Below) Maximum 25kA short circuit available, 0.03 second (2 cycle) fault clearing time. Minimum 18" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 19".	Hazard/Risk Category	Insulated Gloves	Insulated Tools
Perform Infrared Thermography and other non-contact inspections Outside the Restricted Approach Boundary	0	No	No
Circuit breaker (CB) or fused switch operation with covers on	0	No	No
CB or fused switch operation with covers off	0	No	No
Work on energized parts, including voltage testing	1	Yes	Yes
Remove/Install CB's or fused switches	1	Yes	Yes
Removal of bolted covers (to expose bare, energized parts)	1	No	No
Opening hinged covers (to expose bare, energized parts)	0	No	No
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by branch circuit of the panel board	1	Yes	Yes
<b>Panel boards or Switchboards Rated &gt;240V up to 600V (Molded case or insulated circuit breakers)</b> Maximum of 65 kA short circuit current available. 0.03 second (2 cycle) fault clearing time. Minimum 18" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 30"			
Perform Infrared Thermography and other non-contact inspections outside the Restricted Approach Boundary	1	No	No
CB or fused switch operation with covers on	0	No	No
CB or fused switch operation with covers off	1	Yes	No
Work on energized parts, including voltage testing	2	Yes	Yes
Remove/Install CB's or fused switches	2	Yes	Yes
Removal of bolted covers (to expose bare energized circuit parts)	1	No	No
Opening hinged covers (to expose bare, energized electrical conductor)	0	No	No
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the panel board	2	Yes	Yes
<b>600V Class Motor Control Center</b> Maximum of 65 kA short circuit current available. 0.03 second (2 cycle) fault clearing time. Minimum 18" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above. Parameters: 53"	Hazard/Risk Category	Insulated Gloves	Insulated Tools

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	23 of 72

Perform Infrared Thermography and other non-contact inspections outside the Restricted Approach Boundary	1	No	No
CB or fused switch or starter operation with enclosure door closed	0	No	No
Reading a panel meter while operating a meter switch	0	No	No
CB or fused switch or starter operation with enclosure door open	1	No	No
Work on energized parts including voltage testing	2	Yes	Yes
Work on control circuits with energized parts 120V or below, exposed	0	Yes	Yes
Work on control circuits with energized parts > 120V, exposed	2	Yes	Yes
Application of safety grounds, after voltage test	2	Yes	No
Work on energized electrical conductors and circuit parts of utilization equipment fed directly by a branch circuit of the Motor Control Center	2	Yes	Yes
<b>600V Class Motor Control Center</b> Maximum of 42kA short circuit current available. 0.03 second (2 cycle) fault clearing time. Minimum 18" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 165"	Hazard/Risk Category	Insulated Gloves	Insulated Tools
Insertion or removal of individual starter "buckets" from MCC – Note 3	4	Yes	No
Removal of bolted covers (to expose bare, energized parts) Note 3	4	No	No
Opening hinged covers (to expose bare, energized parts) Note 3	1	No	No
<b>600V Class Switchgear (with power circuit breakers or fused switches) and 600v class switchboards</b> Maximum of 35kA short circuit current available. 0.03 second (2 cycle) fault clearing time. Minimum 18" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 233"			
Perform Infrared Thermography and other non-contact inspections outside the Restricted Approach Boundary	2	No	No
CB or fused switch operation with enclosure doors closed	0	No	No
Reading a panel meter while operating a meter switch	0	No	No
CB or fused switch operation with enclosure doors open	1	No	No
Work on energized parts, including voltage testing	2	Yes	Yes
Work on control circuits with energized parts > 120V, or below	0	Yes	Yes
Work on control circuits with energized conductors >120v, exposed	2	Yes	Yes
Insertion or removal (racking) of CB from cubicles, doors open or closed	4	No	No
Application of safety grounds, after voltage test	2	Yes	No
Removal of bolted covers (to expose bare, energized parts)	4	No	No
Opening hinged covers (to expose bare, energized parts)	2	No	No
<b>Other 600V Class (277 through 600V, nominal) equipment</b> Maximum of 65kA short circuit current available. 0.03 second (2 cycle) fault clearing time. Minimum 18" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 53"			
Removal of bolted covers (to expose bare energized parts)	2	No	No
Opening hinged covers (to expose bare, energized parts)	1	No	No
Work on energized parts, including voltage testing	2	Yes	Yes
Application of safety grounds, after test	2	Yes	No
Cable trough or tray cover removal or installation	1	No	No
Miscellaneous equipment cover removal or installation	1	No	No

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	24 of 72

Work on energized parts, including voltage testing	2	Yes	Yes
Application of safety grounds, after voltage test	2	Yes	No
Insertion or removal of plug-in devices into and from busways	2	Yes	No
<b>NEMA E2 (fused contactor) Motor Starters, 2.3V through 7.2kV</b> Maximum of 35kA short circuit current available. 0.03 second (2 cycle) fault clearing time. Minimum 36" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422"			
Perform Infrared Thermography and other non-contact inspections outside the Restricted Approach Boundary	3	No	No
Contactors operation with enclosure doors closed	0	No	No
Reading a panel meter while operating a meter switch	0	No	No
Contactors operation with enclosure doors open	2	No	No
Work on energized parts, including voltage testing	4	Yes	Yes
Work on control circuits with energized parts 120V or below, exposed	0	Yes	Yes
Work on control circuits with energized parts, >120V, exposed	3	Yes	Yes
Insertion or removal (racking) of starters from cubicles, doors open or closed	4	No	No
Application of safety grounds, after voltage test	3	Yes	No
Removal of bolted covers (to expose bare, energized parts)	4	No	No
Opening of hinged covers (to expose bare, energized parts)	3	No	No
Insertion or removal (racking) of starters from cubicles of arc-resistant construction, tested in accordance with IEEE C37.20.7, doors closed only	0	No	No
<b>Metal Clad Switchgear, 1kV through 38kV</b> Maximum of 35kA short circuit current available. 0.02 second (12 cycle) fault clearing time. Minimum 36" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422"			
Perform Infrared Thermography and other non-contact inspections outside the Restricted Approach Boundary	3	No	No
CB or fused switch operations with enclosure doors closed	2	No	No
Reading a panel meter while operating a meter switch	0	No	No
CB or fused switch operation with enclosure doors open	4	No	No
Work on energized parts, including voltage testing	4	Yes	Yes
Work on control circuits with energized parts 120V or below, exposed	2	Yes	Yes
Work on control circuits with energized parts >120V, exposed	4	Yes	Yes
Insertion or removal (racking) of CB from cubicles, doors open or closed	4	No	No
Removal of bolted covers (to expose bare, energized parts)	4	No	No
Opening of hinged covers (to expose bare, energized parts)	3	No	No
Opening voltage transformer or control power transformer compartments	4	No	No
Arc-Resistant Switchgear Type 1 or 2 (for clearing times of <0.5sec with a perspective fault current not to exceed the arc-resistant rating of the equipment)			
CB operation with enclosure door closed	0	No	No
Insertion or removal (racking) of CBs from cubicles, doors closed	0	No	No
Insertion or removal of CBs from cubicles with door open	4	No	No

<b>Subject:</b>	<b>Number:</b>	<b>Rev.</b>	<b>Effective Date:</b>	<b>Page</b>
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	25 of 72

Work on control circuits with energized electrical conductors and circuit parts 120v or below, exposed	<b>2</b>	<b>Yes</b>	<b>Yes</b>
Insertion or removal (racking) of ground and test device with door closed	<b>0</b>	<b>No</b>	<b>No</b>
Insertion or removal (racking) of voltage transformers on or off the bus door closed	<b>0</b>	<b>No</b>	<b>No</b>
<b>Other Equipment 1 kV and Above</b> Maximum of 35kA short circuit current available. 0.02 second (12 cycle) fault clearing time. Minimum 36" working distance. Potential arc flash boundary with exposed energized conductors or circuit parts using above parameters: 422"			
Metal-clad interrupter switchgear, fused or unfused IEEE C37.20.7, doors closed	<b>0</b>	<b>No</b>	<b>No</b>
Switch operation, doors closed	<b>2</b>	<b>No</b>	<b>No</b>
Work on energized parts, including voltage testing	<b>4</b>	<b>Yes</b>	<b>Yes</b>
Removal of bolted covers (to expose bare, energized parts)	<b>4</b>	<b>No</b>	<b>No</b>
Opening hinged covers (to expose bare, energized parts)	<b>3</b>	<b>No</b>	<b>No</b>
Outdoor disconnect switch operation (hookstick operated)	<b>3</b>	<b>Yes</b>	<b>Yes</b>
Outdoor disconnect switch operation (gang-operated, from grade)	<b>2</b>	<b>No</b>	<b>No</b>
Insulated cable examination, in manhole or other confined space	<b>4</b>	<b>Yes</b>	<b>No</b>
Insulated cable examination, in open area	<b>2</b>	<b>Yes</b>	<b>No</b>

Notes applicable to the entire table:

Y = Yes N = No (not required)

(a) Rated gloves are gloves rated and tested for the maximum line-to-line voltage upon which work will be done.

(b) Rated 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 F1505.

Refer to current edition of NFPA 70E for addition table information.

#### **J. Protective Clothing and Personal Protective Equipment Matrix**

Once the Hazard/Risk Category has been identified, Table 3 – Protective Clothing and Personal Protective Equipment Matrix shall be utilized to determine required PPE for the task. Hazard/Risk categories are designated as 0-4. The designated PPE is required while working on energized equipment, with the Arc Flash Protection Boundary (4.0 feet)

**Table 3 – Protective Clothing and Personal Protective Equipment (PPE) Matrix**

<b>Hazard/Risk Category</b>	<b>Protective Clothing and PPE</b>
<b>Hazard/Risk Category 0</b>	
Protective Clothing, Non-melting (according to ASTM F 1506-00 or Untreated natural Fiber (cotton)	Shirt (Long Sleeve) Pants (Long)
Protective Equipment	Safety Glasses or Goggles (SR) Hearing Protection (Ear Canal Inserts) Leather Gloves (AN) (Note 1)

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	26 of 72

Hazard/Risk Category 1	
Arc-rated Clothing, Minimum Arc Rating of : <b>4</b> (Note 3)	Arc-rated Long sleeve shirt Arc-rated pants Arc-rated coverall Arc-rated face shield or arc flash suit hood (Note 2) Arc-rated jacket, parka, or rainwear, or hard hat liner (AN)
Protective Equipment	Hard Hat Safety Glasses or Safety Goggles (SR) Hearing Protection (Ear Canal Inserts) Leather Gloves (Note 1) Leather Work Shoes (AN)
Hazard/Risk Category 2	
Arc-rated Clothing, Minimum Arc-rating of: <b>8</b> (Note 3)	Arc-rated long sleeve shirt Arc-rated pants Arc-rated Coverall Arc-rated flash suit hood or arc-rated face shield (Note 2) and arc-rated balaclava Arc-rated jacket, parka, rainwear or hard hat liner (AN)
Protective Equipment	Hard Hat Safety Glasses or Safety Goggles (SR) Hearing Protection (Ear Canal Inserts) Leather Gloves (Note 1) Leather Work Shoes
Hazard/Risk Category 3	
Arc-rated Clothing, Minimum Arc-rating of: <b>25</b> (Note 3)	Arc-rated long sleeve shirt (AR) Arc-rated pants (AR) Arc-rated Coverall (AR) Arc-rated flash suit jacket (AR) Arc-rated flash suit pants (AR) Arc-rated flash suit hood Arc-rated gloves (Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
Protective Equipment	Hard Hat Safety Glasses or Safety Goggles (SR) Hearing Protection (Ear Canal Inserts) Leather Work Shoes

