Section 45.0
GENERAL ELECTRICAL SAFETY
(NON-QUALIFIED PERSONNEL)

A. Purpose

The purpose of this procedure is to provide **JAGUAR ENERGY SERVICES, LLC** personnel with an overview on the basic principles of electrical safety.

1. The concepts and principles discussed will help further an understanding of OSHA 29 CFR 1910.301 through 309, 331 through 335, and other regulatory standards that apply to our operation.

2. For additional information on electrical safety refer to the Electrical Safety High Voltage and the Assured Grounding procedures. (x-ref Electrical Safety High Voltage) (x-ref Assured Grounding)

B. Scope

This procedure applies to all **JAGUAR ENERGY SERVICES, LLC** jobs and activities involving work on or around electrical power sources or equipment.

C. Responsibilities

1. The Safety Coordinator or his/her designee is responsible for ensuring that employees have completed the training required by this procedure.
   (a) Additional responsibilities include:
      (i) The implementation of this Policy.
      (ii) Take corrective actions on all violations or suspected violations of this procedure.
      (iii) Documentation of completion by each employee.

2. The Safety Director is responsible for providing assistance in the implementation of this Policy.

3. The Supervisor is responsible for providing assistance in the implementation of this policy.

4. **JAGUAR ENERGY SERVICES, LLC** personnel are responsible for implementing the training that is received on general electrical safety.

D. Procedure

1. Electricity Basics

As a source of power, electricity is sometimes accepted without much thought to the potential hazards.

- (a) Although electricity has become a familiar part of our surroundings, electricity must be treated with much deserved respect.
- (b) To handle electricity safely, you must understand:
  - (i) How electricity acts.
  - (ii) How electricity can be directed.
  - (iii) Electrical hazards and how these hazards can be controlled.
- (c) Operating an electric switch may be considered analogous to turning on a water faucet.
- (d) Behind the faucet or switch there must be a source of water or electricity, a transportation vehicle, and pressure to cause flow.
- (e) In the case of water:
  - (i) The source is a reservoir or pumping station
  - (ii) The transportation vehicle is a pipe
  - (iii) The force to make it flow is pressure provided by a pump.
- (f) For electricity:
  - (i) The source is the power generating station
  - (ii) The transportation vehicle is in the form of wires
  - (iii) Pressure, measured in volts, is provided by a generator.
- (g) Resistance to the flow of electricity is measured in ohms.
- (h) The resistance of a material is determined by three factors:
  - (i) Nature of the substance
  - (ii) Length
  - (iii) Cross-sectional area (size) of the substance
  - (iv) Temperature of the substance
- (i) Resistance varies widely.
- (j) Some substances, such as metals, offer very little resistance to the flow of electric current and are called conductors.

(k) Other substances, such as porcelain, pottery, and dry wood offer such a high resistance that they can be used to prevent the flow of electric current and are called insulators.

(l) Dry wood has a high resistance, but when saturated with water its resistance drops to the point where it will readily conduct electricity.

(m) The same thing is true of human skin.
  - (i) Dry skin has fairly high resistance to electric current
  - (ii) When skin is moist, there is a radical drop in resistance.

(n) Pure water is a poor conductor.
  - (i) But small amounts of impurities such as salt and acid, which are contained in perspiration, make skin moist with perspiration a good conductor.
  - (ii) When water is present in the environment or on the skin, additional caution should be exercised when working with or around electricity.

2. Electrical Shocks

Electricity travels in closed circuits, and its normal route is through a conductor.

(a) Electric shock occurs when the body becomes a part of the electric circuit.

(b) The current must enter the body at one point and leave at another.

(c) Electric shock normally occurs in one of three ways:
  - (i) If an individual comes in contact with both wires of an electric circuit.
  - (ii) If an individual comes in contact with one wire of an energized circuit and the ground.
  - (iii) If an individual comes in contact with an energized conductor or a metallic part that has become "hot" by contact with an energized conductor.

(d) The metal parts of electric tools and machines may become energized if there is a break in the insulation of the tool or machine wiring.

(e) The worker using these tools and machines is made less vulnerable to electric shock when there is a low-resistance path from the metallic case of the tool or machine to the ground.

