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Safety and Health Program
Control of Hazardous Energy (Lockout-Tagout)

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SAFETY AND HEALTH PROGRAM
CONTROL OF HAZARDOUS ENERGY
(LOCKOUT-TAGOUT)

OR/WA Supplement to BLM Manual Handbook H-1112-1
Safety and Health Management

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H-1112-1 SAFETY AND HEALTH MANAGEMENT

24.1 Policy Statement

The Oregon/Washington Bureau of Land Management (BLM) is committed to providing a safe and healthful work environment for all employees. The BLM has various work procedures [including administrative and engineering controls] in place which reduces employee exposure to hazards. The agency provides requirements for the establishment of an electrical safety program for electrical equipment, portable electrical devices and electrical appliances; and, for the servicing and maintenance of machines and equipment in which the unexpected start up of the machines or equipment, or the release of stored energy could cause injury to employees. Requirements are provided by reference to the following standards and this policy. (Reference *24.1.3 Scope*)

- OSHA General Industry Standard 29 CFR 1910.147 The Control of Hazardous Energy
- OSHA General Industry Standard 29 CFR 1910.301 Electrical Safety Requirements
- OSHA Construction Industry Standard 29 CFR 1926.400 Electrical Safety Requirements
- BLM Manual Handbook 1112-1 Safety and Health Management
- BLM Manual Handbook 1112-2 Safety and Health for Field Operations

Additional references exist relating to specific types of machinery (e.g., OSHA General Industry Standard 29 CFR 1910.179 – *Overhead Cranes*).

24.1.2 Purpose and General Information

Employees are exposed to hazards on the job each day. These hazards can range from tripping over an electrical cord to exposure to a toxic chemical. Every year in this country, workers die or are permanently disabled because moving parts in machinery or equipment were not blocked or a machine was not completely de-energized before repairs began. Any employee performing service or maintenance on machinery and equipment is exposed to potentially significant injuries from the unexpected start up of the equipment or from the release of stored energy in that equipment.

Machinery and equipment operate because some form of energy provides power. Employees realize that energy is *on* during normal operations. However, if energy comes on or is released unexpectedly such as during servicing or maintenance activities, employees can suffer serious injury – even death. After a machine is turned off, all energy sources must also be turned off and, the energy released, to ensure they do not come back on.

Lockout/Tagout refers to specific practices and procedures to safeguard employees from the unexpected startup or release of stored energy of any equipment during service or maintenance activities. This program states that before service or maintenance is performed on any equipment, it must be turned off and disconnected from the energy source, and, the energy-isolating device must be either locked or tagged out.

Simply turning a machine[1] off or unplugging it while it is being worked on does not give sufficient protection for workers.

24.1.3 Scope

This policy addresses only the general requirements for controlling hazardous energy during service or maintenance of machines or equipment. (29 CFR 1910.147) The OSHA standard covers all employees who are authorized[2] to service and maintain equipment in which the unexpected start up of these machines, or, the release of stored energy could cause workplace injury. This program establishes minimum performance requirements for any source of mechanical, hydraulic, pneumatic, chemical, thermal, or other energy. Activities and/or operations covered include constructing, installing, setting up, adjusting, inspecting, modifying, maintaining, and/or servicing machines or equipment, and making adjustments to tool changes.[3]

Other related standards are listed here for reference. The OSHA electrical standards are based on the National Fire Protection Association Standards NFPA 70, *National Electric Code*, and NFPA 70E *Electrical Safety Requirements for Employee Workplaces*.

29 CFR 1910.301& 331-335 – These standards address electrical safety requirements that are necessary for the practical safeguarding of employees in the workplace. Specific references include 1910.331 – safety-related work practices; and 1910.332-333 – training, selection and use of these work practices.

29 CFR 1926.400 – This standard identifies electrical safety requirements that are necessary for the practical safeguarding of employees involved in construction activities. Electrical installation safety requirements and safety-related work practices and maintenance activities are included.