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	27 of 72

Hazard/Risk Category 4	
Arc-rated Clothing, Minimum Arc Rating of: <b>40</b> (Note 3)	Arc-rated long sleeve shirt (AR) Arc-rated pants (AR) Arc-rated Coverall (AR) Arc-rated flash suit jacket (AR) Arc-rated flash suit pants (AR) Arc-rated flash suit hood Arc-rated gloves (Note 1) Arc-rated jacket, parka, rainwear, or hard hat liner (AN)
FR Protective Equipment	Hard Hat Safety Glasses or Safety Goggles (SR) Hearing Protection (Ear Canal Inserts) Leather Work Shoes

AN = As needed  
 AR = As required  
 SR = Selection Required

Notes:

1. Rubber insulated gloves with leather protectors are required,
2. Face shields are to have wrap-around guarding to protect not only the face but also forehead, ears, and neck or alternatively an arc-rated flash suit hood is required to be worn.
3. Arc rating is defined in Article 100 (NFPA 70E) and can be either arc thermal performance value (ATPV) or energy break open threshold.

**K. Protective Clothing Characteristics**

Table 4 – Protective Clothing Characteristics 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 shall have an arc rating of at least the value listed in the last column of Table 4.

**Table 4 – Protective Clothing Characteristics**

Typical Protective Clothing Systems		
Hazard/ Risk Category	Clothing Description Layers in parentheses	Required Minimum Arc Rating Protection of PPE (J/cm <sup>2</sup> (cal/cm <sup>2</sup> ))
<b>0</b>	Non-melting, flammable materials (untreated cotton, wool, rayon, nylon, silk, or blends of these materials) with a fabric weight of at least 4.5oz/yd squared	N/A
<b>1</b>	Arc-rated FR shirt and FR pants or FR coverall	16.74 ( <b>4</b> )
<b>2</b>	Arc-rated FR shirt and FR pants or FR coverall	33.47 ( <b>8</b> )

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	28 of 72

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 definition as determined by ASTM – transfer of incident energy rate on and through fabric, results in a 50% probability of that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree burn.

#### **L. Factors in Selection of Protective Clothing**

1. 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, non-melting apparel. If arc-rated clothing is required, it shall cover associated parts of the body as well as the flammable apparel while allowing movement and visibility. All PPE shall be maintained in a sanitary and functionally effective condition.
  - a. Layering  
Non-melting, flammable fiber garments shall be permitted to be used as underlayers in conjunction with arc-rated garments in a layered system for added protection. If non-melting, flammable garments are worn under FR garments, the energy rating of the arc-rated FR clothing must be sufficient to prevent break-open of the innermost layer of the FR clothing, to prevent ignition of the flammable underlayers.
  - b. Outer Layers  
Garments worn over arc-rated clothing (jackets, rainwear) must also be made from arc-rated material.
  - c. Under Layers  
Melt-able fibers such as acetate, nylon, polyester, polypropylene and spandex shall not be permitted in under layers (underwear) next to the skin. Exceptions are made for the incidental elastic normally found in underwear or socks.
  - d. Coverage  
Clothing shall cover potentially exposed areas as completely as possible. Shirts shall be fastened at the wrist and shirts shall be closed at the collar.
  - e. Non-permitted apparel within the Shock and Arc Flash Protective Boundary  
The following items are not permitted within the Shock and Arc Flash protective boundaries
    - Metal Jewelry

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	29 of 72

- Conductive eye wear
- Conductive, steel-toed footwear
- Keys (hanging) or in pockets
- Metal belt buckle

#### **M. Arc Flash Protective Equipment**

1. Flash suit design shall permit easy and rapid removal by the wearer. The entire flash suit, including the hood's face shield shall have an arc rating that is suitable for potential exposure.
2. Face shields shall have an arc rating suitable for the potential arc flash exposure. Face shields without arc rating shall not be used. Eye protection (safety glasses or goggles) shall always be worn under face shields or arc flash hoods.

#### **N. Care and Maintenance of Arc-rated Clothing and Arc-rated Flash Suits**

1. Arc-rated apparel shall be inspected before each use. Work clothing or flash suits that are contaminated or damaged to the extent that their protective qualities are impaired shall not be used. Protective items that are contaminated with grease, oil, or flammable liquids or combustible materials shall not be used.
2. Protective items such as sunscreen or insect repellent are normally oil-based and shall not be applied in a manner that will contaminate FR clothing.
  - a. Storage  
Arc-rated Clothing shall be stored in a manner that prevents physical damage; damage from moisture, dust, or other deteriorating agents or contamination from flammable or combustible materials.
  - b. Cleaning, Repairing or Affixing Items  
When arc-rated clothing is cleaned, manufacturer's instructions shall be followed to avoid loss of protection. When arc-rated clothing is repaired, the same arc-rated materials used to manufacture the arc-rated clothing shall be used to provide repairs. When trim, name tags, and/or logos are affixed to arc-rated clothing, they shall be applied in accordance with ASTM 1506.

#### **O. Insulated Tools and Equipment**

1. Employees shall use insulated tools and/or handling equipment where required by Table 2 when working inside the Limited Approach Boundary of exposed live parts where tools or handling equipment might make accidental contact. Insulated tools shall be protected from damage to the insulating material.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	30 of 72

2. Insulated tools and equipment shall be inspected prior to use. The inspection shall look for damage to the insulation or damage that may limit the tool from performing its intended function or could increase the potential for an incident.
3. 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.
4. Fuse or fuse holder handling equipment, insulated for the circuit voltage, shall be used to remove or install a fuse if the fuse terminals are energized.
5. Portable ladders, meeting ANSI Standard, shall have non-conductive side-rails if they are used in applications where there are exposed live parts of 50 volts or higher.

**P. Safety Related Maintenance Requirements**

1. Engineering Design

- a. All electrical distribution panels, breakers, disconnect boxes, electrical switches; junction boxes shall be completely enclosed. Watertight enclosure shall be used where there is possibility of moisture entry either from operations or weather exposure.
- b. Electrical distribution areas will be guarded against accidental damage by locating in specifically designed rooms, use of substantial guard posts and rails and other structural means.
- c. All electrical conduit shall be supported throughout its' length. Non-electrical attachments to conduit are prohibited.

2. System Installation, Repair and Maintenance

- a. Only qualified persons, authorized contractors or employees under direct supervision of a qualified person may install or conduct repairs to electrical equipment. Contractors performing electrical work shall conform to the OSHM electrical Work Practices or shall present and file a Job Safety Plan with the City of Tucson.
- b. All equipment shall be labeled with maximum voltage potential, with clear and distinct control markings and function. Where work may occur on energized equipment, or the equipment has the potential to become energized, the employee shall be warned of the potential Arc Flash Hazard by label and the need to conduct an Arc Flash analysis to determine the proper Approach boundary and Personal Protective Equipment. ANSI Z535 compliant vinyl labels, UV resistant are required.
- c. Access to electrical distribution rooms shall be limited to those employees who have a need to enter. Work on energized circuits shall be avoided if possible. If not, work must be performed by qualified employees, only. All

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	31 of 72

employees shall follow established electrical safety procedures and precautions.

- d. Maintenance procedures and schedules for servicing and maintaining equipment and facilities including documentation of repairs, removals, replacements, and disposals shall be established.
- e. All persons working in areas of high hazard (with high-voltage power supplies, etc.) must be trained in emergency response procedures, and at least one individual shall be certified in cardiopulmonary resuscitation and first aid (CPR/FA).
- f. 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 them from contacting exposed energized conductors or circuit parts.
- g. Non-conductive eye wear shall be worn when performing work on or near energized parts. Conductive articles of jewelry, such as metal watch bands, bracelets, neck chains, rings, may not be worn by the employee while performing an electrical work practice.

**Q. Portable Electrical Equipment**

1. Flexible (extension) cords shall not protrude through walls, ceiling tiles, windows, or doors and shall not be affixed by any manner to walls or pipe. Terminal ends of cord connectors shall be of plastic or non-conductive materials. Terminal ends with metal strain relief or stability rings shall be eliminated. Extension cords shall be properly sized (16 gauge minimum) with respect to cord length and load capacity. Low amperage extension cords (commonly known as "zip cords") are not permitted in city facilities.
2. Extension cords shall maintain a grounding lug or shall be double insulated. Grounding adapters are not permitted. Cords shall be inspected before use for cracks, cuts, or other physical damage that exposes cord insulation and wire. Cords exhibiting wire of any color shall be immediately removed from service and repaired by a qualified electrician before being returned to service. Splices shall utilized approved hardware and technique and shall return the insulating capacity of cord to its' original condition.
3. Extension cords shall be purchased from a retail vendor or shall only be constructed by a Qualified Electrician. Extension cords intended for outdoor use and event use shall be protected with a Ground Fault Circuit Interruption (GFCI) outlet or shall be plugged into a GFCI circuit. Extension cord outlets shall be incased in a water-tight box - "knockout" boxes, designed for indoor applications to be attached to a vertical wall stud, is prohibited for use in the construction of extension cords, extension cord sets or pig tails for use as a city employee in the performance of job duties.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	32 of 72

4. Extension cords shall not be utilized in place of permanent wiring. Extension cords may be utilized for functions such as holiday lighting or temporary events, not to exceed ninety (90) days.
5. Power Strips (multi-outlet extension cords) shall have over current protection (internal circuit breaker). Power strips shall not be placed in series (piggy backed – one; unit plugged directly into another). The Power Strip must be UL approved and care shall be taken not to electrically overload the unit. Power strips utilized in outdoor locations shall be UL approved for outdoor use.
6. Outlet expanding devices, with the exception of Power Strips with integrated circuit override protection, are not permitted in the City of Tucson.

**R. Fixed Electrical Equipment**

1. Electrical equipment shall be free from recognized hazards that are likely to cause physical harm to employees. Electrical equipment must be marked with manufacturer's identity, voltage, current or other markings/ratings as necessary. Markings shall not be removed, obscured, defaced, or painted over. Circuit breaker panels must have an updated and legible schedule in place identifying the circuit that each circuit breaker controls.
2. Each disconnecting means for electrical equipment shall be legibly marked to indicate its purpose. Each service, feeder, and branch circuit, at its disconnecting means or over current device, shall be legibly marked to indicate its purpose. These markings shall be of sufficient durability to withstand the environment involved.
  - a. Access to Fixed Equipment  
Storage of material is not permitted in electrical rooms. Clear access of thirty-six (36) inches shall be provided. The depth of the working space shall be clear to the floor. Working space will vary depending on voltage and physical conditions. Refer to Table 5 and Table 6.