(i) This is done through the use of an equipment grounding conductor, a low-resistance wire that causes the unwanted current to pass directly to the ground, thereby greatly reducing the amount of current passing through the body of the person in contact with the tool or machine.

(ii) A properly installed equipment grounding conductor has a low resistance to ground and the worker is protected.

3. Severity of the Shock

(a) The severity of the shock received when a person becomes a part of an electric circuit is affected by three primary factors:

(i) Amount of current flowing through the body (measured in amperes).

(ii) Path of the current through the body.

(iii) Length of time the body is in contact with the circuit.

(b) Other factors that can affect the severity of shock include:

(i) Frequency of the current.

(ii) Phase of the heart cycle when shock occurs.

(iii) General health of the person.

(c) The effects of electric shock depend upon the type of circuit, voltage, resistance, current, pathway through the body, and duration of the contact.

(d) Effects can range from a barely perceptible tingle to immediate cardiac arrest.

(e) Although there are no absolute limits or even known values that show the exact injury from any given current, the table below, "Effects of Electric Current in the Human Body," shows the general relationship between the degree of injury and amount of current for a 60-cycle hand-to-foot path for a one second duration of shock.

(f) The table also illustrates that a difference of less than 100 milliamperes exists between a current that is barely perceptible and one that can kill.

(g) Muscular contraction caused by stimulation may not allow the victim to free himself or herself from the circuit and the increased duration of exposure increases the dangers to the shock victim.

(i) For example, a current of 100 milliamperes for three seconds is equivalent to a current of 900 milliamperes applied for .03 seconds in causing ventricular fibrillation.

(h) The so-called low voltages can be extremely dangerous because when all other factors are equal, the degree of injury is proportional to the length of time the body is in contact with the circuit.

(i) Low voltage does not imply low hazard.

Effects of Electric Current in the Human Body

Current	**Effect**
1 Milliampere	Perception level. Just a faint tingle.
5 Milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. However, strong involuntary reactions to shock in this range can lead to injuries.
6-25 Milliamperes (women) 9-30 Milliamperes (men)	Painful shock, muscular control is lost. This is called the freezing current or "let-go" range.
50-150 Milliamperes	Extreme Pain, respiratory arrest, severe muscular contractions. Individual can not let go. Death is possible.
1,000-4,300 Milliamperes	Ventricular fibrillation (The rhythmic pumping action of the heart ceases) occurs. Muscular contractions and nerve damage occur. Death is most likely.
10,000 Milliampere	Cardiac arrest, severe burns, and probable death.

1. **Burns and Other Injuries**

The most common shock-related injury is a burn.

(a) Burns suffered in electrical accidents are categorized into three types:

(i) Electrical burns

(ii) Arc burns

(iii) Thermal contact burns

(b) Electrical burns are the result of the electric current flowing through tissues or bones.

(c) Tissue damage is caused from heat generated by the current flowing through the body.

(d) Electrical burns are one of the most serious injuries you can receive and should be given immediate attention.

(e) Arc or flash burns are the result of high temperatures near the body and are produced by an electric arc or explosion.
   (i) Arc or flash burns should be attended to promptly.

(f) Thermal contact burns are those normally experienced when the skin comes in contact with hot surfaces of overheated electric conductors, conduits, or other energized equipment.
   (i) Clothing may be ignited in an electrical accident and a thermal burn will result.

(g) All three types of burns may be produced simultaneously.

(h) Electric shock can also cause injuries of an indirect or secondary nature in which involuntary muscle reaction from the electric shock can cause bruises, bone fractures, and even death resulting from collisions or falls.

(i) In some cases, injuries caused by electric shock can be a contributory cause of delayed fatalities.

(j) A severe shock can cause considerably more damage to the body than is visible.
   (i) For example, a person may suffer internal hemorrhages and destruction of tissues, nerves, and muscles.
   (ii) In addition, shock is often only the beginning in a chain of events.
   (iii) The final injury may well be from a fall, cuts, burns, or broken bones.

(k) In addition to shock and burn hazards, electricity poses other dangers.
   (i) For example, when a short circuit occurs, hazards are created from the resulting arcs.

(l) If high current is involved, these arcs can cause injury or start a fire.

