ELECTRICAL SAFETY

GUIDELINE

To provide general guideline requirements to comply with OSHA regulations, National Electrical Code Requirements and National Fire Protection Association Requirements for employee electrical safety.

PROCEDURE

This guideline reflects compliance with OSHA, NEC, and NFPA requirements for electrical safety within the limits of the references. It also covers certain specific safe practices in the use of electrical equipment, instrumentation and/or tools in classified locations, proper employee protection against electrical shock, and relates by reference, to the guideline requirements on Lockout or Tag out for electrical work. NFPA 70E reference tables are included at the end of the document.

- OSHA Subpart S Sections 1910.301 through .308 consist primarily of requirements for installations of electrical systems by qualified persons (those employees who have training in avoiding the electrical hazards of working on or near exposed energized parts). These employees are required to perform all their electrical duties according to Subpart S – Electrical. No further requirements are detailed for these sections.

- OSHA Sections 1910.3331 through 1910.335 states the safety-related work practices for unqualified and qualified persons. Unqualified persons are those with little or no training in working on, near, or with the following: premises wiring, wiring for connection to supply, other wiring, optical-fiber cable, communications installations, and installations in vehicles.

- All electrical work and workers, including contractors, shall abide by the National Electric Code NEC (2011) and National Fire Protection Association NFPA 70E.
- All electrical equipment installed must be approved by a Nationally Recognized Testing Laboratory (NRTL) and installed according to manufacturers or NRTL specifications, OSHA Subpart S 1910.301-.308, OSHA Subpart K 1926.400-408 (Construction) and NFPA 70E Standards.

- The guideline provides overall guidance in the compliance by all employees in relevant areas. Current regulations must be consulted.

SAFETY-RELATED WORK PRACTICES

Training

- All employees shall be trained in and familiar with electrical safety-related work practices that pertain to their respective job assignments. In accordance with 110.2(E) the employer is required to document electrical safety training for qualified persons (110.2(D(1)), and for unqualified persons relative to electrical safety-related practices necessary for their safety (110.2(D)(2)). This requirement can include:
  - Hazards associated with electrical installations and equipment.
  - Proper use, storage and inspection of personal protective equipment
  - Warning signs.
  - Accessibility of certain areas to qualified people only.
  - Necessity to leave operable all safety devices.
  - Importance of housekeeping and clearance requirements.
  - Inspection of electrical equipment.
  - Operation of electrical equipment.
  - Grounding requirements.
  - Disconnect and restart hazards and procedures.
  - Lockout/tag out procedures
  - Arc flash/Arc blast hazards
  - Rescue and 1st Aid techniques

- In addition to being trained in and familiar with safety-related work practices, unqualified person must be trained in the inherent hazards of electricity such as high voltages, electric current, arcing grounding, and where existing, electrical voltage present an electrical contact hazard. Any electrically-related safety practices not specifically addressed by this guideline and procedure, but necessary for safety in specific workplace conditions, shall be included.
INTERPRETIVE GUIDANCE FOR QUALIFIED PERSON

- **Definitions**: Qualified/Unqualified Persons
  - Section 1910.331 through 1910.335 defines a qualified person as one familiar with construction and operation of the equipment and the hazards involved. “Qualified Persons” are intended to be only those who are well acquainted with and thoroughly conversant in the electric equipment and electrical hazards involved with the work being performed.