**TABLE 5 - WORKING CLEARANCES**

Nominal voltage to ground	Minimum clear distance for condition <sup>(2)</sup> (ft)		
	(a)	(b)	(c)
0-150	<sup>(1)</sup> 3	<sup>(1)</sup> 3	3
151-600	<sup>(1)</sup> 3	3 1/2	4

(1) Minimum clear distances may be 2 feet 6 inches for installations built prior to April 16, 1981.

(2) Conditions (a), (b), and (c), are as follows: (a) 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 bussbars operating at not over 300 volts are not considered live parts. (b) Exposed live parts on one side and grounded parts on the other side. (c) Exposed live parts on both sides of the workspace [not guarded as provided in Condition (a)] with the operator between.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	33 of 72

**TABLE 6 - MINIMUM DEPTH OF CLEAR WORKING SPACE IN FRONT OF ELECTRIC EQUIPMENT**

Nominal voltage to ground	Conditions <sup>(2)</sup> (ft)		
	(a)	(b)	(c)
601 to 2,500	3	4	5
2,501 to 9,000	4	5	6
9,001 to 25,000	5	6	9
9,001 to 75kV <sup>(1a)</sup>	6	8	10
Above 75kV <sup>(1a)</sup>	8	10	12

**(1a)** Minimum depth of clear working space in front of electric equipment with a nominal voltage to ground above 25,000 volts may be the same as for 25,000 volts under Conditions (a), (b), and (c) for installations built prior to April 16, 1981.

**(2a)** Conditions (a), (b), and (c) are as follows: (a) 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 materials. Insulated wire or insulated bussbars operating at not over 300 volts are not considered live parts. (b) Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces. (c) Exposed live parts on both sides of the workspace not guarded as provided in Condition (a) with the operator between.

At least one entrance, not less than 24 inches wide and 6 feet 6 inches high shall be provided to give access to the working space about electric equipment. On switchboard and control panels exceeding 48 inches in width, there shall be one entrance at each end of such board where practicable. Ladders or stairways, permanent where required, shall be provided to give safe access to the working space around electric equipment installed on platforms, balconies, mezzanine floors, or in attic or roof rooms or spaces.

**b. Disconnecting Means**

All disconnecting means (switches or circuit breakers) shall be located for easy access and shall be clearly and permanently marked for the specific environment. The disconnect label shall readily identify what equipment and/or circuits are affected by the device. Labeling should match and be traceable to appropriate drawings. Disconnecting means shall be capable of being locked out where required. Multiple service main disconnects shall be appropriately labeled to include:

- Number (i.e., 1 of 3)
- Physical location of other disconnects if not readily apparent
- Location/equipment serviced
- Amperage rating and system voltage and phases

**c. Over-current Protection – Circuit Breakers and Fuses**

**i.** Conductors and equipment shall be protected from over-current in accordance with the National Electrical Code. Except for motor running

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	34 of 72

overload protection, over-current devices shall not interrupt the continuity of the grounded conductor unless all conductors of the circuit are opened simultaneously. Over-current protection of circuits and conductors shall not be modified or taped, even on a temporary basis.

- II. Over-current devices shall be readily accessible to each employee or authorized building management personnel. These over-current devices may not be located where they will be exposed to physical damage or in the vicinity of easily ignitable material.
- III. All fuses which are accessible to other than qualified persons and all fuses and thermal cutouts on circuits over 150 volts to ground shall be provided with disconnecting means. This disconnecting means shall be installed so that the fuse or thermal cutout can be disconnected from its supply without disrupting service to equipment and circuits unrelated to those protected by the over-current device.
- IV. Fuses and circuit breakers shall be located or shielded (dead front or enclosure) so that employees will not be burned or otherwise injured by their operation. Breakers that have been removed from a port shall be covered by a plastic cover designed by the manufacturer for the manufactured equipment, for insertion into a blank port.
- V. Circuit breakers shall clearly indicate whether they are in the open (off) or closed (on) position. Where circuit breaker handles on switchboards are operated vertically rather than horizontally or rotationally, the up position of the handle shall be the closed (on) position.
- VI. If used as switches in 120-volt, fluorescent lighting circuits, circuit breakers shall be approved for the purpose and marked "SWD". For remodeling, where feasible or for new construction, circuit breakers shall not be used as switches.

Any circuit over 600 volts shall have short circuit protection.

#### **S. Lighting**

Employees may not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely. Where lack of illumination or an obstruction precludes observation of the work to be performed, employees shall not perform task near exposed energized parts. Employees shall not reach blindly into areas which may contain energized parts.

#### **T. Guarding of Live Parts**

1. Except as required or permitted elsewhere, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact:

- By approved cabinets or other forms of approved enclosures;

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	35 of 72

- 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 live parts;
- By location on a suitable balcony, gallery, or platform so elevated and arranged as to exclude unqualified employees;
- By elevation of 8 feet or more above the floor or other working surface;
- In locations where electric equipment would be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage;
- Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.

#### **U. Underground or Overhead Utility Work**

1. Work areas where employees may be excavating, digging, or disturbing the surface using tools of any type, including excavation of any portion of structure foundations, including guy anchors which support overhead high-voltage lines Arizona Blue Stake shall be called prior to start of work. See Occupational Safety and Health Manual - **S-013, Blue Stake Program.**
2. Prior to beginning a job, examine the worksite to determine if there are any overhead high-voltage lines (600 volts or higher) at the worksite. If it is necessary to perform work within ten feet of overhead high-voltage lines (600 volts or higher), the project supervisor or qualified person shall immediately contact the determined facility owner and request an overhead utility survey no later than 48 hours prior to the beginning of the job.
3. In order to perform work within ten feet of overhead high-voltage lines (600 volts or higher), the project supervisor or qualified person shall make precautionary safety measures with the utility company that may include any or all of the following:
  - a. The overhead high-voltage lines being de-energized by the utility;
  - b. Temporary placement of mechanical barriers to separate and prevent contact between equipment, material, other objects, or person and high-voltage lines by the utility;
  - c. Temporary relocation or raising of the high-voltage lines by the utility;
  - d. Other precautionary safety measures as recommended by the utility company.
4. No overhead communication lines, including fiber optics, are to be raised, moved, or displaced for any reason without contacting the facility owner through Arizona Blue Stake. No materials are to be stored within ten feet of the overhead high-voltage line.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	36 of 72

5. All employees shall be trained and understand the hazard of operating motorized equipment in proximity to high voltage electrical lines. All equipment shall have posted warning signs that state "UNLAWFUL TO OPERATE THIS EQUIPMENT WITHIN TEN FEET OF OVERHEAD HIGH-VOLTAGE LINES" and the signage is readily visible to the equipment operator, and are located on the outside of the equipment to be readily visible to other employees at the worksite.
6. All employees on the worksite shall wear Class B hard hats which provide protection against high-voltage. Additionally, any other electrical protective devices (e.g., rubber gloves.) shall be used as applicable.
7. Intentional contact with any overhead high voltage line whether protected or not, is prohibited. If the equipment does contact an overhead high-voltage line, the equipment operator and other on-board personnel shall remain on that piece of equipment until the overhead high-voltage line is de-energized.
8. If fire breaks out from the contact between the equipment and the overhead high-voltage line, the equipment operator and any other persons shall jump off the piece of equipment with both legs against each other (not spread apart). These individuals shall then "bunny" jump/hop with both legs against each other for no less than 25 feet but as far as the individuals can get away from the overhead high-voltage line.
9. When a qualified electrician or authorized personnel is working in the vicinity of overhead lines, that person may not approach or take any conductive object without an approved insulating handle closer to exposed energized parts than shown in OSHA Table 7 (given below) unless:
  - a. The person is insulated from the energized part (gloves, with sleeves if necessary, rated for the voltage involved are considered to be insulation of the person from the energized part on which work is performed), or
  - b. The energized part is insulated both from all other conductive objects at a different potential and from the person, or
  - c. The person is insulated from all conductive objects at a potential different from that of the energized part.

**Table 7**  
**APPROACH DISTANCES FOR QUALIFIED EMPLOYEES - ALTERNATING CURRENT**

Voltage range (phase to phase)	Minimum approach distance
300V and less	Avoid Contact
Over 300V, not over 750V	1 ft. 0 in. (30.5 cm).
Over 750V, not over 2kV	1 ft. 6 in. (46 cm).
Over 2kV, not over 15kV	2 ft. 0 in. (61 cm).
Over 15kV, not over 37kV	3 ft. 0 in. (91 cm).
Over 37kV, not over 87.5kV	3 ft. 6 in. (107 cm).
Over 87.5kV, not over 121kV	4 ft. 0 in. (122 cm).
Over 121kV, not over 140 kV	4 ft. 6 in. (137 cm).

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	37 of 72

10. When an unqualified electrician or authorized personnel is working in the vicinity of overhead lines, that person may not bring any conductive object closer to unguarded, energized overhead lines than as follows:

- a. For voltages to ground 50kV or below - 10 feet
- b. For voltages to ground over 50kV - 10 feet plus 4 inches for every 10kV over 50kV.
- c. For unknown voltages a minimum of 20 feet shall be maintained.

11. Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearances depicted in #10 above are maintained.

12. Under any of the following conditions, the clearance may be reduced:

- a. If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. If the voltage is higher than 50kV, the clearance shall be increased 4 in. for every 10kV over that voltage;
- b. If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or it's raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier;
- c. If the equipment is an aerial lift insulated for the voltage involved. And if the work is performed by a qualified person, the clearance (between the un-insulated portion of the aerial lift and the power line) may be reduced to the distance given in Table 7.

13. Employees standing on the ground shall not contact the vehicle or mechanical equipment or any of its attachments, unless:

- a. The employee is using protective equipment rated for the voltage; or
- b. The equipment is located so that no un-insulated part of it's structure can come closer to the line than permitted, as noted above (10 ft. plus);
- c. If any vehicle or mechanical equipment near energized overhead lines is intentionally grounded:

14. Employees working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

## **V. Confined Space**

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	38 of 72

1. Employees shall conform to the OSHM policy S-005 Confined Space when preparing to work in a confined space. When an employee works in a confined space (such as a manhole or vault) that contains exposed energized parts, 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.
2. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.

#### **W. Housekeeping**

1. Where live parts present an electrical contact hazard, non-qualified employees may not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided.
2. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.
3. Barriers or other means of guarding shall be provided to ensure that workspace for electrical equipment will not be used as a passageway during periods when energized parts of electrical equipment are exposed. Working spaces, walkways, and similar locations shall be kept clear of cords so as not to create a trip hazard to employees.

#### **X. Opening and Closing of Circuits**

1. Only load rated switches, circuit breakers, or other devices specifically designed as disconnecting means under load shall be used for the opening, reversing, or closing of circuits under load conditions. Cable connectors not of the load break type, fuses, terminal lugs, and cable splice connections shall not be used for such purposes, except in an emergency.
2. After a circuit is de-energized by a circuit protective device, the circuit may not be manually reenergized until it has been determined by a Qualified Electrician or Authorized Personnel that the equipment and circuit can be safely energized. The repetitive manual re-closing of circuit breakers or reenergizing circuits through replaced fuses is prohibited.
3. The Qualified Electrician or Authorized Employee shall stand off to the side of the disconnecting device and shall re-energize the circuit with the weak hand.