(m) Extremely high-energy arcs can damage equipment causing fragmented metal to fly in all directions.

(n) Even low-energy arcs can cause violent explosions in atmospheres that contain flammable gases, vapors, or combustible dusts.

2. Preventing Electrical Hazards

Electrical accidents appear to be caused by a combination of three possible factors- unsafe equipment and/or installation, workplaces made unsafe by the environment, and unsafe work practices.

(a) There are various ways of protecting people from the hazards caused by electricity.

(b) These include:

- (i) Insulation
- (ii) Guarding
- (iii) Grounding
- (iv) Electrical protective devices
- (v) Safe work practices
- (vi) Illumination

3. Insulation

One way to safeguard individuals from electrically energized wires and parts is through insulation.

(a) An insulator is any material with high resistance to electric current.

(b) Insulators such as glass, mica, rubber, and plastic are put on conductors to prevent shock, fires, and short circuits.

(c) Before employees prepare to work with electrical equipment, it is always a good idea for them to check the insulation before making a connection to a power source to be sure there are no exposed wires.

(d) The insulation on flexible cords, such as extension cords, is particularly vulnerable to damage.

(e) Regulations generally require circuit conductors (the material through which current flows) to be insulated to prevent people from coming into accidental contact with the current.

- (i) Also, the insulation should be suitable for the voltage and existing conditions, such as temperature, moisture, oil, gasoline, or corrosive fumes.
- (ii) All these factors must be evaluated before the proper choice of insulation can be made.

(f) Conductors and cables are marked by the manufacturer to show the maximum voltage and American Wire Gage size, the type letter of the insulation, and the manufacturer's name or trademark.

(g) Insulation is often color coded.

- (i) In general, insulated wires used as equipment grounding conductors are continuous green or green with yellow stripes.
- (ii) The grounded conductors that complete a circuit are generally covered with continuous white or natural gray-colored insulation.

(iii) The ungrounded conductors, or "hot wires," may be any color other than green, white, or gray.
(iv) They are often colored black or red.

4. Guarding

Live parts of electric equipment operating at 50 volts or more must be guarded against accidental contact.

(a) Guarding of live parts may be accomplished by:
- (i) Location in a room, vault, or similar enclosure accessible only to qualified persons.
- (ii) Use of permanent, substantial partitions or screens to exclude unqualified persons.
- (iii) Location on a suitable balcony, gallery, or platform elevated and arranged to exclude unqualified persons.
- (iv) Elevation of 8 feet (2.44 meters) or more above the floor,

(b) Entrances to rooms and other guarded locations containing exposed live parts must be marked with conspicuous warning signs forbidding unqualified persons to enter.

(c) Indoor electric wiring of more than 600 volts, and that is open to unqualified persons, must be made with metal-enclosed equipment or enclosed in a vault or area controlled by a lock.
- (i) This equipment must also be marked with appropriate caution signs.

5. Grounding

Grounding is another method of protecting employees from electric shock and is normally considered to be a secondary protective measure.

(a) The "ground" refers to a conductive body, usually the earth, and means a conductive connection, whether intentional or accidental, by which an electric circuit or equipment is connected to earth or the ground plane.

(b) By grounding a tool or electrical system, a low-resistance path to the earth is intentionally created.

(c) When properly done, a grounding path offers sufficiently low resistance and has sufficient current carrying capacity to prevent the buildup of hazardous voltages.

(d) Grounding does not guarantee that no one will receive a shock, be injured, or be killed.

(e) Grounding, however, will substantially reduce the possibility of such accidents, especially when used in combination with other safety measures.

(f) There are two kinds of grounds required by governmental regulations:

- (i) Service or system ground.
  - (i) In this ground, a wire called the neutral conductor or grounded conductor is grounded. In an ordinary low-voltage circuit, the white (or gray) wire is grounded at the generator or transformer and again at the service entrance of the building.
  - (ii) This type of ground is primarily designed to protect machines, tools, and insulation against damage.
- **(ii) Equipment ground.**
  - (i) To offer enhanced protection to the worker's themselves, an equipment ground must be furnished by providing another path from the tool or machine through which the current can flow to the ground.
  - (ii) This additional ground safeguards the electric equipment operator in the event that a malfunction causes the metal frame of the tool to become accidentally energized.
  - (iii) The resulting heavy surge of current will then activate the circuit protection devices and open the circuit.

