4. ELECTRICAL SAFETY

The following sections provide general safety guidelines and procedures for electrical safety. This section covers the following topics:

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4.1 General Electrical Safety

The danger of injury through electrical shock is possible whenever electrical power is present. When a person's body completes a circuit and thus connects a power source with the ground, an electrical burn or injury is imminent. Most fatal injuries result from high-voltage exposure; however, people can sustain severe injuries from low voltage power if it has a high current flow.

Electrical safety is important in every work environment. The following sections cover circuit breaker loads, electrical grounding, electrical safety guidelines, and electrical emergency response.

A. Definitions

The following definitions help clarify general electrical safety:

- Amps:

  The standard unit for measuring electrical current.

- Authorized Employee:

  A person who locks out or tags out equipment for service or maintenance. Authorized employees have been formally trained in proper lockout/tagout procedures.

- Breaker Box:

  An insulated box on which interconnected circuits are mounted.

- Circuit Breaker:

  A device designed to open and close a circuit by non-automatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within it rating.

- Current Flow:

  The rate of flow of an electrical charge, generally expressed in amps.

- Electrical Load:

  The amount of power delivered by a generator or carried by a circuit. A device to which the power is delivered.

- Electrical Panel:

  An insulated panel on which electrical wires are mounted.

- Energy-Isolating Device:

  A mechanical device that prevents the transmission or release of energy. Examples include the following:

  - Manually operated circuit breakers
  - Disconnect switches
  - Line or block valves

  Pushbuttons, selector switches, and other control circuit devices do not isolate energy.

  Energy-isolating devices should be lockable by means of a hasp or other type of attachment. It should not be necessary to dismantle or reassemble a device to lock it.

- Ground-Fault Circuit Interrupter (GFCI):

  A GFCI detects grounding problems and shuts electricity off to prevent a possible accident.
- Hazardous Energy Sources:

  This term applies to stored or residual energy such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure.
- High Voltage:

  The term high voltage applies to electrical equipment that operates at more than 600 Volts (for terminal to terminal operation) or more than 300 Volts (for terminal to ground operation). Low voltage, high current AC or DC power supplies are also considered to be high voltage.
- Lockout:

  The placement of a lock on an energy-isolating device. This act prevents workers from energizing and operating a piece of equipment until the lock is removed.
- Tagout:

  The placement of a tag on an energy-isolating device. A tagout device is a prominent warning device of a lockout.
- Voltage:

  Electromotive force expressed in volts.
- Watt:

  A unit of electrical power, equal to the power developed in a circuit by a current of amp flowing through a potential difference of one volt.

B. Circuit Breaker Loads

Most office and laboratory locations have 20 amp circuit breakers that serve two or more outlets. These breakers can handle most office equipment; however, the widespread use of personal computers and associated hardware can create an electrical overload. To determine your current electrical load, follow these steps:

1. Check office/laboratory equipment for a manufacturer's rating label that indicates total watts or amps. Take special care to check appliances that use electricity to generate heat.
2. Convert the watts rating to amps:

   Amps = Watts / 120 Volts
3. Total the amps for each circuit.
4. If the total equals more than 15 amps per 20-amp circuit, you may be overloading the circuit. Move enough equipment to a different circuit to reduce the circuit load; otherwise, have the Facilities Department inspect the circuit wiring.

C. Electrical Grounding

Proper electrical grounding can help prevent electrical injury. Most electrical equipment is grounded with either a three-prong plug or a two-prong plug and insulation. Because a grounding system may be defective without your knowledge, use a GFCI to ensure electrical safety. GFCIs are required in moist or potentially damp environments.

D. Electrical Panels

Electrical panels or breaker boxes require special safety considerations, including the following:

- Know where your panel box is located.
- Do not tape circuit switches to keep a breaker from tripping.
- Ensure that breaker circuits are accurately labeled within panel boxes.
- Ensure that panel box doors are securely attached.
- Do not block panel boxes. There should be at least 36 inches of clear space in front of a panel box.

Report tripped breakers and refer any electrical questions to the Facilities Department.

