ELECTRICAL

Examination, Installation, and Use of Equipment

Identification of Disconnecting Means and Circuits

Working Space About Electrical Equipment

Guarding of Live Parts

Identification of Conductors

Polarity of Connections

Grounding

Grounding Path

Grounding of Equipment Connected by Cord and Plug

Ground Fault Circuit Interrupters (GFCI's)

Cabinets, Boxes, and Fittings

Flexible Cords and Cables

References:
OSHA General Industry Standards, Subpart S, *Electrical*

Additional Source of Information:
NFPA 70, *National Electric Code*

Discussion - 1.9 MB

Overhead - 1.83 MB

Student Handouts - 668 K

Self- Inspection Checklist

ELECTRICAL

INTRODUCTION

Electricity has become an essential of modern life, both at home and on the job. Some employees work with electricity directly, as is the case with engineers, electricians, or people who do wiring, such as overhead lines, cable harnesses, or circuit assemblies. Others, such as office workers and salespeople, work with it indirectly. As a source of power, electricity is accepted without much thought to the hazards encountered. Perhaps because it has become such a familiar part of our surroundings, it often is not treated with the respect it deserves.

OSHA's electrical standards address the government's concern that electricity has long been recognized as a serious workplace hazard, exposing employees to such dangers as electric shock, electrocution, fires and explosions. The objective of the standards is to minimize such potential hazards by specifying *design* characteristics of safety in use of electrical equipment and systems.

OSHA's electrical standards were carefully developed to cover only those parts of any electrical system that an employee would normally use or contact. The exposed and/or operating elements of an electrical installation - lighting equipment, motors, machines, appliances, switches, controls, enclosures, etc. - must be so constructed and installed as to minimize electrical dangers to people in any workplace.

The OSHA electrical standards were based on the National Fire Protection Association's standard NFPA 70E, *Electrical Safety Requirements for Employee Workplaces*, and the NFPA 70 Committee derived Part I of their document from the 1978 edition of the *National Electrical Code* (NEC). The standards extracted from the NEC were those considered to most directly apply to employee safety and least likely to change with each new edition of the NEC. OSHA's electrical standards are performance oriented; therefore they contain few direct references to the NEC. However, the NEC contains specific information as to how the

required performance can be obtained.

This discussion does not cover OSHA's Electrical Safety-Related Work Practices Standard, which contains requirements for working on or near energized and de-energized electrical equipment, the use of personal protective equipment, and the safe use of electrical equipment.

This discussion covers requirements in OSHA's Design Safety Standards for Electrical Systems that are frequently overlooked and may present serious hazards. The reader is encouraged to consult the complete text of OSHA's electrical standards for all of OSHA's requirements.

EXAMINATION, INSTALLATION AND USE OF EQUIPMENT

Examination

Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees.(1) Safety of equipment shall be determined using the following considerations:

- Suitability for installation and use in conformity with the provisions of this subpart. Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that identified purpose.
- Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.
- Electrical insulation.
- Heating effects under conditions of use.
- Arcing effects.
- Classification by type, size, voltage, current capacity, and specific use.
- Other factors which contribute to the practical safeguarding of employees using or likely to come in contact with the equipment.

_____

FOOTNOTE(1) Note that this requirement is, in effect, and electrical "general duty clause" similar to Section 5(a)(1) of the OSH Act: "each employer shall furnish . . . a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious harm to his employees."

Installation and Use

Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling.

IDENTIFICATION OF DISCONNECTING MEANS AND CIRCUITS

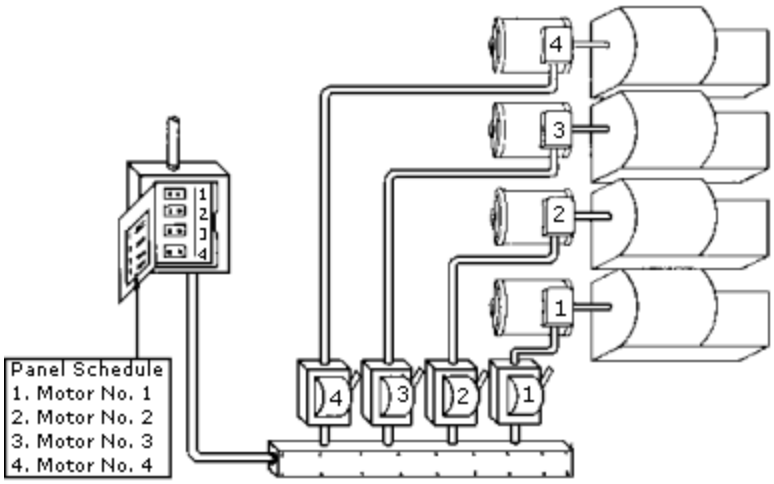
Each disconnecting means required by this subpart for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. These markings shall be of sufficient durability to withstand the environment involved.

A disconnecting means is a switch that is used to disconnect the conductors of a circuit from the source of electric current. Disconnect switches are important because they enable a circuit to be opened, stopping the flow of electricity, and thus can effectively protect workers and equipment.

Each disconnect switch or overcurrent device required for a service, feeder, or branch circuit must be clearly labeled to indicate the circuit's function, and the label or marking should be located at the point where the circuit originates. For example, on a panel that controls several motors or on a motor control center, each disconnect must be clearly marked to indicate the motor to which each circuit is connected. In the figure below, the Number 2 circuit breaker in the panel box supplies current only to disconnect Number 2, which in turn controls the current to motor Number 2. This current to motor Number 2 can be shut off by the Number 2 circuit breaker or the Number 2 disconnect.