- **Qualified persons** (those permitted to work on or near exposed energized parts) shall be trained at the minimum in the following:
  - The skills and techniques necessary to distinguish exposed energized parts from other parts of electric equipment.
  - The skills and techniques necessary to determine the nominal voltage of exposed energized parts.
  - The clearance distances specified in OSHA regulation 1910.333(c) and approach distances in NFPA 70E 130.4(C) A&B.
  - The skills necessary to determine the proper personal protective equipment.
  - OSHA 1910.301 & NFPA 70E installation safety requirements.
  - As indicated in 130.2(D)(3) an employer is required to provide additional training when:
    1. Supervision or the annual inspection indicates that an employee is not following the required electrical safety-related work practices; or
    2. When new technology or new equipment or changes in work procedures requires the use of electrical safety-related work practices that are different from those which the employee would normally use, or
    3. When an employee is required to use electrical safety-related work practices that are new to them.
    4. Tasks performed less often than one time a year shall require retraining before the work is done.
  - Retraining shall also be performed at intervals not to exceed 3 years. (70E 2012 110.2(D))
  - Telecommunications employees will also be acquainted with thoroughly conversant in the electrical hazards in the work being performed.

**Work Practices**

- Work Practices consistent with the nature and extent of the hazard require the following specific safety-related actions:
- Energized parts to which an employee may be exposed must be de-energized before the work is performed, unless it is shown that equipment design or operating limits make it unfeasible or introduces additional hazards. The rule for the industry and the law is “don’t work it hot,” OSHA 1910.333(a)(1) requires live parts to be deenergized before an employee works on or near them except for two demonstrable reasons by the employer:

1. Deenergizing introduces additional or increased hazards (such as cutting ventilation to a hazardous location) or
2. Infeasible due to equipment design or operational limitations (such as voltage testing is required for diagnostics).

- Financial considerations are not an adequate reason to perform energized work.

- If exposed energized parts are not de-energized, other safety practices are to be used which are suitable for the work conditions and voltage level of the exposed parts. A shock hazard analysis should be performed to determine voltage, establish boundaries and establish necessary PPE and tools needed. A written energized electrical work permit may also be required per NFPA 70E 130.2(B) (1). The limited boundary must be established by rope, tape or other effective means to ensure that no unqualified individuals enter the area. A job briefing is required for any energized work that includes all involved employees, supervisors and contractors. The job briefing must discuss electrically safe working conditions including PPE, LOTO and approach boundaries.

- The circuits energizing the parts shall be locked out and tagged in accordance with current federal requirements. All employees affected by this electrical safety procedure must be familiar with these requirements and the order in which the steps are to be followed before work is performed.

- Arc protection blankets (ASTM F2676) and arc protection shields (ASTM F2522) are to be utilized when applicable to reduce the potential for Arc Flash injury.

- Deenergized electrical parts are considered as energized until all steps of the lockout/tag out procedure are successfully completed per OSHA
1910.333(b)(1). Similarly, all electrical conductors and circuit parts must be considered to not be in an electrically safe work condition until all the requirements of Article 120 have been met per NFPA 70E 120.2(A). Verifying that the circuit elements and equipment parts are deenergized by a qualified person is a required step while completing the lockout/tag out procedure per OSHA 1910.333(b)(2)(IV)(B). Conductors and parts of electric equipment that have been deenergized but have not been locked out or tagged and proven to be deenergized are required to be treated as energized parts per 1910.333(b)(1). Similarly NFPA 70E 120.2(A) requires that all electrical conductors and circuit parts are not considered to be in an electrically safe work condition - until the entire process of establishing the electrically safe work condition is met.

- Only qualified persons may perform testing work on electrical circuits or equipment. Test instruments must be rated for the voltage and types of equipment to be tested.
- Trips and overloads shall only be reset by a qualified person.

**Equipment Labeling** NFPA 70E 130.5(C)
- Electrical equipment such as switchboards, panelboards, industrial control panels, meter socket enclosures and motor control centers that are likely to require examination, adjustment, servicing or maintenance while energized shall be field marked with a label containing all the following information:

  (1) At least one of the following:
  - a. Available incident energy and the corresponding working distance
  - b. Minimum arc rating of clothing
  - c. Required level of PPE
  - d. Highest Hazard/Risk Category (HRC) for the equipment

(2) Nominal system voltage
(3) Arc Flash Boundary

- Identification of disconnecting means (dm) and circuits 1910.303(f)(1-3)
  - Each disconnecting means must be legible marked to indicate its purpose unless so arranged so the purpose is evident.
  - Each service, feeder and branch circuit at its dm or overcurrent device, legibly and durably marked to indicate its purpose.
  - Switches and circuit breakers must be clearly labeled to indicate its circuit’s function.