6. Illumination

Employees may not enter spaces containing exposed energized parts unless illumination is provided that enables the employees to work safely.

7. Circuit Protection Devices

Circuit protection devices are designed to automatically limit or shut off the flow of electricity in the event of a ground-fault, overload, or short circuit in the wiring system.

(a) Examples include:

- (i) Fuses

(ii) Circuit breakers
(iii) Ground-fault circuit interrupters.

(b) Fuses and circuit-breakers are over-current devices that are placed in circuits to monitor the amount of current that the circuit will carry.
(i) These devices automatically open, or break the circuit, when the amount of current flow becomes excessive and unsafe.
(ii) Fuses are designed to melt when excessive current flows through them.
(iii) Circuit breakers, on the other hand, are designed to trip open the circuit by electromechanical means.

(c) Fuses and circuit breakers are intended primarily for the protection of conductors and equipment.
(i) These devices prevent over heating of wires and components that might otherwise create hazards for operators.
(ii) They also open the circuit under certain hazardous ground-fault conditions.

(d) The ground-fault circuit interrupter (GFCI) is designed to shutoff electric power within as little as 1/40 of a second.
(i) A GFCI works by comparing the amount of current going to electric equipment against the amount of current returning from the equipment along the circuit conductors.
(ii) If the current difference exceeds 6 milliamperes, the GFCI interrupts the current quickly enough to prevent electrocution.
(iii) GFCI's are used in high risk areas such as wet locations and construction sites.

8. Safe Work Practices

Employees and others working with electric equipment shall use safe work practices to prevent electrical shock or other injuries resulting from either direct or indirect electrical contacts when work is performed near or on equipment which is or may be energized.

(a) These include:
(i) Deenergizing electric equipment before inspecting or making repairs.
(ii) Using electric tools that are in good repair.
(iii) Using good judgment when working near energized lines
(iv) Using appropriate protective equipment.

9. Deenergized Electrical Equipment

This applies to work on exposed deenergized parts or near enough to them to expose the employee to any electrical hazard they present.

(a) The accidental or unexpected sudden starting of electrical equipment can cause severe injury or death.

(b) Before any inspections or repairs are made, even on the low-voltage circuits, the current must be turned off at the switch box and the switch padlocked in the OFF position.

(c) The switch or controls of the machine or other equipment being locked out of service must also be securely tagged to show which equipment or circuits are being worked on.

(d) **JAGUAR ENERGY SERVICES, LLC** has a Lockout/Tagout procedure for electrical work as well as any other source of energy. (x-ref Lockout/Tagout)

10. Energized Electrical Equipment

This applies to work performed on exposed live parts or equipment (involving either direct contact or by means of tools or materials) or near enough to them for employees to be exposed to any electrical hazard present.

(a) Non - Qualified are not allowed to work on any energized parts or equipment.

(b) Only qualified personnel will be allowed to perform work on or near energized parts or equipment.

(c) These personnel will be made familiar with the use of special precautionary techniques.

- (i) They will be trained in and use:
  - (i) Lockout/Tagout
  - (ii) PPE
  - (iii) Insulating and shielding materials
  - (iv) Insulated tools

(d) Equipment maintenance employees must be qualified persons who have been trained in proper electrical procedures.

(e) Maintenance workers must ensure equipment maintenance activities do not expose other employees to danger.

(f) If more than one employee is repairing a piece of equipment, each should lock out the switch with his/her or her own lock and never permit anyone else to remove their lock.

11. Overhead Lines

If work is to be performed under or near overhead power lines, the lines must be deenergized and grounded by the owner or operator of the lines, or other protective measures must be provided before work is started.

(a) Protective measures (such as guarding or insulating the lines) must be employed to prevent employees from contacting the lines.

(b) Unqualified employees and mechanical equipment must stay at least 10 feet (3 meters) away from overhead power lines.

- (i) No object that an unqualified person carries must come any closer than this distance.
- (ii) This distance limit increases by 4 inches (10.2 cm) for every 10,000 volts over 50,000 volts.