#### **Y. Grounding**

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	39 of 72

1. "Grounded" means that the connection to ground between the service panel and earth has been made. Grounding is used to:
  - a. Limit the electrical shock hazard to employees in case of ground fault;
  - b. Safely conduct ground-fault current at sufficient magnitude for fast operation of the circuit over current protection devices.

2. Grounding is required to:

- a. Be permanent and continuous;
- b. Have ample capacity to safely conduct ground-fault current;
- c. Have impedance sufficiently low to limit the voltage to ground to a safe magnitude and to facilitate the operation of the circuit over current protection devices.

3. Systems to be Grounded

- a. Three wire DC systems (neutral conductor grounded);
- b. Two wire DC systems between 50 and 300 volts.

AC circuits of less than 50 volts if:

- a. Installed as overhead conductors outside of buildings;
- b. Supplied by transformer which is ungrounded or exceeds 150 volts to ground.

AC circuits of 50 to 1,000 volts if:

- a. The system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts;
- b. The system is nominally rated 480Y/277 volt, 3-phase, 4-wire in which the neutral is used as a circuit conductor;
- c. The system is nominally rated 240/120 volt, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor; or
- d. A service conductor is un-insulated.

4. Systems Not Required to be Grounded

AC systems of 50 volts to 1,000 volts are not required to be grounded under the following conditions;

- a. If the system is separately derived and is used exclusively for rectifiers supplying only adjustable speed industrial drives; or
- b. If the system is separately derived and is supplied by a transformer that has a primary voltage rating less than 1,000 volts, provided all of the following conditions are met:

- The system is used exclusively for control circuits,

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	40 of 72

- The conditions of maintenance and supervision assure that only qualified persons will service the installation,
- Continuity of control power is required, and ground detectors are installed on the control system.

5. Grounding Connections/Conductors

- a. For AC premises wiring systems the identified conductor shall be grounded. A conductor used as a grounded conductor or as an equipment grounding conductor shall be identifiable and distinguishable from all other conductors. No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity. A grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug may not be used for purposes other than grounding.

6. Grounded Systems

- a. A grounding electrode conductor shall be used to connect both the equipment grounding conductor and the grounded circuit conductor to the grounding electrode.
- b. Both the equipment grounding conductor and the grounding electrode conductor shall be connected to the grounded circuit conductor on the supply side of the service disconnecting means, or on the supply side of the system disconnecting means or overcurrent devices if the system is separately derived.
- c. A common ground loop shall be utilized where appropriate.

7. Ungrounded Systems

- a. The equipment grounding conductor shall be connected to the grounding electrode conductor at the service equipment. For an ungrounded separately derived system, the equipment grounding conductor shall be connected to the grounding electrode conductor at, or ahead of, the system disconnecting means or overcurrent devices.

8. Branch Circuit Extensions

- a. Extensions of existing branch circuits which do not have an equipment grounding conductor shall be grounded or GFCI receptacles may be used if appropriately labeled as ungrounded.

9. Supports, Enclosures and Equipment to be Grounded

- a. Supports and enclosures for conductors, metal cable trays, metal raceways, and metal enclosures for conductors shall be grounded, except that:
1. Metal enclosures such as sleeves that are used to protect cable assemblies from physical damage need not be grounded.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	41 of 72

2. Metal enclosures for conductors added to existing installations of open wire, knob-and-tube wiring, and nonmetallic-sheathed cable need not be grounded if all of the following conditions are met:
  3. Runs are less than 25 feet;
  4. Enclosures are free from probable contact with ground, grounded metal, metal laths, or other conductive materials;
  5. Enclosures are guarded against employee contact.
- b. Metal enclosures for service equipment shall be grounded. Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and metal outlet or junction boxes which are part of the circuit for these appliances shall be grounded.
- c. Exposed non-current-carrying metal parts of fixed equipment which may become energized shall be grounded under any of the following conditions:
1. If within 8 feet vertically or 5 feet horizontally of ground or grounded metal objects and subject to employee contact;
  2. If located in a wet or damp location and not isolated;
  3. If in electrical contact with metal;
  4. If in a hazardous location;
  5. If supplied by a metal-clad, metal-sheathed, or grounded metal raceway wiring method.
- d. If equipment operates with any terminal at over 150 volts to ground; however, the following need *not be grounded*:
1. Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only;
  2. Metal frames of electrically heated appliances which are permanently and effectively insulated from ground;
  3. Distribution apparatus such as transformers and capacitors mounted on wooden poles at a height exceeding 8 feet above ground or grade level.
- e. Equipment connected by cord and plug. Under any of the conditions below, exposed non-current-carrying metal parts of cord-and-plug connected equipment which may become energized shall be grounded:
1. If in hazardous locations;
  2. If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.
- f. If the equipment is of the following types:
1. Refrigerators, freezers, and air conditioners;

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	42 of 72

2. Clothes-washing, clothes-drying and dishwashing machines, sump pumps, and electrical aquarium equipment;
  3. Hand-held motor-operated tools;
  4. Motor-operated appliances of the following types: hedge clippers, lawn mowers, and wet scrubbers;
  5. Cord-and-plug connected appliances used in damp or wet locations or by employees standing on the ground or on metal floors or working inside of metal tanks or boilers;
  6. Portable hand lamps;
  7. Tools likely to be used in wet or conductive locations or utilized outdoors (wet locations) for “construction-like” activities.
- g. Tools likely to be used in wet and conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts.
  - h. Listed or labeled portable tools and appliances protected by an approved system of double insulation, or its equivalent, need not be grounded. If such a system is employed, the equipment shall be distinctively marked to indicate that the tool or appliance utilizes an approved system of double insulation.
  - i. Non-current-carrying metal parts of fixed equipment, if required to be grounded by this subpart, shall be grounded by an equipment grounding conductor which is contained within the same raceway, cable, or cord, or runs with or encloses the circuit conductors. **For DC circuits only, the equipment grounding conductor may be run separately from the circuit conductors.**
  - j. Electric equipment is considered to be effectively grounded if it is secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack or structure is grounded by the method specified above.
10. Grounding of Systems Over 1,000 Volts
- a. Grounding of systems with over 1,000 volts shall comply with all requirements mentioned above in this section. Systems supplying portable or mobile high voltage equipment, other than substations installed on a temporary basis, shall comply with the following:
    1. Portable and mobile high voltage equipment shall be supplied from a system having its neutral grounded through an impedance. If a delta-connected high voltage system is used to supply the equipment, a system neutral shall be derived;

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	43 of 72

2. Exposed non-current-carrying metal parts of portable and mobile equipment shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.
  - b. Ground-fault detection and relaying shall be provided to automatically de-energize any high voltage system component which has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to de-energize automatically the high voltage feeder to the portable equipment upon loss of continuity of the equipment grounding conductor.
  - c. The grounding electrode to which the portable or mobile equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 20 feet from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as buried pipe, fence, etc.
  - d. All non-current-carrying metal parts of portable equipment and fixed equipment including their associated fences, housings, enclosures, and supporting structures shall be grounded. However, equipment which is guarded by location and isolated from ground need not be grounded.
  - e. Additionally, pole-mounted distribution apparatus at a height exceeding 8 feet above ground or grade level need *not be grounded*.

## **Z. Portable and Vehicular Mounted Generators**

1. Under the following conditions, the frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator:
  - a. The generator supplies only equipment mounted on the generator and/or cord-and-plug connected equipment through receptacles mounted on the generator; and
  - b. The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.
2. Under the following conditions the frame of a vehicle may serve as the grounding electrode for a system supplied by a generator located on the vehicle:
  - a. The frame of the generator is bonded to the vehicle frame; and
  - b. The generator supplies only equipment located on the vehicle and/or cord-and-plug-connected equipment through receptacles mounted on the vehicle or on the generator; and

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	44 of 72

- c. The non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame; and
  - d. The system complies with all other provisions of this section.
3. A neutral conductor shall be bonded to the generator frame if the generator is a component of a separately derived system. No other conductor need be bonded to the generator frame.
  4. Appropriate GFCI protection shall be used when operating portable tools powered by a generator.

**A1. Bonding**

1. "Bonding" means the permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed on the material.
2. Bonding is required to:
  - a. Provide a permanent connection;
  - b. Provide a positive continuity at all times; and
  - c. Provide ample capacity to conduct fault current.

**A2. Wiring Methods, Components and Equipment**

1. Installation

- a. Metal raceways, cable armor, and other metal enclosures for conductors shall be metallically joined together into a continuous electric conductor and shall be so connected to all boxes, fittings, and cabinets as to provide effective electrical continuity.
- b. Electrical wiring, even if encased in conduit, through duct work of any type is prohibited.
- c. Feeders shall originate in an approved distribution center. The conductors shall be run as multi-conductor cord or cable assemblies, or, where not subject to physical damage, they may be run as open conductors on insulators not more than 10 feet apart.
- d. Branch circuits shall originate in an approved power outlet or panel board. Conductors shall be multi-conductor cord or cable assemblies or open conductors. If run as open conductors they shall be fastened at ceiling height every 10 feet. No branch-circuit conductor may be laid on the floor. Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor if run as open conductors.
- e. Receptacles shall be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit shall contain a separate

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	45 of 72

equipment grounding conductor and all receptacles shall be electrically connected to the grounding conductor. No bare conductors or earth returns may be used for the wiring of any circuit.

- f. Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

## 2. Cable Trays

- a. Only the following may be installed in cable tray systems:

1. Mineral-insulated metal-sheathed cable (Type MI);
2. Armored cable (Type AC);
3. Metal-clad cable (Type MC);
4. Power-limited tray cable (Type PLTC);
5. Nonmetallic-sheathed cable (Type NM or NMC);
6. Shielded nonmetallic-sheathed cable (Type SNM);
7. Multi-conductor service-entrance cable (Type SE or USE);
8. Multi-conductor underground feeder and branch-circuit cable (Type UF)
9. Power and control tray cable (Type TC);
10. Other factory-assembled, multi-conductor control, signal, or power cables which are specifically approved for installation in cable trays;
11. Any approved conduit or raceway with its contained conductors.

- b. In industrial establishments only, where conditions of maintenance and supervision assure that only qualified persons will service the installed cable tray system, the following cables may also be installed in ladder, ventilated trough, or 4 inch ventilated channel-type cable trays:

1. Single conductor cables which are 250 MCM or larger and are Types RHH, RHW, MV, USE, or THW, and other 250 MCM or larger single conductor cables if specifically approved for installation in cable trays.

- c. Where exposed to direct rays of the sun, cables shall be sunlight-resistant.