**Equipment Accessibility & Guarding:**
• All overcurrent devices must be capable of being reached quickly for operation, renewal, or inspection, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc. OSHA 1910.399
• Electrical equipment areas shall NOT be used for storage. OSHA 1910.303(g)(1)(ii)
• Depth of working space in front of electrical equipment must be maintained according to table S-1 in 1910.303
• Width of working space in front of electrical equipment less than 600V should be the width of the equipment or 30 inches, whichever is greater, and in all cases shall permit a 90 degree opening of equipment doors.
• Minimum headroom of working space about service equipment, switchboards, panelboards, or motor control centers shall be at least 6.5ft.
• Width of working space in front of electrical equipment 600V or more should follow 1910.303(h) Table S-2. Space increases to 12 ft., entrance must be 24 in. wide and 6 ft. 6in. tall.
• Illumination of area must be adequate.
• Permanent ladders or stairs provided to give safe access to working space around electrical equipment installed on platforms, balconies, mezzanine floors, or attic or roof rooms, or spaces.
• Must provide enclosure or guard where electrical equipment is exposed to physical damage.
• Disconnects should not be placed in corners where it would be difficult to “stand clear”.
• Live parts of electrical equipment operating at 50V or more shall be guarded against accidental contact by:
  o Approved cabinets.
  o By location in a room, vault, with lock and key and accessible only to qualified persons.
  o By permanent, substantial partitions or screens.
  o By placement on a suitable balcony, gallery, or platform so elevated and otherwise located as to prevent access by unqualified persons.
  o By elevation of 8 feet or more above the floor or other working surface.
  o Entrances to rooms and other guarded locations containing live parts shall be marked with warning signs forbidding unqualified persons to enter. (DANGER-HIGH VOLTAGE)
• Follow NEC 314.16(A) which designates how many conductors are permitted to be in a mental receptacle box based on the size of the box.
• Conductor entering boxes, cabinets, or fittings shall be protected from abrasion and openings through which conductors enter shall be effectively closed.
• All pull boxes, junction boxes and fittings shall be provided with covers approved for the purpose. If metal covers are used, they shall be grounded.
• Faceplates for receptacles must completely cover the outlet openings, and they must seat firmly against the mounting surface.
• Faceplate enclosures for damp or wet locations must be weatherproof.
  o Damp locations are protected from weather and not subject to saturation with water or other liquids but subject to moderate degree of moisture. Examples include: partially protected locations under canopies, marquees, roofed open porches, or other similar locations. Interior locations subject to moderate degrees of moisture such as basements, barns, cold storage warehouses.
  o Wet locations include: installations underground, in concrete slabs, in masonry in direct contact with the earth, locations subject to saturation with water or other liquids, unprotected locations exposed to weather.

**Personal Protective Equipment (PPE)**

Employees working around electrical hazards must be provided with and be required to use electrical protective equipment appropriate for the parts of the body exposed to the hazard. All personal protective equipment must meet the American Society of Testing and Materials standard (ASTM).

**Head, Face & Neck Protection:**
Employees must be provided with nonconductive headgear where there is a danger of head injury from electric shocks and burns, and protective eye or face shields where there is danger to the eyes or face from electrical arcs or flashes. An arc-rated balaclava shall be used with an arc-rated face shield when the back of the head is within the arc flash boundary. An arc-rated hood shall be permitted to be used instead of an arc-rated face shield and balaclava. (2) An arc-rated hood shall be used when the anticipated incident energy exposure exceeds 12 cal/cm². Face Protection: Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area shall be used. Refer to Table 130.7(C)(16) Protective Clothing and PPE

**Hand & Body Protection**
Employees must be provided with the proper insulated voltage rated gloves appropriate for the task. Refer to Table 130.7(C)(15) Hazard/Risk Category Classifications for gloves. Leather protector gloves must be 0.7mm thickness.