The LO/TO standard ***does not apply*** in the following situations:

- While servicing or maintaining *cord and plug* connected electrical equipment, provided that the equipment is unplugged from the energy source and the plug remains under the *exclusive* control of the employee performing the servicing and/or maintenance.[4]

[1] For purposes of brevity only [not to limit the scope of the policy], the terms 'machine' and 'equipment' are used interchangeably.
[2] Reference Definitions for identification of '*authorized*' employees
[3] This LO/TO standard does not cover electrical hazards. (Reference 1910.301 & 333 for electrical safety requirements)
[4] This situation applies only if electricity is the only form of hazardous energy to which employees may be exposed. This exception encompasses many portable hand tools and some cord and plug connected machinery and equipment. (Reference Appendix A – *Standard Operating Procedures for Electrical Plug-Type Equipment*)

- During *hot tap operations* that involve transmission and distribution systems for gas, steam, water, or petroleum products when they are performed on pressurized pipelines provided that continuity of service is essential, shutdown of the system is impractical, and employees are provided with alternative protection that is equally effective.[5]

- Installations under the exclusive control of electric utilities for power generation, transmission, and distribution.[6]

Machines and equipment present various types of hazardous situations during normal operations (i.e., whenever machines and equipment are used to perform intended production functions). These types of hazards are covered by rules in other general industry standards. (Reference *29 CFR 1910.211 Machines and Machine Guarding*)

24.1.4. Specific Situations - Servicing and Maintenance

In certain circumstances, *some servicing or maintenance hazards encountered during normal production operations are covered* by the lockout/tagout rule. BLM work activities generally do not include production-type operations. However, employees do perform minor tool changes and adjustment on equipment and machines.

- Servicing and/or maintenance operations
  If a servicing activity such as lubricating, cleaning, inspecting, or un-jamming the production equipment takes place *during* production, the employee performing the servicing may be subjected to hazards that are not encountered as part of the production operation itself. Employees engaged in these types of operations *are covered* by the Lockout/Tagout standards when ANY of the following conditions occur:

  ► The employee must either remove or bypass machine guards or other safety devices, resulting in exposure to hazards at the point of operation; or,
  ► An employee is required to be in contact with the point of operation of the machine or equipment; or,
  ► An employee is required to work in any area considered dangerous during the normal operating cycle.

  In each of these situations, the equipment must be de-energized and locks or tags must be applied to the energy-isolation devices.

[5] No hot top operations are performed by BLM employees. (Reference Definitions)
[6] These types of operations are performed by electric utilities only. Information is included here for clarification.

In addition, when other servicing tasks occur such as setting up equipment, and/or making significant adjustments to machines, employees performing such tasks are required to lockout or tagout if they can be injured by the unexpected startup of the equipment.

At times, various servicing operations must be performed with the *power on*, such as making certain types of fine adjustments, or performing troubleshooting methods. In these circumstances, effective *protection must be provided* for employees while they perform such operations.

In general, **if any** of the **conditions** illustrated below exist, the identified machine or equipment **must be included** in the LO/TO program. Each district should perform a survey of all equipment and machinery for potential inclusion in the program. (See Illustration 2 – *Sample Equipment List*)

- The machine has potential for stored or residual energy or re-accumulation of stored energy after shutdown
- The machine has more than a single energy source
- The isolation and locking out of any single energy source will not completely de-energizer and deactivate the machine
- The lockout device is not under exclusive control of an authorized employee performing the servicing or maintenance
- The servicing or maintenance of the machinery creates hazards for other employees
- The existence of any previously documented accidents involving the unexpected activation or re-energizing of machines during servicing or maintenance

- Minor Servicing Tasks
  Employees performing minor tool changes and adjustments and/or other minor servicing activities that are routine,[7] repetitive and integral (inherent to the production process) to the use of the production equipment, and, that occur during normal production operations are *not* covered by the lockout/tagout standard, *provided* the work is performed using alternative measures[8] that provide effective protection for employees.[9]

OR/WA districts may use this policy as a template to create a Lockout/Tagout program specific to site needs. District policies must meet the minimum requirements of OSHA General Industry Standard 29 CFR 1910.147 & 301 and this policy.

[7] The term, *'routine'* refers to a regular course or procedure with established practices which involves making minor adjustments while equipment is operating.
[8] Alternate measures for effective machine safeguarding protection are identified in Subpart O of 29 CFR 1910.211 *Machine and Machine Guarding*.
[9] Lockout/Tagout procedures are not required if equipment must be operating for proper adjustment. Adjustments are made only by trained and authorized employees. All consideration must be made to prevent the need for an employee to break the plane of a normally guarded area of the equipment by use of tools and other devices.

24.1.5 Responsibilities

Managers and supervisors are responsible for administering the lockout/tagout program and providing employee training. Supervisors must ensure that authorized employees use these procedures when indicated. The District Safety manager may be contacted to assist in locating training sources.