- d. Cable Trays shall not be installed or utilized in the following manner:

1. In hoist ways or where subjected to severe physical damage
2. As a climbing/walkway device
3. To support anything other than electrical cable and conduit
4. Installation of cables carrying over 600 volts and under 600 volts unless a permanent separation barrier is installed

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	46 of 72

- e. Cable trays in hazardous locations shall contain only the cable types permitted in such locations.

3. Cabinets, Boxes and Fittings

- a. Conductors entering boxes, cabinets, or fittings shall also be protected from abrasion, and openings through which conductors enter shall be effectively closed. Unused openings in cabinets, boxes, and fittings shall be effectively closed.
- b. All pull boxes, junction boxes and fittings shall be provided with covers approved for the purpose. The following shall apply to pull and junction boxes for systems over 600 volts:
  - 1. Boxes shall provide a complete enclosure for the contained conductors or cables
  - 2. Boxes shall be closed by suitable covers securely fastened in place.
- c. Underground box covers that weigh over 100 pounds meet this requirement. Covers for boxes shall be permanently marked "HIGH VOLTAGE". The marking shall be on the outside of the box cover and shall be readily visible and legible.

4. Knife Switches - (except enclosed disconnects)

- a. Knife switches shall be so connected that the blades are dead when the switch is in the open position. Single-throw knife switches shall be so placed that gravity will not tend to close them. Single-throw knife switches approved for use in the inverted position shall be provided with a locking device that will ensure that the blades remain in the open position when so set.
- b. Double-throw switches may be mounted so that the throw will be either vertical or horizontal. However, if the throw is vertical a locking device shall be provided to ensure that the blades remain in the open position when so set.

5. Switchboards and Panel boards

- a. Switchboards that have any exposed live parts shall be located in permanently dry locations and accessible only to qualified persons. Panel boards shall be mounted in cabinets, cutout boxes, or enclosures approved for the purpose and shall have a dead front. However, panel boards other than the dead front externally-operable type are permitted where accessible only to qualified electricians or authorized personnel.

6. Enclosures for Damp or Wet Locations

- a. Cabinets, cutout boxes, fittings, boxes and panel board enclosures in damp or wet locations shall be installed so as to prevent moisture or

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	47 of 72

water from entering and accumulating within the enclosures. In wet locations the enclosures shall be weatherproof.

- b. Switches, circuit breakers, and switchboards installed in wet locations shall be enclosed in weatherproof enclosures. Receptacles must have a "weather-proof in-use" cover.

#### 7. Conductors for General Wiring

- a. All current carrying conductors used for general wiring shall be insulated. The conductor insulation shall be of a type that is approved for the voltage, operating temperature, and location of use. Insulated conductors shall be distinguishable by appropriate color or other suitable means as being grounded conductors, ungrounded conductors, or equipment grounding conductors.

#### 8. Temporary Wiring

- a. Temporary electrical wiring of 600 volts or less is permitted during remodeling, maintenance, repair, or demolition of buildings, structures, or equipment, and similar activities and for experimental or development work for a period not to exceed 90 days for event lighting, carnivals, and similar purposes.
- b. All temporary electrical wiring of 600 volts or less shall be plugged into a Ground Fault Current Interrupting (GFCI) outlet or device, or in absence of a GFCI outlet, shall be adequately grounded by means of proper installation and shall be documented as a component of an Assured Grounding Program designed and implemented by a Qualified Electrician.
- c. All electrically powered tools or equipment utilized outdoors or in wet conditions, in building or facility maintenance, but utilized in a "construction-like" application shall be plugged into a GFCI outlet or device.
- d. Temporary wiring over 600 volts is permitted only for testing, experiments or emergencies.

#### 9. Flexible Cords and Cables

- a. The flexible cord shall be equipped with an attachment plug and shall be energized from an approved receptacle outlet. Flexible cords and cables shall only be used only for the following and are otherwise prohibited:
  1. Pendants (with wire-type strain relief)
  2. Wiring of fixtures
  3. Connection of portable lamps or appliances
  4. Elevator cables

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	48 of 72

5. Wiring of cranes and hoists
6. Connection of stationary equipment to facilitate their frequent interchange
7. Prevention of the transmission of noise or vibration
8. Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair
9. Data processing cables approved as a part of the data processing system

10. Portable Cables Over 600 Volts

- a. Multi-conductor portable cable for use in supplying power to portable or mobile equipment at over 600 volts, nominal, shall consist of No. 8 or larger conductors employing flexible stranding. Cables operated at over 2,000 volts shall be shielded for the purpose of confining the voltage stresses to the insulation. Grounding conductors shall be provided.
- b. Connectors for these cables shall be of a locking type with provisions to prevent their opening or closing while energized. Strain relief shall be provided at connections and terminations.
- c. Portable cables may not be operated with splices unless the splices are of the permanent molded, vulcanized, or other approved type. Termination enclosures shall be suitably marked with a high voltage hazard warning, and terminations shall be accessible only to authorized and qualified personnel.

11. Lighting Fixtures

- a. Fixtures, lamp-holders, lamps, rosettes, and receptacles may have no live parts normally exposed to employee contact.
- b. Lamp-holders of the screw-shell type shall be installed for use as lamp-holders only. Lamp-holders installed in wet or damp locations shall be of the weatherproof type.
- c. Fixtures installed in wet or damp locations shall be approved for the purpose and shall be so constructed or installed that water cannot enter or accumulate in wire ways, lamp-holders, or other electrical parts.
- d. Lamps for general illumination shall be protected from accidental contact or breakage. Protection shall be provided by elevation of at least 7 feet from normal working surface or by a suitable fixture or lamp-holder with a guard.
- e. Temporary lights shall not be suspended by their electric cords unless cords and lights are designed for this means of suspension.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	49 of 72

## 12. Appliances

- a. Appliances shall have no live parts normally exposed to employee contact. A means shall be provided to disconnect each appliance. Each appliance shall be marked with its rating in volts and amperes or volts and watts by means of an identification tag or plate supplied by the manufacturer

## **B3** Motors

If specified that one piece of equipment shall be "in sight of" another piece of equipment, one shall be visible and not more than 50 feet from the other.

### 1. Disconnecting Means:

- a. A disconnecting means shall be located in sight of the controller location. The controller disconnecting means for motor branch circuits over 600 volts, nominal, may be out of sight of the controller, if the controller is marked with a warning label giving the location and identification of the disconnecting means which is to be locked in the open position.
- b. The disconnecting means shall disconnect the motor and the controller from all ungrounded supply conductors and shall be so designed that no pole can be operated independently.
- c. If a motor and the driven machinery are not in sight from the controller location, the installation shall comply with one of the following conditions:
  - The controller disconnecting means shall be capable of being locked in the open position.
  - A manually operable switch that will disconnect the motor from its source of supply shall be placed in sight from the motor location.
- d. The disconnecting means shall plainly indicate whether it is in the open (off) or closed (on) position. The disconnecting means shall be readily accessible. If more than one disconnect is provided for the same equipment, only one need be readily accessible.
- e. An individual disconnecting means shall be provided for each motor, but a single disconnecting means may be used for a group of motors under any one of the following conditions:
  - If a number of motors drive special parts of a single machine or piece of apparatus, such as a metal or woodworking machine, crane, or hoist;
  - If a group of motors is under the protection of one set of branch-circuit protective devices; or

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	50 of 72

- If a group of motors is in a single room in sight of the location of the disconnecting means

2. Motor Overload, Short-circuit, and Ground-fault Protection

- Motors, motor-control apparatus, and motor branch-circuit conductors shall be protected against overheating due to motor overloads or failure to start, and against short circuits or ground faults.
- These provisions shall not require overload protection that will stop a motor where a shutdown is likely to introduce additional or increased hazards, as in the case of fire pumps, or where continued operation of a motor is necessary for a safe shutdown of equipment or process and motor overload sensing devices are connected to a supervised alarm.

3. Protection of Live Motor Parts (all voltages)

- Stationary motors having commutators, collectors, and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground need not have such parts guarded.
- Exposed live parts of motors and controllers operating at 50 volts or more between terminals shall be guarded against accidental contact by any of the following:
  - By installation in a room or enclosure that is accessible only to qualified electrician or authorized person
  - By installation on a suitable balcony, gallery, or platform, so elevated and arranged to exclude unqualified persons
  - By method of protection such as sheet metal, hardware cloth or expanded metal, where the greatest opening is less than .50 inch
  - By elevation 8 feet or more above the floor
- Where live parts of motors or controllers operating at over 150 volts to ground are guarded against accidental contact only by location, and where adjustment or other attendance may be necessary during the operation of the apparatus, suitable insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms.

**A4. Transformers**

- The following covers the installation of all transformers **except** the following:
  - Current transformers
  - Dry-type transformers installed as a component part of other apparatus

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	51 of 72

- c. Transformers which are an integral part of an X-ray, high frequency, or electrostatic-coating apparatus
  - d. Transformers used with Class 2 and Class 3 circuits, sign and outline lighting, electric discharge lighting, and power-limited fire-protective signaling circuits and
  - e. Liquid-filled or dry-type transformers used for research, development, or testing, where effective safeguard arrangements are provided
2. The operating voltage of exposed live parts of transformer installations shall be indicated by warning signs or visible markings on the equipment structure. Dry-type, high fire point liquid-insulated, and askarel-insulated transformers installed indoors and rated over 35kV shall be in a vault.
  3. If they present a fire hazard to employees, oil-insulated transformers installed indoors shall be in a vault and vault labeled as to hazards inside.
  4. Combustible material, combustible buildings and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires which may originate in oil-insulated transformers attached to or adjacent to a building or combustible material.
  5. Transformer vaults shall be constructed so as to contain fire and combustible liquids within the vault and to prevent unauthorized access. Locks and latches shall be so arranged that a vault door can be readily opened from the inside.
  6. Any pipe or duct system foreign to the vault installation may not enter or pass through transformer vault.
  7. Materials may not be stored in transformer vaults.

#### **A5. Capacitors**

1. All capacitors, except surge capacitors or capacitors included as a component part of other apparatus, shall be provided with an automatic means of draining the stored charge after the capacitor is disconnected from its source of supply.
2. Capacitors rated over 600 volts, nominal, shall comply with the following additional requirements:
  - a. Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load interrupting device or shall be provided with prominently displayed caution signs to prevent switching load current.
3. For series capacitors, the proper switching shall be assured by use of at least one of the following:

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	52 of 72

- a. Mechanically sequenced isolating and bypass switches, Interlocks,
- b. Switching procedure prominently displayed at the switching location.

**A6. Electric Signs and Outline Lighting**

1. Signs operated by electronic or electromechanical controllers located outside the sign shall have a disconnecting means located inside the controller enclosure or within sight of the controller locations, and it shall be capable of being locked in the open position.
2. All other signs, except the portable type, and all outline lighting installations shall have a means of lockout or an externally operable disconnecting means which can open all ungrounded conductors and is within the sight of the sign or outline lighting it controls.
3. Doors or covers giving access to un-insulated parts of indoor signs or outline lighting exceeding 600 volts and accessible to other than qualified persons shall either be provided with interlock switches to disconnect the primary circuit or shall be so fastened that the use of other than ordinary tools will be necessary to open them.