Electrical hazard (EH), safety-toe footwear are nonconductive and will prevent the wearers' feet from completing an electrical circuit to the ground. These shoes can protect against open circuits of up to 600 volts in dry conditions. The insulating protection of electrical hazard, safety-toe shoes may be compromised if the shoes become wet, the soles are worn through, metal particles become embedded in the sole or heel, or workers touch conductive, grounded items. Note: Nonconductive footwear must not be used in explosive or hazardous locations. Dielectric Insulated (DI) footwear are required for wet conditions.

No synthetic clothing or metal jewelry is permitted whenever working within the arc flash boundary. Employees must wear hearing protection whenever working within the arc flash boundary. For information on selection of arc-rated clothing and other PPE, see Table 130.7(C)(16).

**Tools and handling equipment** used near energized parts must be insulated and meet ATSM standards. Ropes and hand lines used near energized parts must be nonconductive.

- Employees working in confined spaces near energized parts must be provided protective shields, barriers, or insulators to protect against inadvertent contact with parts. Swinging doors, hinges, and panels must be secured to prevent their swinging into the employee and causing contact with energized parts. Portable metal ladders are not permitted. Employees may not perform housekeeping duties or use conductive cleaning materials, solvents, or equipment near energized parts, unless protective equipment or work practices designed to avoid shock hazards are employed.

- Rubber insulated matting or platforms will used by any qualified person for voltages between 150 and 600 volts to ground.

**Use of Equipment**
Portable electrical equipment must be inspected for damage before use (NFPA 70E 110.9). Flexible electrical cords for portable electric tools and equipment cannot be used for raising or lowering the tools or equipment and cannot be fastened or stapled in a way that could damage the outer protective insulation. Cords with grounding-type equipment must contain equipment-grounding conductors. Attachment plugs and receptacles cannot be connected or altered in a way to prevent proper grounding. Adapters that interrupt the continuity of equipment-grounding conductors are barred. Double insulated tools must be UL listed. In conductive work areas such as those where water may be present, only electrical equipment approved for such work areas may be used. Employees may not plug or unplug energized cords or plug-connected equipment with wet hands. Metal box extension cords are prohibited. If there is evidence of damage that might expose an employee to injury, the defective or damaged item shall be tagged out of service and no employee may use it until repairs and tests necessary render the equipment safe.

**Electrical Grounding & Ground Fault Protection:**

- The path to ground from circuits, equipment, and enclosures shall be permanent and continuous. OSHA 1910.304(g)(5)

- A ground-fault circuit interrupter (GFCI) is a fast-acting device which senses small current leakage to ground, and in a fraction of a second shuts off the electricity and “interrupts” its fault current flow to ground. All Ground Fault Circuit Interrupters (GFCI) must be inspected monthly. They should also be inspected before each use.

- Ground-fault protection for personnel on construction sites shall be provided on all 110-120 volt, single-phase, 15 and 20 ampere receptacle outlets which are not a part of the permanent wiring of a building or structure and which are in use by employees. If permanently-installed receptacles are used, no GFCI is necessary.

- There are no requirements for GFCI protection of 240 volt receptacles, three-phase receptacle, or receptacles rated over 20 amperes. However, a grounding conductor shall be installed along with the phase conductors to provide equipment grounding.

- Wiring for all permanently-installed 15 and 20 ampere receptacle circuits shall be the two wires with ground receptacles and the receptacles shall be two-pole wire
type. All new permanently-installed receptacles shall be tested for circuit integrity with a receptacle circuit tester immediately after installation. Immediately following any receptacle circuit maintenance work, the circuit shall be tested for circuit integrity with a receptacle circuit tester. To assure a receptacle is properly grounded and polarity is correct, only qualified persons will install, perform maintenance work on, and test receptacle circuits. All qualified persons will use a three prong receptacle circuit tester when working on or testing receptacles.