Only those employees who are properly trained and certified on equipment maintenance and appropriate lockout/tagout procedures are authorized to implement these procedures. All employees must understand the requirements of the lockout/tagout program and abide by safe work practices when these procedures are used in their work area. Employees must not attempt to operate any equipment or machinery that has been locked or tagged out or attempt to bypass locks or tags.

Failure to follow these procedures is considered a serious safety violation and may result in disciplinary action.

24.1.6 Lockout/Tagout – General Information and Requirements

Lockout/tagout is necessary whenever servicing or maintenance is performed around any machine or equipment where employees or contractors could be injured. *Lockout is the preferred method* of isolating machines from energy sources. The use of lockout devices will provide a more secure and effective means of protecting employees. Any new equipment installed will have lockout capability. Additionally, whenever any major repair, renovation or modification to any existing equipment is performed, energy-isolating devices for each machine must be lockable.

The energy-isolating device(s) for each machine must be locked or tagged out in accordance with documented procedures. Procedures can be created to meet specific needs. There are two types of energy isolating devices; those capable of being locked out and those that are not.

A **lockout** is a method of keeping equipment from being set in motion and endangering employees. In lockouts, one of the following occurs:

- A disconnect switch, circuit breaker, value or other energy-isolating mechanism is placed in the '*safe*' or '*off*' position
- A device is placed over the energy-isolating mechanism to hold it in the safe position
- A lock is attached so that the equipment cannot be energized

A **tagout** is used when the energy-isolating device cannot be locked out. Tagouts are essentially *only warning devices* and do not provide the physical restraint of a lock. In a tagout the energy-isolating device is placed in the safe position and a written warning is attached to the device.[10]

[10] Written warning example language: *DO NOT START - DO NOT ENERGIZE*

A **lockout** device must be durable and able to withstand wear and harsh environments, sufficiently substantial so that easy removal is impossible, uniquely keyed, standardized by color, shape or size, and capable of identifying the employee who applied it. Additionally, tagout devices will be non-reusable, self-locking, standardized according to print and format, and have a high level of locking strength. In all instances, a lockout device used in combination with an OSHA warning tag is preferred.

Generally, qualified employees will be assigned a lock with one key, hasp, and tag. All locks will be keyed differently, except when an individual is issued a series of locks for complex lockout/tagout tasks. In some case, more than one lock, hasp, and tag is required to completely de-energize equipment and machinery. All locks and hasps must be uniquely identifiable to a specific employee (e.g., tag signed and dated by the employee initiating the procedure).

Important: Locks and tags by themselves do not de-energize equipment. Whether the power switch is on or off, energy of some sort is always present in any powered equipment. Therefore, locks and tags must be attached ONLY after the machinery has been isolated from the energy source.

Contractors

All contractors hired by the BLM and performing any type of work referenced in this energy control program will comply with their established LO/TO program or minimum OSHA requirements. BLM employees will be informed of lockout or tagout procedures to be used by contract employees working on job sites.

Group Lockout/Tagout Requirements

When servicing or maintenance activities are performed by more than one employee, each must utilize a procedure which affords each a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device.[11]

Each employee is required to lockout or tagout equipment by placing a personal lockout or tagout device. When an energy isolating device cannot accept multiple locks or tags, a multiple lo/to may be used with this key being place in a lockout box or cabinet which allows the use of multiple locks for security purposes. Each employee will use their personal lock to secure the box or cabinet. Documentation of authorized employees is required.[12]

[11] Group LO/TO is defined as servicing or maintenance procedures performed by a crew, department, or other group [more than one individual]. Primary responsibility for the group is vested in a single authorized employee. The exposure status of all group members must be determined prior to initiation of any procedure.

[12] Group lockout/tagout procedures are not recommended and, are generally not required on BLM-managed sites. [Reference 29 CFR 1910.147 (f)(3)(ii)(A) through (D) for detailed requirements of individual responsibilities in group lockout or tagout.]

Shift and Personnel Changes

When maintenance work extends over more than one day, specific procedures must be developed to ensure continuity of employee protection. These procedures should include the provision for the orderly transfer of lockout or tagout control. This process will assist in minimizing employee exposure to hazards.

24.1.7 Lockout/Tagout Procedures

Preparation for Shutdown
Before any equipment is turned off and a lockout or tagout procedures applied, the authorized employee must notify all other employees who work in the area. Additionally, the employee must review the types of energy hazards posed by the equipment and the method(s) to be used to control this energy.[13]

Machine or Equipment Shutdown and Isolation
Machinery and equipment will be shut down in an orderly manner using the shutdown checklist procedures on the associated lockout/tagout card. The switch, value or other energy-isolating device must be operated so that the equipment is isolated from the energy source.