E. Electrical Safety Guidelines

Follow these guidelines for general electrical safety:

- Be familiar with the electrical hazards associated with your workplace.
- Unplug electrical equipment before repairing or servicing it.
- If a prong breaks off inside an outlet, do not attempt to remove it yourself. Call the Facilities Department for assistance.
- Ensure that outlets are firmly mounted. Report loose outlets to the Facilities Department.
- Report all electrical problems, including tripped breakers, broken switches, and flickering lights, to the Facilities.
- All appliances used in Texas State University buildings must be UL or FM (Factory Mutual) labeled.
- Do not use an appliance that sparks, smokes, or becomes excessively hot, unless the appliance is specifically designed to exhibit these characteristics.
- Portable electrical heaters must be placed to avoid causing a trip hazard and must be kept away from combustible material. Never leave a heater unattended. Unplug the heater at the end of the day or when not in use.
- Keep electrical equipment away from water, unless the appliance is specifically designed for use around water, such as a wet-dry shop vacuum.
- Use GFCIs whenever possible.
- Be aware of overhead power lines when working with tall equipment (e.g., grain augers, cranes, sailboats, etc.).
- Never unplug an appliance by pulling on the cord, pull on the molded plug cap.
- Follow University Energy Lockout/Tagout Procedures (FSS PPS 04.05.02), as appropriate.

Follow these guidelines for electrical plug and cord safety:

- Do not remove the prongs of an electrical plug. If plug prongs are missing, loose, or bent, replace the entire plug.
- Do not use an adapter or extension cord to defeat a standard grounding device. (e.g., Only place three-prong plugs in three-prong outlets; do not alter them to fit in a two-prong outlet.)
- Use extension cords only when necessary and only on a temporary basis. Do not use extension cords in place of permanent wiring. Request new outlets if your work requires equipment in an area without an outlet.
- Use extension cords that are the correct size or rating for the equipment in use. The diameter of the extension cord should be the same or greater than the cord of the equipment in use.
- Do not run electrical cords above ceiling tiles or through walls.
- Keep electrical cords away from areas where they may be pinched and areas where they may pose a tripping or fire hazard (e.g., doorways, walkways, under carpet, etc.)
- Avoid plugging more than one appliance in each outlet. If multiple appliances are necessary, use an approved power strip with surge protector and circuit breaker. Do not overload the circuit breaker.
- Discard damaged cords, cords that become hot, or cords with exposed wiring.
- Never unplug an appliance by pulling on the cord; pull on the plug.

F. Electrical Emergency Response

The following instructions provide guidelines for handling three types of electrical emergencies:

1. Electric Shock:

   When someone suffers serious electrical shock, he or she may be knocked unconscious. If the victim is still in contact with the electrical current, immediately turn off the electrical power source. If you cannot disconnect the power source, try to separate the victim from the power source with a nonconductive object, such as a wood-handled broom.

IMPORTANT!
Do not touch a victim that is still in contact with a power source; you could electrocute yourself.

   Have someone call for emergency medical assistance immediately. Administer first aid, as appropriate.

2. Electrical Fire:

   If an electrical fire occurs, try to disconnect the electrical power source, if possible. If the fire is small, you are not in immediate danger, and you have been trained in fighting fires, use any type of fire extinguisher except water to extinguish the fire.

IMPORTANT!
Do not use water on an electrical fire.

3. Power Lines:

   Stay away from live power lines and downed power lines. Be particularly careful if a live power line is touching a body of water. The water could conduct electricity.

   If a power line falls on your car while you are inside, remain in the vehicle until help arrives.

4.2 Lockout/Tagout Procedures

Lockout/tagout procedures are used to isolate hazardous energy sources from electrical, hydraulic, or pneumatic machinery. Furthermore, when service or maintenance work is required, lockout and tagout devices help ensure personal safety from possible energy releases. All employees whose work involves hazardous energy sources must be trained in lockout/tagout procedures.

Before performing service or maintenance work on machines, turn them off and disconnect them from their energy sources. To further ensure employee safety, use lockout and tagout energy-isolating devices.

The following sections provide information on lockout/tagout procedures. In addition to the procedures in this manual, Texas State University maintains a University Lockout/Tagout Procedures for the control of hazardous energy. A copy of this document is available from the Facilities Department and shall be referenced when preparing to work with high energy devices.

A. Applying Lockout/Tag-out Devices

Only authorized employees may apply lockout/tagout devices. The following steps provide a brief outline of approved application procedures:

1. Notify employees that the equipment requires service or maintenance and is scheduled for shutdown and lockout/tagout.
2. Use established procedures to identify the type, magnitude, and hazards of the equipment's energy source. Make sure you know the proper methods for controlling the energy source.
3. If the equipment is currently operating, shut it down using normal shutdown procedures.
4. Isolate the equipment from its energy source by activating the energy-isolating device(s). Either lockout or tagout the energy-isolating device(s).
5. Dissipate or restrain stored and residual energy using methods such as grounding, repositioning, blocking, bleeding, etc. (Capacitors, springs, hydraulic systems, and air/gas/water pressure system may contain stored or residual energy.)
6. Ensure that all employees are removed from the equipment. Then, test the equipment for successful isolation by attempting to operate it.