**A7. Elevators, Dumbwaiters, Escalators, and Moving Walks**

1. There shall be a single means for disconnecting all ungrounded main power supply conductors for each unit.
2. If control panels are not located in the same space as the drive machine, they shall be located in cabinets with doors or panels capable of being locked.
3. If interconnections between control panels are necessary for operation of the system on a multi-car installation that remains energized from a source other than the disconnecting means, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and shall read "Warning – Parts of the control panel are not de-energized by this switch."

**A8. Electric Welders**

1. A disconnecting means shall be provided in the supply circuit.

**A9. Data Processing Systems**

1. A disconnecting means shall be provided to disconnect the power to all electronic equipment in data processing or computer rooms. This disconnecting means shall be controlled from locations readily accessible to the operator at the principal exit doors. There shall also be a similar disconnecting means to disconnect the air conditioning system serving this area.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	53 of 72

**A10. Swimming Pools, Fountains, Wet Locations**

1. A single receptacle of the locking and grounding type that provides power for a permanently installed swimming pool re-circulating pump motor may be located not less than 5 feet from the inside walls of a pool. All other receptacles on the property shall be located at least 10 feet from the inside walls of a pool. Receptacles which are located within 15 feet of the inside walls of the pool shall be protected by ground-fault circuit interrupters.
2. Unless they are 12 feet above the maximum water level, lighting fixtures and lighting outlets may not be installed over a pool or over the area extending 5 feet horizontally from the inside walls of a pool. Unless installed 5 feet above the maximum water level and rigidly attached to the structure adjacent to or enclosing the pool, lighting fixtures and lighting outlets installed in the area extending between 5 feet and 10 feet horizontally from the inside walls of a pool shall be protected by a ground-fault circuit interrupter.
3. Flexible cords used with the following equipment may not exceed 3 feet in length and shall have a copper equipment grounding conductor with a grounding-type attachment plug:
  - a. Cord-and plug connected lighting fixtures installed within 16 feet of the water surface of permanently installed pools.
  - b. Other cord-and plug connected, fixed or stationary equipment used with permanently installed pools.
4. A ground-fault circuit interrupter shall be installed in the branch circuit supplying underwater fixtures operating at more than 15 volts. No underwater lighting fixtures may be installed for operation at over 150 volts between conductors. Equipment installed underwater shall be approved for the purpose.
5. All electric equipment operating at more than 15 volts, including power supply cords, used with fountains shall be protected by ground-fault circuit interrupters.

**A11. Cranes and Hoists**

1. A readily accessible disconnecting means shall be provided between the runway contact conductors and the power supply. Another disconnecting means, capable of being locked in the open position, shall be provided in the leads from the runway contact conductors or other power supply on any crane or monorail hoist. If this additional disconnecting means is not readily accessible from the crane or monorail hoist operating station, means shall be provided at the operating station to open the power circuit to all motors of the crane or monorail hoist. The additional disconnect may be

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	54 of 72

omitted if a monorail hoist or hand-propelled crane bridge installation meets all of the following:

- a. The unit is floor controlled;
  - b. The unit is within view of the power supply disconnecting means;
  - c. No fixed work platform has been provided for servicing the unit.
2. The dimension of the working space in the direction of access to live parts which may require examination, adjustment, servicing, or maintenance while alive shall be a minimum of 2 feet 6 inches. Where controls are enclosed in cabinets, the door(s) shall either open at least 90 degrees or be removable.
  3. All exposed metal parts of cranes, monorail hoists, hoists and accessories including pendant controls shall be metallicity joined together into a continuous electrical conductor so that the entire crane or hoist will be grounded.
  4. Moving parts, other than removable accessories or attachments, having metal-to-metal bearing surfaces shall be considered to be electrically connected to each other through the bearing surfaces for grounding purposes.
  5. The trolley frame and bridge frame shall be considered as electrically grounded through the bridge and trolley wheels and its respective tracks unless conditions such as paint or other insulating materials prevent reliable metal-to-metal contact. In this case a separate bonding conductor shall be provided.

## **A12. Hazardous Locations**

1. This section covers the requirements for electric equipment and wiring in locations which are classified depending on the properties of the flammable vapors, liquids or gases, or combustible dusts or fibers which may be present. Each room, section or area shall be considered individually in determining its classification.
2. These hazardous locations are assigned six designations noted below:
  - A. Classifications

**Class I Locations**  
Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

**Class I, Division 1 Location is a location:**

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	55 of 72

- I. In which ignitable concentrations of flammable gases or vapors can exist under normal operating conditions; or
- II. In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or
- III. In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

**Class I, Division 2 Location is a location:**

- I. In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or
- II. In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or
- III. That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

**Class II Locations**

Class II locations are those that are hazardous because of the presence of combustible dust.

**Class II Division 1 Location is a Location:**

- I. In which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures; or
- II. Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes, or
- III. In which combustible dusts of an electrically conductive nature may be present.

**Class II, Division 2 Location is a Location:**

- I. In which combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitable mixtures,

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	56 of 72

and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus; or

- II. In which dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment, and dust accumulations resulting may be ignitable by abnormal operation or failure of electrical equipment or other apparatus.

### **Class III Locations**

Class III locations are those that are hazardous because of the presence of easily ignitable fibers or flyings but in which such fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures

#### **Class III, Division 1 Location is a Location:**

- I. In which easily ignitable fibers or materials producing combustible filings are handled, manufactured, or used.

#### **Class III, Division 2 Location is a Location:**

- I. In which easily ignitable fibers are stored or handled, except in process of manufacture.

#### **B. Electrical Installations**

Equipment, wiring methods, and installations of equipment in hazardous locations shall be:

- I. Intrinsically safe, or
- II. Approved for the hazardous location, or
- III. Safe or for the hazardous (classified) location.

#### **C. Intrinsically Safe**

Equipment and associated wiring approved as intrinsically safe shall be permitted in any hazardous location for which it is approved.

#### **D. Approved for the Hazardous Location**

Equipment shall be approved not only for the class of location but also for the ignitable or combustible properties of the specific gas, vapor, dust, or fiber that will be present. Equipment shall be marked to show the class, group, and operating temperature or temperature range for which it is approved. The temperature marking may not exceed the ignition temperature of the specific gas or vapor to be encountered. However, the following provisions modify this marking requirement for specific equipment:

- a. Equipment of the non-heat-producing type, such as junction boxes, conduit, and fittings, and equipment of the heat-producing type having a maximum temperature not more than 100 degrees C (212

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	57 of 72

degrees F) need not have a marked operating temperature or temperature range.

- b. Fixed lighting fixtures marked for use in Class I, Division 2 locations only, need not be marked to indicate the group.
- c. Fixed general-purpose equipment in Class I locations, other than lighting fixtures, which is acceptable for use in Class I, Division 2 locations need not be marked with the class, group, division, or operating temperature.
- d. Fixed dust-tight equipment, other than lighting fixtures, which is acceptable for use in Class II, Division 2 and Class III locations need not be marked with the class, group, division, or operating temperature.

**E. Safe for the Hazardous (Classified) Location**

- a. Equipment which is safe for the location shall be of a type and design which the employer demonstrates will provide protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts, or fibers.
- b. All conduits shall be threaded and shall be made wrench-tight. Where it is impractical to make a threaded joint tight, a bonding jumper shall be utilized.

**F. Equipment in Division 2 Locations**

- a. Equipment that has been approved for a Division 1 location may be installed in a Division 2 location of the same class and group. General-purpose equipment or equipment in general-purpose enclosures may be installed in Division 2 locations if the equipment does not constitute a source of ignition under normal operating conditions.

**A13. Special Systems**

1. This section covers the requirements for the following specific or special systems:

- a. Systems Over 600 Volts
- b. Emergency Power Systems
- c. Fire Protective Signaling Systems
- d. Communications Systems

**A. Systems Over 600 Volts**

**1. Installation**

- a. Above-ground conductors shall be installed in rigid metal conduit, in intermediate metal conduit, in cable trays, in cablebuss, in other suitable raceways or as open runs of metal-clad cable suitable for the use and purpose. Open runs of non-metallic-

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	58 of 72

sheathed cable or of bare conductors or buss bars may be installed in locations accessible only to qualified persons.

- b. Metallic shielding components, such as tapes, wires, or braids for conductors, shall be grounded. Open runs of insulated wires and cables having a bare lead sheath or a braided outer covering shall be supported in a manner designed to prevent physical damage to the braid or sheath. Conductors emerging from the ground shall be enclosed in approved raceways.

2. Interrupting and Isolating Devices

- a. Circuit breaker installations located indoors shall consist of metal-enclosed units or fire-resistant cell-mounted units. If installed in locations accessible only to qualified personnel, open mounting of circuit breakers is permitted. A means of indicating the open and closed position of circuit breakers shall be provided. Fused cutouts installed in buildings or transformer vaults shall be of a type approved for the purpose. They shall be readily accessible for fuse replacement. A means shall be provided to completely isolate equipment for inspection and repairs.
- b. Isolating means which are not designed to interrupt the load current of the circuit shall be either interlocked with an approved circuit interrupter or provided with a sign warning against opening them under load. City of Tucson requires warning signs on all equipment not designed for loadbreaking.

B. Emergency Power Systems

1. Installation

- a. Emergency circuit wiring shall be kept entirely independent of all other wiring and equipment and may not enter the same raceway, cable, box, or cabinet or other wiring except either where common circuit elements suitable for the purpose are required, or for transferring power from the normal to the emergency source.

2. Emergency Illumination

- a. Where emergency lighting is necessary, the system shall be so arranged that the failure of any individual lighting element, such as the burning out of a light bulb, cannot leave any space in total darkness.

C. Fire Protective Signaling Systems

1. Installation

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	59 of 72

- a. The power supply of non-power-limited fire protective signaling circuits shall have an output voltage not in excess of 600 volts. The power for power-limited fire protective signaling circuits shall be either inherently limited, in which no over current protection is required, or limited by a combination of a power source and over current protection.
2. Non-power-limited Conductor Location
    - a. Non-power-limited fire protective signaling circuits and Class 1 circuits may occupy the same enclosure, cable, or raceway provided all conductors are insulated for maximum voltage of any conductor within the enclosure, cable or raceway. AC power supply and fire protective signaling circuit conductors are not permitted in the same conduit enclosure, cable, or raceway except for initial and final termination points.
  3. Power-limited conductor Location
    - a. Where 7pin conductors are installed, power-limited fire protective signaling circuits shall be separated at least 6 inches from conductors of any light, power, Class 1, and non-power-limited fire protective signaling circuits unless a special and equally protective method of conductor separation is employed.
    - b. Cables and conductors of two or more power-limited fire protective signaling circuits or Class 3 circuits are permitted in the same cable, enclosure, or raceway.
    - c. Conductors of one or more Class 2 circuits are permitted within the same cable, enclosure, or raceway with conductors of power-limited fire protective signaling circuits provided that the insulation of Class 2 circuit conductors in the cable, enclosure, or raceway is at least that needed for the power-limited fire protective signaling circuits.
  4. Identification
    - a. Fire protective signaling circuits shall be identified at terminal and junction locations in a manner which will prevent unintentional interference with the signaling circuit during testing and servicing. Power-limited fire protective signaling circuits shall be durably marked as such and plainly visible at terminations.
- D. Communications Systems  
The provisions for communication systems apply to such systems as central-station-connected and non-central-station-connected telephone circuits, radio and television receiving and transmitting equipment, including community antenna television and radio

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	60 of 72

distribution systems, telegraph, district messenger, and outside wiring for fire and burglar alarm, and similar central station systems.