Application of Lockout/Tagout Devices

- Lockout devices will be used to secure energy isolating devices unless the machinery or equipment is not capable of being locked out. Lockout devices must be able to hold energy isolation devices in a safe or '*off*' position.

- Tagout devices will be used ONLY if machinery or equipment is not capable of being locked out. Tags will clearly state that moving energy isolating devices from the 'safe' or 'off' position is strictly prohibited. If a tag cannot be affixed to the energy-isolating device, it will be located as close as safely possible to the device so that the tag is obvious to any employee who may attempt operation. A tagout is a warning device only. No physical restraint is provided.

Equipment Isolation Verification
Immediately after applying lockout or tagout devices, the authorized employee performing the work will ensure all potentially hazardous stored or residual energy is relieved, disconnected, restrained, or otherwise rendered safe. The authorized employee will verify that the equipment is actually isolated and de-energized by attempting activation.[14]

[13] More than one energy source may be involved.
[14] Following verification procedures, all controls should be placed in the *'neutral'* position.

Removal of Lockout/Tagout Devices
Prior to removing any lockout or tagout device and restoring energy to equipment the authorized employee will ensure that the equipment is properly reassembled, all employees are outside danger zones and notified that devices have been removed and that energy will be reapplied to the equipment.

Only the authorized employee who applied the device may remove that device. Exception: When the authorized employee is not available, only the facilities manager or other designated individual is authorized to remove the lockout/tagout device. [Reference OSHA 1910.147(f) (3) (ii) (A-D)] Districts may determine procedures applicable to specific situations. All procedures must be documented.

24.1.8 Training Requirements

General informational training in lockout/tagout procedures will be provided to all employees [affected or other] who may be in an area where energy control procedures are used. Specific training will be provided for employees authorized to use lockout/tagout procedures. [15] (Reference ***Definitions***) Training will ensure that the purpose and function of the energy control program is understood and that identified employees gain the needed knowledge and skills to safely apply, use and remove energy controls as appropriate to their work tasks and positions. As a minimum, training will include:

- Recognition of applicable hazardous energy sources
- Details regarding the type and magnitude of the hazardous energy sources present in the workplace
- The methods and means necessary to isolate and control identified energy sources
- An understanding of the limitation of tagout systems as compared to lockout procedures

Employees will receive retraining whenever there is a change in job assignments, a change in equipment or procedures that present a new hazard, or, a change in established energy control procedures. Additional training will be provided when periodic inspections reveal a deviation from, or inadequacies in, the knowledge of employees or use of the energy control procedures.

Various training strategies may be used to accomplish the required training, such as formal written tests, video presentations, and hands-on demonstrations. To assist managers and supervisor with training efforts, a Power Point presentation is available on the BLM Intranet Safety Web page at http://web.or.blm.gov/safety/training/training.htm. This site also contains additional training aids including preparation notes for supervisors, an informal LO/TO quiz (also part of the LO/TO program), and a training certificate.

[15] Reference Illustration 5 – *List of Authorized Lockout/Tagout Employees and Training Certification*

24.1.9 Inspections and Record Keeping

Per OSHA regulations, an **annual** inspection of all lockout/tagout procedures must be conducted on each district/site. An authorized employee *other than* the individual(s) using the identified energy control procedure being inspected should perform the inspection. The purpose of this inspection is to correct any deviations or inadequacies in established procedures.

The inspector and authorized employee must review responsibilities under the established energy control procedures. The review must be certified and documented by the Safety manager or other designated individual. Certification elements listed should include the following:

- Identification of equipment or machinery
- Date of inspection
- Employees included in the inspection
- Name of employee performing the inspection

Each district may create an inspection form specific to their needs. (See *Illustration 1* and *3* for sample *Inspection Certification* forms).

In addition to the inspection form, each district will create a comprehensive equipment identification form listing all equipment or machinery that requires periodic servicing or maintenance. All associated hazards must be listed on the form. (See *Illustration 2* for a sample form - *Equipment List*). Districts will also identify all lockout/tagout procedures used on site. (See *Illustration 4* for a sample form - *Listing of Lockout/Tagout Procedures*).