IMPORTANT!

After verifying isolation, return the controls to neutral or off.

B. Removing Lockout/Tag-out Devices

When service and maintenance are complete, authorized employees may remove lockout/tagout devices and return equipment to normal operations. The following steps provide a brief outline of approved removal procedures:

1. Inspect the work area and remove any nonessential items. Make sure the isolation equipment is intact and in good working condition.
2. Ensure that all employees are safely removed from the equipment.
3. Verify that the equipment controls are in neutral or off.
4. Remove the lockout/tagout devices and re-energize the equipment.

NOTE:

The removal of some forms of blocking may require the equipment to be re-energized before safe removal.

5. Notify employees that the equipment is ready for operation

4.3 High Voltage Procedures

In addition to the guidelines associated with general electrical safety and lockout/tagout procedures, there are more stringent safety requirements for high voltage procedures.

The following list provides high-voltage safety tips. For more information, please refer to OSHA Title 29 Section 1910.269 of the Code of Federal Regulations or NFPA 70 (National Electric Code).

- Ensure that only authorized employees work around high voltage equipment.
- Label entrances with a High Voltage Sign.
- Ensure that terminal voltage ratings can withstand surges caused by electrical faults or switching transients.
- Be careful around output circuits even when the input power is off. Parallel power sources and energy storage devices can still be dangerous.
- Be careful when working with power supplies that serve more than one area.
- Before working in a high voltage area, inspect the power supply and check all protective devices.
- Do not work alone near high voltage.
- Label equipment to identify power sources. Label input power sources to identify connected power supply loads.
- Attach emergency shutdown instructions and phone numbers to equipment that is remotely controlled or unattended while energized.
- Before entering a power supply or associated equipment enclosure to work on hazardous energy sources, complete the following:
  - De-energize the equipment.
  - Open and lockout the main input power circuit breaker.
  - Check for auxiliary power circuits that could still be energized.
  - Inspect automatic shorting devices for proper operation.
  - Short the power supply with grounding hooks.

A. Minimum Clear Working Space

The following table from the National Electric Code provides minimum depth of clear working space in front of electrical equipment:

Nominal Voltage to Ground	Conditions		
	i	ii	iii
	(ft)	(ft)	(ft)
601 – 2,500	3	4	5
2,501 – 9,000	4	5	6
9,001 – 25,000	5	6	9
25,001 – 75kV	6	8	10
Above 75kV	8	10	12

Where conditions (i), (ii), and (iii) are as follows:

(i) 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 bus bars operating at not over 300 volts shall not be considered live parts.

(ii) Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces.

(iii) Exposed live parts on both sides of the workspace [not guarded as provided in condition (i)] with the operator between.

B. Proper Electrical Repair Procedures

It will be mentioned that no electrical device should be opened, repaired, upgraded or changed with the power circuit energized to that device if possible.

There are times when an electrical device will be worked on for some reason while the device circuit is energized. All safety precautions and equipment will be utilized to safe guard the employee from coming in contact with a live electrical circuit.

If an electrical device is requested by work order for repair, these procedures should always be followed no matter the situation:

1. The electrical device circuit should be tested to see if the device is energized before any attempt of repair. There are many UL listed devices that can be used for this testing procedure.
2. If the device circuit is energized, then the power sources should be located by subpanel and breaker location or by using a tracer device to locate the circuit breaker and then the breaker for that circuit should be switched off and locked out and tagged out (LO/TO) as prescribed by Texas State University Standards FSS/PPS No. 04.05.02.

3. If the electrical circuit cannot be located and the device must be repaired with the electrical circuit energized (HOT), then this procedure will be followed to insure that the HOT circuit will not come in contact with the device or the person doing the repairs.

    - The HOT circuit will be identified and will be isolated from the device frame by removing the HOT circuit from the device junction block, wire nut connection or internal connection.

    - The HOT circuit will have a wire nut or some type of insulated termination installed and tested before any attempt to repair the device. If the wire nut is larger than the wire itself than the employee will either fold the wire to increase the size of the wire so that the wire nut will attach to the HOT circuit or the employee will wrap the HOT circuit with UL listed electrical rubber and vinyl tape to prevent the HOT circuit from coming in contact with the frame or the employee.

    - If the device is to be repaired with a HOT circuit in the device than there will be no less than two employees assigned to the repairs in the case that there will be a safety person on site if a electrocution were to occur.

    - Once the device is repaired than the HOT circuit can be reattached to the device to energize the device.

END OF SECTION