1. Protective Devices

- a. Communication circuits so located as to be exposed to accidental contact with light or power conductors operating at over 300 volts shall have each circuit so exposed provided with a protector approved for the purpose. Each conductor of a lead-in from an outdoor antenna shall be provided with an antenna discharge unit or other suitable means that will drain static charges from the antenna system.

2. Conductor Location

a. Outside of Buildings

- I. Receiving distribution lead-in or aerial-drop cables attached to buildings and lead-in conductors to radio transmitters shall be so installed as to avoid the possibility of accidental contact with electric light or power conductors. The clearance between lead-in conductors and any lightning protection conductors shall not be less than 6 feet except for coaxial cables, waveguides, and any RF transmission lines.

b. Inside of Buildings

- I. Indoor antennas, lead-ins, and other communication conductors attached as open conductors to the inside of buildings shall be located at least two (2) inches from conductors of any light or power or Class 1 circuits unless a special and equally protective method of conductor separation, approved for the purpose, is employed.

c. On Poles

- I. Where practicable, communication conductors on poles shall be located below the light or power conductors. Communications conductors shall not be attached to a cross arm that carries light or power conductors.

E. Equipment Location

- 1. Outdoor metal structures supporting antennas, as well as self-supporting antennas such as vertical rods or dipole structures, shall be located as far away from overhead conductors of electric light and power circuits of over 150 volts to ground as necessary to avoid the possibility of the antenna or structure falling into or making accidental contact with such circuits.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	61 of 72

F. Grounding

1. If exposed to contact with electric light and power conductors, the metal sheath of aerial cables entering buildings shall be grounded or shall be interrupted close to the entrance to the building by an insulating joint or equivalent device. Where protective devices are used, they shall be grounded in an approved manner.
2. Masts and metal structures supporting antennas shall be permanently and effectively grounded without splice or connection in the grounding conductor.
3. Transmitters shall be enclosed in a metal frame or grill or separated from the operating space by a barrier, all metallic parts of which are effectively connected to ground. All metal equipment enclosures, chassis, and hardware shall be effectively bonded to ground.

**A14. Batteries and Battery Charging**

1. Installation and Housing – Communications and Generators
  - a. All wet cell battery charging stations shall be shielded, with ventilation holes or other means, by Lexan or other similar material, with secondary containment. Face shields, safety glasses (employee issue) aprons, and chemical gloves shall be provided for workers handling acids or wet cell and solid (gel) cell batteries. Facilities for quick drenching of the eyes and body shall be within 25 feet of acid (wet) cell battery and for gel cell batteries greater than quad set-up handling areas with no obstruction to travel. Material handling equipment shall be provided for handling all batteries. Batteries shall be provided with safety venting caps for wet cell batteries.
  - b. Racks and trays shall be substantial and shall be treated to make them resistant to the electrolyte. Floors exposed to wet cell batteries shall be of acid resistant construction unless protected from acid accumulations. Facilities shall be provided or available for flushing and neutralizing spilled electrolyte and for fire protection.
  - c. Smoking shall be prohibited in any battery charging area. Precautions shall be taken to prevent open flames, sparks, or electric arcs in battery charging area.
2. Vehicles or other non-stationary equipment
  - a. All batteries in vehicles or non-stationary equipment shall be secured. Battery terminals and all exposed live parts shall be protected or isolated from accidental contact. Tools and other metallic objects shall be kept away from the top of uncovered batteries.
  - c. Facilities for quick drenching of the eyes and body shall be within 25 feet of acid (wet) cell battery with no obstruction to travel. Face

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	62 of 72

shields, safety glasses (employee issue), aprons, and chemical gloves shall be provided for workers filling batteries prior to charging. Batteries shall be charged according to manufacturer specifications.

### 3. Spill Control

- a. Appropriate spill containment shall be provided and a Small Spill Control Kit shall be provided and maintained. See Occupation Safety and Health Manual; section number S-012, Hazardous Substance/Spill Response Program.

### 4. Ventilation

- a. Ventilation shall be provided to ensure diffusion of the gases from wet cell batteries and to prevent the accumulation of an explosive mixture. Continuous ventilation shall be provided at a rate of not less than 1 cubic foot per minute per square foot of floor area of the room.

### 5. Signs

- a. Doors into rooms or buildings containing stationary battery charging areas shall be provided with approved signs to alert Emergency Responders. The signs shall state that the room contains:
  - I. Communications; or,
  - II. Battery Charging Area; or,
  - III. Energized electrical circuits, Battery Backup System (recognized acronym); or,
  - IV. Corrosive Battery Electrolyte Solutions.

## 7.0 **ADVICE AND COUNSEL**

The Electrical Work Practices shall be reviewed by Central Safety Services every three (3) years, or as required by OSHA and/or NFPA 70E updates.

#### References:

OSHA 1910 – Subpart S  
OSHA 1926 – Subpart K  
NFPA 70E - 2012

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	63 of 72

## APPENDIX A

# INSULATED RUBBER ELECTRIC GLOVES USE, TESTING, AND MAINTENANCE

### 1.0 PURPOSE

This procedure has been established to provide electrical personnel with direction for the proper use, testing and maintenance of electrical rubber gloves and their protectors.

### 2.0 SCOPE

This procedure applies to all Qualified Electricians and Authorized Personnel working in the Hazard/Risk Category 2 and above.

Failure to comply with this procedure may result in disciplinary action.

### 3.0 DEFINITIONS

***Dielectric Testing:*** A laboratory method of testing insulating qualities of electrical protective equipment.

***Roll Test:*** An employee initiated method of testing Insulated Rubber Gloves.

***Rubber Gloves:*** Insulated rubber gloves to be worn by the employee when working on or near energized electrical equipment, including voltage testing of such equipment.

### 4.0 RESPONSIBILITIES

#### A. Employee

Each employee shall be responsible for the proper care, handling and inspection of their assigned gloves, protectors and canvas bags.

#### B. Supervision

Supervisors shall provide:

- Glove bags and lockers for storage of gloves and protectors
- Training in the proper care, testing, handling and inspection of the gloves
- Dielectric testing and/or replacement of gloves every six (6) months
- Replacement of worn or damaged gloves/protectors

When gloves are replaced, they shall be dielectrically tested and certified for use, prior to first issue.

### 5.0 EDUCATION AND TRAINING

#### A. Training

1. Every Qualified Electrician and Authorized Personnel shall attend a training session prior to being issued any electrical gloves/protectors.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	64 of 72

2. Refresher training will be mandatory every three (3) years thereafter or as technology or work conditions change.
3. Supervisors may provide one-on-one training for new hires and transfer employees. They shall use the Electrical Glove Training Module and Lesson Plan.

**B. Training Documentation**

1. This training shall be documented with:
  - a. Employee Name and signature
  - b. Employee Number
  - c. Instructor's Name and signature
  - d. Outline of the topics taught
  - e. Employee's test results
2. A copy of this documentation shall be retained for a period not less than 3 years in the employee's personnel file AND the Division training file.

**6.0 GENERAL**

**A. Insulated Rubber Gloves Issue**

1. Required insulated rubber gloves will be issued at the end of the training sessions. The serial number will be recorded with the name of the assigned individual.

**B. Insulated Rubber Glove Testing**

1. A second pair of required insulated rubber gloves will be issued to the employee 90 days later. This will ensure that when the first pair issued is sent for six (6) month dielectric testing, the second pair is available for use in the field.

**C. Insulated Rubber Glove Purchase**

1. A second pair of required, insulated rubber gloves shall be purchased in a time frame or manner prescribed by the department that will ensure an employee always has one (1) pair of required, insulated rubber gloves available for use by the employee. At the conclusion of the six (6) month wear period, the insulated rubber gloves shall be removed from service.

a. Types of Insulated Rubber Gloves to be used:

- I. **Class 00** for usage up to 500 VAC and are tested at 2500 VAC.
- II. **Class 1** for usage up to 7500 VAC and are tested at 10kVAC.

b. Use of electric insulated rubber gloves and protectors may be at the discretion of the Qualified Electrician or Authorized Personnel performing the function **EXCEPT** in the following **MANDATORY USE** situations:

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	65 of 72

- I. The appropriate class of insulated rubber gloves **shall be worn** for the highest known voltage rating of the equipment in the immediate location where the work is performed, whenever an employee may come in contact with or is exposed to energized conductors.
- II. Insulated rubber gloves **shall be worn** when doing voltage checks on electrical equipment or applying a data logger. Example: When the “dead-front” on a service panel, traffic control or streetlight control cabinet is removed, energized parts are no longer isolated. Once the main circuit breaker is checked with a volt meter to see that it is de-energized, gloves may be removed and the equipment handled without the rubber gloves.

**D. Insulated Rubber Glove Maintenance**

1. A pair of gloves is defined as the two (2) rubber gloves and the leather protectors.

**Note: Dielectric testing** of gloves, and replacement of gloves, will be scheduled in such manner that an employee shall always have one (1) pair of insulated gloves in tested and in service.

**E. Insulated Rubber Glove Storage**

1. When not in use gloves will be stored cuff first in the storage bag. Rubber glove bags shall not be used for any other purpose than to store the gloves.

**F. Insulated Rubber Glove Use**

1. Insulated rubber gloves shall **NEVER** be worn inside out. Insulated rubber gloves shall **NEVER** be worn without leather protectors and only leather protectors shall be worn over the gloves. Wearing work gloves over the insulated rubber gloves will not be permitted.

**Exemption:** Class 00 gloves may be worn without leather protectors when performing intricate work and wiring tasks.

- a. Leather protectors shall only be worn in conjunction and over insulated rubber gloves.
- b. Insulated rubber gloves shall be protected from environmental, physical and chemical damage.
- c. Conductive material, rings and watches or other, shall not be worn when wearing insulated rubber gloves.
- d. Insulated rubber gloves shall not be shared or loaned to another employee.

**G. Inspection Procedure for Insulated Rubber Gloves:**

1. Remove leather protectors from insulated rubber gloves.
2. Visually inspect insulated rubber gloves for corona marks, bruises, cuts, tears, pinholes or any other possible damage. Class 1 gloves have lighter

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	66 of 72

color (red or yellow) rubber inside, check for lighter color showing through black exterior.

3. Turn gloves inside out and perform the same visual inspection you did for the outside. On class 1 gloves check for black color of outside glove showing through lighter color on the inside.
4. Turn gloves right side out. Roll up glove starting at the cuff, in order to trap air on the inside of the glove. Look, listen and feel for any air leakage, which will indicate a pinhole or tear.