QUICK CHECKLIST

→ Always lock or tag machine energy sources before maintenance or repair
→ Never ignore or bypass locks or tags found on machinery
→ Never remove a lock installed by another employee
→ Use lockout procedures when possible – tagout procedures are warnings only
→ Notify affected employees before beginning lockout/tagout activities
→ Contact the supervisor or the Safety manager regarding questions
→ Participate in all required training
→ Always use safe work practices

H-1112-1 SAFETY AND HEALTH MANAGEMENT DEFINITIONS

Affected or Other employee An employee whose job requires them to operate or use a machine or piece of equipment on which servicing or maintenance is being performed under lockout or tagout; or, whose job requires work in an area in which such servicing or maintenance is being performed

Authorized employee A person who locks out or tags out machines in order to perform servicing or maintenance - An affected employee becomes authorized when trained and assigned these servicing or maintenance duties

Capable of being locked out An energy isolating device that has either a built-in locking mechanism; a hasp or other means of attachment to or through which a lock can be affixed; or that can be locked out without being dismantled, rebuilt, or replaced, or having the energy control capabilities permanently altered

Energized Connected to an energy source or containing residual or stored energy

Energy-isolating device A mechanical device that physically prevents the transmission or release of energy. [e.g., manually operated electrical circuit breakers, disconnect switches, and line values and blocks]

Energy source Any identified energy source such as electrical, mechanical, hydraulic, pneumatic, chemical, or thermal

Hot tap A procedure used in repair or maintenance activities which involves welding on a piece of equipment under pressure. [e.g., pipelines, vessels, or tanks]

Hydraulic energy Power that is created by water or other pressurized fluid that moves through pipes or hoses

Lockout The placement of a lockout device on an energy-isolating device in accordance with an established procedure

Lockout device A device that uses a positive means such as a lock to hold an energy-isolating device in the safe position

Mechanical energy Power that is created by built-up energy such as in springs

Normal production operations The utilization of a machine or equipment to perform its intended production function

Pneumatic energy Power that is created by pressurized steam or gases or compressed air

Qualified employee One who is permitted to work on or near exposed energized parts and is trained to recognize live parts, determine the voltage, and know what distance to stay from those parts

Setting up Any work performed to prepare a machine or equipment to perform its normal production operation

Servicing and/or maintenance Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, and servicing equipment [e.g., cleaning]

Tagout The placement of a tagout device on an energy-isolating device in accordance with an established procedure

Tagout device Any prominent warning device that can be securely fastened to an energy-isolating device in accordance with an established procedure.

H-1112-1 SAFETY AND HEALTH MANAGEMENT REFERENCES

Federal

OSHA 29 CFR Part 1910.147 - Control of Hazardous Energy (Lockout/Tagout)
OSHA 29 CFR 1910.269 - Electric Power Generation, transmission and distribution
OSHA 29 CFR 1910.333 - Selection and use of work practices
OSHA 29 CFR 1910.306 Specific purpose equipment and installations
OSHA 29 CFR 1910.302-308 – General Industry Electrical Standards
OSHA 29 CFR 1926.417 Lockout and tagging of circuits
OSHA 29 CFR 1926.702 Requirements for equipment and tools

OSHA Booklet 3120 Control of Hazardous Energy
OSHA Booklet 3075 Controlling Electrical Hazards
OSHA Booklet 3007 Ground-Fault Protection on Construction Sites

Websites

Occupational Safety & Health Administration www.osha.gov
Oregon OSHA www.orosha.gov
Washington State OSHA www.wisha.gov
National Electrical Code www.nfpa.org
National Fire Protection Association (Reference Section 70) www.nfpa.org

Web-based Tools from OSHA

Lockout/Tagout Interactive Training Program http://www.osha.gov/dts/osta/lototraining/index.htm

Lockout/Tagout Expert Advisor www.osha.gov [Click on ***eTools***]
Lockout/Tagout electronic Compliance Assistant Tool www.osha.gov [Click on ***eTools]***

H-1112-1 SAFETY AND HEALTH MANAGEMENT
Sample LOTO Procedure for Electrical Plug-Type Equipment

This procedure covers all electrical plug-type equipment such as, but not limited to, the following:

- Battery chargers
- Product Pumps (specific)
- Office equipment (e.g., vacuum cleaners)
- Powered hand tools
- Powered bench tools
- Lathes
- Fans

When working on, repairing, or adjusting equipment, the following procedures must be utilized to prevent accidental or sudden startup.

- Unplug electrical equipment from wall socket or in-line socket
- Attach a '**DO NOT OPERATE'** tag and plug box and lock on end of power cord*

An exception is granted to not install a plug box and lock when the equipment and plug and cord remain in the **exclusive** control [fully visible] of the employee working on, adjusting, or inspecting the equipment.