(c) Vehicular and mechanical equipment may not be operated near overhead lines by employees standing on the ground unless required clearances are met.

(d) Qualified persons working near exposed energized overhead lines may not approach, or take any object without an approved insulating handle, and get no closer to exposed energized parts than shown in the table below:

APPROACH DISTANCE FOR QUALIFIED EMPLOYEES (ALTERNATING CURRENT - A/C)

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

(a) There are safety considerations and clearance distances applicable to vehicular or mechanical equipment, such as a man-lift, that apply when working near overhead lines.

- (i) Since this equipment may become energized down to the ground level, all overhead distance restrictions apply at the ground level as well.

(ii) Warning signs should be used to keep people away from any vehicle operating near overhead lines.

(a) It is acceptable for a qualified person to come closer to the above voltages under the following conditions:
(i) The person is wearing insulated gloves with the proper voltage rating.
(ii) The energized part is insulated.
(iii) The person is insulated from all conductive objects (for example, by an insulated mat with the proper voltage rating).

2. Tools

To maximize personal safety, an employee should always use tools that work properly.
(a) Tools must be inspected before use, and unfit tools should be removed from service and properly tagged.
(b) Tools and other equipment should be regularly maintained.
(c) Tools that are used by employees to handle energized conductors must be designed and constructed to withstand the voltages and stresses to which they are exposed. (x-ref Hand and Portable Power Tools)

3. Good Judgment

Perhaps the single most successful defense against electrical accidents is the continuous exercising of good judgment or common sense.
(a) All employees should be thoroughly familiar with the safety procedures for their particular jobs.
(b) When work is performed on or around electrical equipment, good judgment includes: Having the equipment deenergized.
(c) Ensuring that the equipment remains deenergized by using some type of lockout and tag procedure.
(d) Using insulating protective equipment.
(e) Keeping a safe distance from energized parts.

4. Confined or Enclosed Work Spaces

A confined space is any space with a restricted means of entry and regress, or a space where natural ventilation through openings does not prevent dangerous gasses or vapors from accumulating.
(a) Examples include a manhole or a vault.

(b) Do not enter a confined or enclosed space that contains exposed energized parts unless qualified to do so. (x-ref confined space Entry).

(c) Personnel working in a confined space that contains electrical hazards will use:
- (i) Proper PPE
- (ii) Protective shields
- (iii) Barriers
- (iv) Insulating
- (v) Proper illumination

(d) **JAGUAR ENERGY SERVICES, LLC** will furnish all necessary materials to protect the employees entering a confined space which contains electrical hazards at no charge to the employees.
- (i) All requirements of **JAGUAR ENERGY SERVICES, LLC**'s Confined Space Program must be met.

5. Conductive Materials and Equipment

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.

(a) If an employee must handle long dimensional conductive parts in areas with exposed live parts, the employer shall institute work practices which will minimize the hazard.

(b) Portable ladders shall have non - conductive side rails if they are used where the employee or the ladder could contact exposed energized parts.

(c) Conductive articles of jewelry and clothing may not be worn if they might contact exposed energized parts.
- (i) However, such articles may be worn if they are rendered non - conductive by covering wrapping, or other insulating means.

6. Personal Protective Equipment

Employees whose work tasks require them to work directly with electricity must use the personal protective equipment (PPE) required for the specific jobs they perform.

(a) This equipment may consist of rubber:
- (i) Insulating gloves
- (ii) Hoods
- (iii) Sleeves
- (iv) Matting
- (v) Blankets

(vi) Line hoses
(vii) Industrial protective helmets.

B. Training Requirements

1. Unqualified **JAGUAR ENERGY SERVICES, LLC** personnel who could face electrical shock will be trained on the following topics:
   (a) Basic principles of electricity.
   (b) Preventing electrical shock.
   (c) Burns and other injuries.
   (d) Circuit protection devices.
   (e) Electrical related safety practices.
   (f) Safety practices related work practices that pertain to their respective job assignments.
   (g) Clearance distances
   (h) Personal protective equipment.
   (i) Contents of this procedure.

C. Training Frequency

1. **JAGUAR ENERGY SERVICES, LLC** personnel will be trained according to the following schedule:
   (a) Initially upon hire.
   (b) As necessary thereafter.