#### **H. Testing of Insulated Rubber Gloves**

1. A roll test shall be conducted:
  - a. Before starting work requiring usage of gloves
  - b. At the end of each working shift before gloves are stored
  - c. Whenever it is suspected the gloves may have been damaged
2. Check inside and outside of leather protector glove for any damage, oil, grease, etc., that might affect the rubber gloves.
3. Check canvas glove bag for any damage, oil, grease or debris that might damage the gloves.
4. When gloves pass your inspection and are clean, put leather protector back on the insulated rubber glove and place gloves in storage bag cuff first. Snap the storage bag closed.
5. Place the gloves in the storage locker provided.

#### **I. Documentation**

1. The Department's Electrical Safety Coordinator will keep a record of all the information so a glove history for each pair may be kept. This glove history will include:
  - a. Name of employee assigned the gloves
  - b. Serial number of the gloves and date of issue
  - c. Testing dates
  - d. Repairs, date and type and by whom
  - e. Replacement reason and date
2. Employees will be required to sign a receipt for each pair of gloves issued.

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	67 of 72

## Appendix B



### Job TASK Analysis

- T** – Think and Plan your Job
- A** – Ask Questions and Act on Answers
- S** – Set up a Safe Job Site
- K** – Know the Hazards and Prepare for Emergencies

THINK	<input checked="" type="checkbox"/>
Identify the hazards	<input checked="" type="checkbox"/>
Identify the voltage involved	<input type="checkbox"/>
Consider and eliminate any secondary source of voltage	<input type="checkbox"/>
Determine Shock Protection Boundary	<input type="checkbox"/>
Consider Flash Hazard potential	<input type="checkbox"/>
Establish Flash Protection Boundary	<input type="checkbox"/>
Consider the available Incident Energy	<input type="checkbox"/>
Review the line drawings, job plans	<input type="checkbox"/>
Review Confined Space procedure and obtain permit if required	<input type="checkbox"/>

ASK	<input checked="" type="checkbox"/>
Has an Electrically Safe Work Condition been established?	<input checked="" type="checkbox"/>
Are back feeds of the circuit to be worked on possible?	<input type="checkbox"/>
Are two qualified electricians required or needed?	<input type="checkbox"/>
Are other electricians, mechanics or contractors on the site that will be affected by this work?	<input type="checkbox"/>
Has the manager of the worksite been informed of pending electrical work?	<input type="checkbox"/>

SET-UP	<input checked="" type="checkbox"/>
Install barricades and barriers	<input type="checkbox"/>
Lockout/Tagout	<input type="checkbox"/>
Test, re-test, verify voltages and document	<input type="checkbox"/>
Insulated tools, equipment and proper PPE for the job	<input type="checkbox"/>
Install and remove grounds	<input type="checkbox"/>

KNOW	<input checked="" type="checkbox"/>
Locate all pertinent emergency disconnects	<input type="checkbox"/>
Check function of communication devices (radio/cell phones)	<input type="checkbox"/>
Locate fire alarm	<input type="checkbox"/>
Double check the first aid and CPR qualifications of the second qualified/authorized person	<input type="checkbox"/>
Locate the nearest fire extinguisher	<input type="checkbox"/>

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	68 of 72



## Appendix C Energized Electrical Work Permit

Date: \_\_\_\_\_  
Work Order: \_\_\_\_\_

Direction	
1	Description of circuit/equipment/job location
2	Justification for energized work
<b>Supervisor:</b> _____	
<b>Date:</b> _____	

Qualified Persons performing the energized work				
Completed				
1	<b>Description of safe work practices</b>			
	Results of Shock Hazard Analysis	<b>Limited</b>	<b>Restricted</b>	<b>Prohibited</b>
	- Approach Boundary Calculations from Table 1			
	Flash Protection Boundary	<b>4.0'</b>		
	Results of Flash Hazard Analysis			
	- Color selection from Table 2			
	Determination of Arc Flash Protection	<b>Hazard</b>	<b>Gloves</b>	<b>Tools</b>
	- Classification from Table 2		Y/N	Y/N
	PPE Selection by Arc Rating	<b>Arc Rating</b>		
	- Provide Arc rating from Table 3			
2	Means of Restricting Access			
3	Job Briefing/Checklist			
4	Safe Work Agreement and Acceptance			
<b>Qualified Electrician:</b> _____		<b>Date:</b> _____		
<b>Qualified Electrician:</b> _____		<b>Date:</b> _____		

Approval to Perform Work	
<b>Administrator:</b> _____	<b>Date:</b> _____
<b>Superintendent:</b> _____	<b>Date:</b> _____
<b>Supervisor:</b> _____	<b>Date:</b> _____
<b>Electrical Safety Coordinator:</b> _____	<b>Date:</b> _____

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	69 of 72

## APPENDIX D

### INDEX

<b>1.0</b>	<b>PURPOSE</b>	1
<b>2.0</b>	<b>SCOPE</b>	1
<b>3.0</b>	<b>DEFINITIONS</b>	1
<b>4.0</b>	<b>RESPONSIBILITIES</b>	7
	A. Director or Designee	
	B. Supervision	
	C. Employee	
<b>5.0</b>	<b>EDUCATION AND TRAINING</b>	8
	A. Qualified Electrician and Authorized Personnel	
	B. Unqualified Personnel	
	C. Continuing Education and Training	
<b>6.0</b>	<b>GENERAL</b>	10
	A. Establishing an Electrically Safe Work Condition	
	B. Principles of Lockout/Tagout	10
	C. Working on or Near Live Parts	11
	1. Energized Equipment	
	2. Energized Electrical Work Permit	
	3. Approach Boundaries – Live Parts	
	A. Shock Hazard Analysis	
	B. Shock Protection Boundaries	
	C. Flash Hazard Analysis	
	D. Flash Protection Boundary	
	E. Restricted Approach Boundary	
	D. Protective Clothing and Personnel Protective Equipment	18
	1. Head, Face, Neck and Chin Protection	
	2. Eye Protection	
	3. Body Protection	
	4. Hand and Arm Protection	
	5. Insulating Equipment	
	E. Protective Clothing and Personnel Protective Equipment Matrix	25
	1. Protective Clothing Characteristics	
	2. Factors in Selection of Protective Clothing	
	A. Layering	
	B. Outer Layers	
	C. Underlayers	
	D. Coverage	
	3. Arc Flash Protective Equipment	
	4. Care and Maintenance of FR Clothing and FR Flash Suits	
	F. Insulated Tools and Equipment	29
	G. Safety Related Maintenance Requirements	30
	1. Engineering Design	

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	70 of 72

## 2. System Installation, Repair and Maintenance

H. Portable Electrical Equipment (Extension cord sets)	31
I. Fixed Electrical Equipment	32
1. Access to Fixed Equipment	32
2. Disconnecting Means	33
3. Over-current Protection – Circuit Breakers and Fuses	33
J. Lighting	34
K. Guarding of Live Parts	34
L. Underground or Overhead Utility Work	35
M. Confined Space	38
N. Housekeeping	38
O. Opening and Closing of Circuits	38
P. Grounding	39
A. Systems to be Grounded	39
B. Systems Not Required to be Grounded	39
C. Grounding Connections/Conductors	40
D. Grounded Systems	40
E. Ungrounded Systems	40
F. Branch Circuits	40
G. Supports, Enclosures and Equipment to be Grounded	40
H. Grounding of Systems over 1,000 Volts	42
Q. Portable and Vehicle Mounted Generators	43
R. Bonding	44
S. Wiring Methods, Components and Equipment	44
A. Installation	44
B. Cable Trays	45
C. Cabinets, Boxes and Fittings	46
D. Knife Switches (except enclosed disconnects)	46
E. Switchboards and Panel boards	46
F. Enclosures for Damp or Wet Locations	47
G. Conductors for General Wiring	47
H. Temporary Wiring	47
I. Flexible Cords and Cables	47
J. Portable Cables Over 600 Volts	48
K. Lighting Fixtures	48
L. Appliances	49
M. Motors	49
1. Disconnecting Means	49
2. Motor Overload, Short Circuit, and GFCI	50
3. Protection of Live Parts (all voltages)	51
T. Transformers	51
U. Capacitors	51
V. Electric Signs and Outline Lighting	51
W. Elevators, Dumbwaiters, Escalators and Moving Walks	51
X. Electric Welders	51
Y. Data Processing Systems	51

Subject:	Number:	Rev.	Effective Date:	Page
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	71 of 72

Z.	Swimming Pools, Fountains, Wet Locations	53
AA.	Cranes and Hoists	53
BB.	Hazardous Locations	54
	1. Classifications	
	Class I	
	Class I, Division 1	
	Class I, Division 2	
	Class II	
	Class II, Division 1	
	Class II, Division 2	
	Class III	
	Class III, Division 1	
	Class III, Division 2	
	2. Electrical Installations	56
	1. Intrinsically Safe	56
	2. Approved for the Location	56
	3. Equipment in Division 2 Locations	57
CC.	Special Systems	57
	1. Stems over 600 Volts	57
	1. Installation	
	2. Interrupting and Isolating Devices	
	2. Emergency Power Systems	58
	1. Installation	
	2. Emergency Illumination	
	3. Fire Protective Signaling Systems	58
	1. Installation	
	2. Non-power-limited Conductor Location	
	3. Power-limited Conductor Location	
	4. Identification	
	4. Communication Systems	59
	1. Protective Devices	
	2. Conductor Location	
	A. Outside of Buildings	
	B. Inside of Buildings	
	C. On Poles	
	3. Equipment Location	
	4. Grounding	
DD.	Batteries and Battery Charging	61
	1. Installation and Housing	
	2. Spill Control	
	3. Ventilation	
	4. Signs	
<b>7.0</b>	<b>ADVICE AND COUNSEL</b>	<b>62</b>

<b>Subject:</b>	<b>Number:</b>	<b>Rev.</b>	<b>Effective Date:</b>	<b>Page</b>
Electrical Work Practices	S-019	January 1, 2013	October 10, 2002	72 of 72

## **TABLES**

Table 1 – Approach Boundaries to Live Parts for Shock Protection	15
Table 2 – Hazard/Risk Category Classifications	22
Table 3 – Protective Clothing and Personnel Protective Equipment Matrix	25
Table 4 – Protective Clothing Characteristics	27
Table 5 – Working Clearances	32
Table 6 – Minimum Depth of Clear Working Space in Front of Electric Equipment	33
Table 7 – Approach Distances for Qualified Employees – Alternating Current	36
Table A – Electrical PPE Testing	20
Table B – AC Proof Test Requirements	20
Table C – DC Proof Test Requirements	20
Table D – Glove Test and Water Level	20
Table E – Rubber Insulating Equipment Voltage Requirements	21
Table F – Rubber Insulating Equipment Test Intervals	21

## **APPENDICIES**

Appendix A INSULATED RUBBER ELECTRIC GLOVES - USE, TESTING, AND MAINTENANCE	63
Appendix B JOB TASK ANALYSIS	67
Appendix C ENERGIZED ELECTRICAL WORK PERMIT	68
Appendix D INDEX	69