- Test equipment to assure power source has been removed by depressing the 'START' or 'ON' switch.
- Perform required operations
- Replace all guards that were removed
- Remove lock and plug box and tag (if used)
- Inspect power cord and socket before plugging equipment back into the power source. Any defects must be repaired before placing the equipment back into service.

Note: Occasionally, equipment may be unplugged from the power source when not is use.

H-1112-1 SAFETY AND HEALTH MANAGEMENT
The Basics of Electricity

Electricity is essential to modern life, both at home and on the job. In fact, it is the most commonly used form of energy in the workplace. Because it has become such a familiar part of daily life, we tend to overlook the hazards electricity can pose and fail to treat it with the respect it deserves.

Electricity has long been recognized as a serious workplace hazard, exposing employees to electric shock, electrocution, burns, fires, and explosions. Each year electrocution accounts for almost 5% of all on-the-job fatalities.

OSHA standards focus on the design and use of electrical equipment and systems. The standards cover only the exposed or operating elements of an electrical installation such as lighting, equipment, motors, machines, appliances, switches, controls, and enclosures, requiring that they be constructed and installed to minimize workplace electrical dangers. Also, the standards require that certain approved testing organizations test and certify electrical equipment before use in the workplace to ensure it is safe.[16]

The following information is summarized from these publications and provided here for ease of reference.

- OSHA 3075 – Controlling Electrical Hazards
- OSHA 3007 – Ground-Fault Protection on Construction Sites

The Flow of Electricity

Electricity flows more easily through some materials than others. Some substances such as metals generally offer very little resistance to the flow of electric current and are called "conductors."[17] Glass, plastic, porcelain, clay, pottery, dry wood, and similar substances generally slow or stop the flow of electricity. They are called "insulators." Even air, normally an insulator, can become a conductor, as occurs during an arc or lightning stroke.

The Power of Water

Pure water is a poor conductor. But small amounts of impurities in water like salt, acid, solvents, or other materials can turn water itself and substances that general act s insulators into conductors Dry wood, for example, usually slows or stops the flow of electricity. But when saturated with water, wood turns into a conductor. The same is true of human skin. When skin is moist or wet, it acts as a conductor for electricity. This means that anyone working with electricity in a damp or wet environment needs to exercise extra caution to prevent electrical hazards.

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[16] OSHA general industry electrical safety standards are based on the National Fire Protection Association Standards NFPA 70, *National Electric Code*, and NFPA 70E, *Electrical Safety Requirements for Employee Workplaces*.
[17] A common but perhaps overlooked conductor is the surface or subsurface of the earth.

The Basics of Electricity

Shock - Causes

Electricity travels in closed circuits, normally through a conductor. But sometimes a person's body – an efficient conductor of electricity – mistakenly becomes part of the electric circuit. This can cause an electrical shock. Shocks occur when a person's body completes the current path with:

- Both wires of an electric circuit
- One wire of an energized circuit and the ground
- A metal part that accidentally becomes energized (e.g., a break in the insulation)
- Another conductor that is carrying a current

When a person receives a shock, electricity flows between parts of the body or through the body to a ground to the earth.

Shock - Effects

An electric shock can result in anything from a slight tingling sensation to immediate cardiac arrest. The severity depends on the following:

- The amount of current flowing through the body
- The path of the current through the body
- The length of time the body remains in the circuit path
- The frequency of the current

This table shows the general relationship between the amount of current received and the reaction when current flows from the hand to the foot for *just 1 second.*

Effects of Electric Current in the Human Body	
Current	**Reaction**
Below 1 milliampere	Generally not perceptible
1 milliampere	Faint tingle
5 milliamperes	Slight shock felt; not painful but disturbing. Average individual can let go. Strong involuntary reactions can lead to other injuries
6 – 25 milliamperes (for women)	Painful shock, loss of muscular control
9 – 30 milliamperes (men)	The freezing current or "let-go" range. Individual cannot let go Can be thrown away from the circuit if extensor muscles are stimulated
50 – 150 milliamperes	Extreme pain, respiratory arrest, severe muscular contractions – possibly death
1,000 – 4,300 milliamperes	Rhythmic pumping action as the heart ceases – muscular contraction and nerve damage occur – death likely
10,000 milliamperes	Cardiac arrest, severe burns – death probable

The Basics of Electricity

Shock - Burns

Burns are the most common shock-related injury. An electrical accident can result in an electrical burn, arc burn, thermal contact burn, or a combination of burns.