- Cord sets (extension cords) shall be three wires, consisting of circuit conductors and one green conductor for grounding.

- As a safety precaution for employee protection, cord and plug sets (extension cords) shall be visually inspected and tested by the use of a Receptacle Circuit Tester which can identify the following: open ground, reverse polarity, open hot, open neutral, hot and ground reversed, hot on neutral, and hot open. The test shall be made as follows:

  o All new cord sets before first use.
  o Where there is evidence of damage to the cord set. Defective cord sets will immediately be placed out of service.
  o After any repair to the cord set.
  o NOTE: OSHA regulations state that cord sets which remain connected, once they are put into place and in use and are not exposed to damage, need not be inspected until they are relocated. Cord sets are to be used only with portable plug and cord equipment that is not intended or used as a permanent installation.

  - Relocatable Power Taps (RPT’s):
    o Should only be used for low power loads such as computer peripherals, electronics, TV’s and stereos. No refrigerators, space heaters, microwaves, toaster ovens or coffee makers.
    o Must be directly connected to a permanent receptacle.
    o May not be daisy chained to other RPT’s.
    o May not be plugged into extension cords.
    o May not be used at construction sites or similar locations.
    o May not be permanently secured to building structures, tables, benches or used as a substitute for fixed wiring.
    o Flexible cords may not be run through holes in walls, ceilings or floors.
The following types of equipment that are cord and plug connected must be grounded and periodically tested to assure the ground is maintained.

- Refrigerators, freezers, and air conditioners.
- Clothes washers, clothes dryers, and sump pumps.
- Hand-held motor-operated tools such as drills, grinders, etc.
- Motor-operated appliances of the following types: hedge trimmers, lawn mowers, snow blowers, and wet scrubbers.
- 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.
- Portable and mobile x-ray and associated equipment.
- Tools likely to be used in wet and conductive locations.
- Portable hand lamps, if any part exposed is conductive.
- Any other equipment connected by cord and plug which has exposed, non-current carrying metal parts.
- Two-wire extension cords are not permitted.

- Temporary electrical power and lighting 600V(OSHA 1910.305 (a)(2)(i)) and less may be used only:
  - During the period of construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or other similar activities.
  - 90 days for holiday decorative lighting, carnivals or similar purposes.
  - Must be removed immediately when through.
  - Flexible cords and cables shall be protected from accidental damage (sharp corners, projections and doorways or other similar pinch points).

- Temporary wiring over 600V may be used for tests or emergencies only.

- Tools likely to be used in wet and conductive locations need not be grounded if supplied through isolating transformers with an ungrounded secondary of not over 50 volts. UL 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 utilized an approved system of double insulation.

**Portable and Vehicle-Mounted Generators**
• Under the following conditions, the frame of a portable generator shall not be required to be grounded and shall be permitted to serve as the grounding electrode for a system supplied by the generator.

  o The generator supplies only equipment mounted on the generator and/or cord and plug-connected equipment through a receptacle mounted on the generator, and
  o The non-current carrying metal parts of equipment and the equipment-grounding conductor terminals of the receptacle are bonded to the generator frame. This can be accomplished by using grounding-type receptacles and three-wire cords and plugs.

Under the following conditions, the frame of a vehicle shall be permitted to serve as the grounding electrode for a system supplied by a generator located on the vehicle.

• The frame of the generator is bonded to the vehicle frame, and
• The generator supplies only equipment located on the vehicle and/or cord and plug-connected equipment through receptacles mounted on the vehicles or on the generator, and
• The non-current carrying metal parts of the equipment and the equipment-grounding conductor terminals of the receptacles mounted on the vehicle or on the generator are bonded to the frame of the generator. A grounding-type receptacle and three-wire cord and plug are necessary.
• When employing these type generators as a separately-derived system, the neutral conductor of the generator shall be bonded to the generator if connected to an existing distribution system during an emergency.