Electrical burns are among the most serious burns and require immediate medical attention. They occur when electric current flows through tissues or bone, generating heat that causes tissue damage.

Arc or flash burns result from high temperatures caused by an electric arc or explosion near the body. These burns should be treated promptly.

Thermal contact burns are caused when the skin touches hot surfaces of overheated electric conductors, conduits, or other energized equipment. Thermal burns also can be caused when clothing catches on fire, as may occur when an electric arc is produced. A severe shock can cause considerably more damage than can be seen. A victim may suffer internal hemorrhage and destruction of tissues, nerves, and muscles that are not readily visible. Renal damage also can occur. Seek emergency medical assistance immediately.

Shock – The Freeze Effect

When a person receives an electrical shock, sometimes the electrical stimulation causes the muscles to contract. This "freezing" effect makes the person unable to pull free of the circuit. It is extremely dangerous because it increases the length of exposure to electricity and because the current causes blisters which reduce the body's resistance and increases the current.

The risk of serious injury increases for longer exposures. Even at relatively low voltages, extended exposure time can be just as dangerous as short exposures at higher voltages. Low voltage does not imply low hazard. Electrical shocks also can cause involuntary muscle reactions. These reactions can result in a wide range of other injuries from collisions or falls, including bruises, bone fractures, and even death.

If a person is "frozen" to a live electrical contact, shut off the current immediately. If this is not possible, use boards, poles, or sticks made of wood or any other non-conducting materials and safely push or pull the person away from the contact. It is important to act quickly, but remember to protect yourself as well from electrocution or shock.

Static Electricity

Static electricity also can cause a shock, though in a different way and generally not as potentially severe as the type of shock described previously. Static electricity can build up on the surface of an object and under the right conditions, can discharge to a person, causing a shock. The most familiar example of this is when a person reaches for a door knob or other metal object on a cold, relatively dry day and receives a shock.

However, static electricity also can cause shocks or can just discharge to an object with much more serious consequences as when friction causes a high level of static electricity to build up at a specific spot on an object. This can happen through handling plastic pipes and materials or during normal operation of rubberized drive or machine belts found in many worksites. In these situations, static electricity can potentially discharge when sufficient amounts of flammable or combustible substances are located nearby and cause an explosion. Grounding may be necessary to prevent this type of static electricity buildup.

H-1112-1 SAFETY AND HEALTH MANAGEMENT
Protection against Electrical Hazards

Most electrical accidents result from one of the following three factors:
- Unsafe equipment or installation
- Unsafe environment
- Unsafe work practices

Some ways to prevent these accidents are through the use of insulation, guarding, grounding, electrical protective devices, and safe work practices.

Insulation

Insulation such as glass, mica, rubber, or plastic used to coat metals and other conductors help stop or reduce the flow of electrical current. This helps prevent shock, fires and short circuits. To be effective, the insulation must be suitable for the voltage used and conditions such as temperature and other environmental factors like moisture, oil, gasoline, corrosive fumes, or other substances that could cause the insulator to fail.

Insulation on conductors is often color coded. Insulated equipment grounding conductors usually are either solid green or green with yellow stripes. Insulation covering grounded conductors is generally white or gray. Ungrounded conductors or “hot wires” often are black or red, although they may be any color other than green, white, or gray. Before connecting electrical equipment to a power source, it is important to check the insulation for any exposed wires or defects. Insulation covering flexible cords such as extension cords is particularly vulnerable to damage.

Guarding

Guarding involves locating or enclosing electric equipment to ensure employees do not accidentally come into contact with live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where it is accessible ONLY to authorized individuals qualified to use the equipment. Conspicuous signs should be posted at the entrances to electrical rooms and similarly guarded locations to alert employees to the hazards.

Grounding

Grounding a tool or electrical system means intentionally creating a low-resistance path that connects to the earth. This prevents the buildup of voltages that could cause an electrical accident. Grounding is normally a secondary protective measure to protect against electric shock. It does not guarantee that you will not get a shock or be injured or killed by an electrical current. However, grounding substantially reduced this risk, especially when used in combination with other safety measures.

A *service or system ground* is designed primarily to protect machines, tools and insulation against damage. One wire is grounded at the generator or transformer and at the building service entrance.

An *equipment ground* helps protect the equipment operator. It furnishes a second path for the current to pass through from the tool or machine to the ground should the machine malfunction and the frame becomes

energized. The circuit protection device will be activated.

Circuit Protection Devices

A circuit protection device limits or stops the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. Examples of these devices are fuses, circuit breakers, ground-fault circuit interrupters, and arc-fault circuit interrupters.

Fuses and *circuit breakers* open or break the circuit automatically when too much current flows through them (fuses melt and circuits breakers trip the circuit open). These devices are designed to protect conductors and equipment. (Surge protectors or power strips are examples of this type of circuit breaker device.)

Ground-fault circuit interrupters, or GFCIs, are used in wet locations, construction sites, and other high-risk areas. These devices interrupt the flow of electricity (shuts off the electric power) when the amount of current going into and out of electric equipment differs by >5 milliamperes. (Reference: OSHA 3007 – *Ground-Fault Protection on Construction Sites*.)[18]

Arc-fault devices provide protection from the effects of arc-faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc-fault is detected.

Safe Work Practices

Electrical accidents are largely preventable through safe work practices. Examples of these practices include the following:

- De-energizing electric equipment before inspection or repair
- Keeping electric tools properly maintained
- Exercising caution when working near energized lines
- Using appropriate protective equipment

References for electrical safety-related work practice requirements are listed below.

General Industry	Construction Industry
Subpart S of 29 CFR 1910	Subpart K of 29 CFR 1926
Sections 331-335	Sections 416-417

A break in the insulation of an electric tool or a machine can cause the metal parts to become “hot” or energized, meaning that they can conduct electricity. Touching these energized parts can result in an electrical shock, burn, or electrocution. The best way to provide protection is to ensure that the tool or machine has a properly installed grounding conductor. Cord and plug equipment with a *three-prong plug* is a common example of equipment incorporating this ground conductor. Another form of protection is to use listed or labeled portable tools and appliances protected by an approved system of double insulation. Tools using this type of insulation will be clearly marked. (e.g., UL listed)

Proper lockout/tagout procedures, such as those identified in this policy, provide protection from the

[18] Flexible cords may be easily damaged by activities and weather conditions on the job site and thus can present significant danger of shocks, burns, or fire. Cord terminals must be properly connected.

dangers of accidental or unexpected startup of electrical equipment by ensuring that electrical equipment is de-energized before it is repaired or inspected.

Illustration 1
(24.1-1)

H-1112-1 SAFETY AND HEALTH MANAGEMENT

Lockout/Tagout Program - Sample Inspection Certification

Lockout/Tagout Program – Periodic Inspection Certification*				
Equipment Inspected	**Inspector Signature**	**Date**	**Authorized Employee**	**Comments**

*Also reference *Illustration 3*

Lockout/Tagout Program – Sample Equipment List

Energy Hazard Assessment Inventory Equipment List			
Location	**Equipment Description (Make/Model/Power Source)**	**Type of LO/TO Required**	**Authorized Employee**
Sample Entry *Warehouse*	*Air Compressor* *Stewart Warner* *Serial No. 3-68-gm* *220 volt*	*Breaker Lock* *Fixed, not portable*	*John Smith* *Maintenance Foreman*

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Lockout/Tagout Program – Sample Annual Inspection Form

Annual Inspection
Lockout/Tagout Program

District _____

Equipment Type/Location _____

Authorized Employee(s) _____ _____

Locks/Tags Used (describe type of hardware)

_____

_____

_____

1. Can all sources of hazardous energy be isolated or controlled? **YES NO**

Comments _____

2. Do authorized employee(s) verify that the energy is isolated? **YES NO**

Comments _____

3. Is equipment tested prior to completing the maintenance work? **YES NO**

Comments _____

4. Do employee(s) properly remove locks? **YES NO**

Comments _____

5. Are affected employees notified prior to, and after LO/TO procedures were applied? **YES NO**

Comments _____

_____ _____

Inspector
(This individual must be an authorized employee not involved In the energy control procedures being inspected.)

Date of Inspection

Sample Listing of Lockout/Tagout Procedures

Lockout/Tagout Procedures

District _____

Location _____

Procedure No.	Equipment, Machinery or Process
_____	_____
	_____
	_____
_____	_____
	_____
	_____
_____	_____
	_____
	_____
_____	_____
	_____
	_____

H-1112-1 SAFETY AND HEALTH MANAGEMENT
Sample Form – List of Authorized Employees And Training Certification

LOCKOUT/TAGOUT
Authorized Employees and Training Certification

DISTRICT/SITE

_____

Employee	Work Area	Lock No.	Mechanical/Electrical (indicate YES/NO)	Training Completed YES/NO	Date