If the purpose of the circuit is obvious, no identification of the disconnect is required.

All labels and markings must be durable enough to withstand weather, chemicals, heat, corrosion, or any other environment to which they may be exposed.



Motor No. 1 is Controlled by Disconnect No. 1 and Circuit Breaker No. 1

NOTE: As shown in diagram, the purposes of these disconnecting switches are clearly evident. In such cases identification may be omitted. In the actual installation however, the motors may not be within sight of the disconnects or arranged in such a way that the purpose is not evident and identification would be required.

Each Disconnect and Circuit Requires Identification

WORKING SPACE ABOUT ELECTRIC EQUIPMENT

Note that this particular section is concerned with the safety of a *person qualified to work on the equipment* (presumably an electrician). Obviously, the hazard must be treated in a different way if the person will remove guards and enclosures and actually work on the live parts. Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

Clear Spaces

Working space required by this subpart may not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded.

GUARDING OF LIVE PARTS

It should be noted that the purpose of this requirement is to protect *any person* who may be in the vicinity of electrical equipment against accidental contact. These people are presumably not electricians working on the equipment, and are not qualified or trained to be in close proximity to live parts.

Except as required or permitted elsewhere in this subpart, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:

- By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
- By suitable permanent, substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them. It is good practice to use covers, screens or partitions which can only be removed by use of tools, so that unqualified persons are less likely to violate them.
- By location on a suitable balcony, gallery, or platform.
- By elevation of 8 feet or more above the floor or other working surface. Note that, although equipment elevated at least 8 feet is considered to be guarded, this may not be adequate if material being handled is likely to make contact with live parts.

In locations where electric equipment would be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

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

You should be constantly aware of hazards in your workplace. New work or changes may create a new hazard, or poor maintenance may allow reappearance of old ones.

IDENTIFICATION OF CONDUCTORS

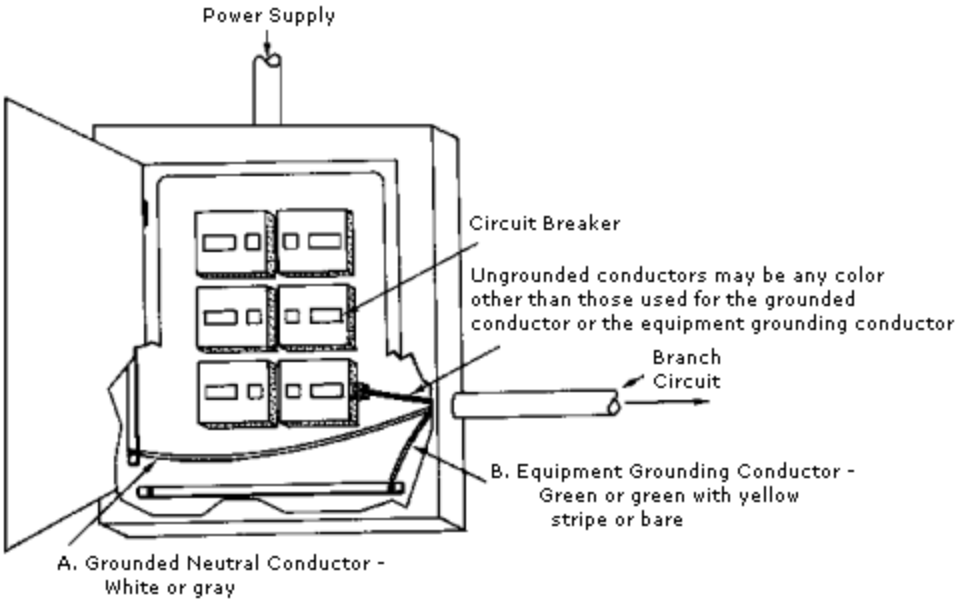
A conductor used as a grounded conductor shall be identifiable and distinguishable from all other conductors. A conductor used as an equipment grounding conductor shall be identifiable and distinguishable from all other conductors.

The grounded conductor is an energized circuit conductor that is connected to earth through the system ground. It is commonly referred to as the *neutral*. The equipment grounding conductor is not an energized conductor under normal conditions. The equipment grounding

conductor acts as a safeguard against insulation failure or faults in the other circuit conductors. The equipment grounding conductor is energized *only* if there is a leak or fault in the normal current path, and it directs this current back to the source. Directing the fault current back to the source enables protective devices, such as circuit breakers or fuses, to operate thus preventing fires and reducing the hazard of electrical shocks.

The grounded and equipment grounding conductors of an electrical circuit must be marked or color coded in a way that allows employees to identify them and tell them apart from each other and from the other conductors in the circuit.

The figure below illustrates a distribution panelboard. One means by which each conductor's use is identified and made distinguishable from the other circuit conductors is the use of color coding. Acceptable color coding includes the method required by the *National Electrical Code*, Section 210-5. The Code states: "The grounded conductor of a branch circuit shall be identified by a continuous white or natural gray color." Also, "The equipment grounding conductor of a branch circuit shall be identified by a continuous green color or a continuous green color with one or more yellow stripes unless it is bare." Bare copper or aluminum wire is permitted for use as a grounding conductor.



A. The grounded conductor is identified and distinguished from other conductors by using white or gray color-coded insulated wires.

B. The equipment grounding conductor is identified and distinguished from other conductors by using green, or green with yellow stripe, color coding on wires, or run as a bare conductor.

Distribution Panelboard

POLARITY OF CONNECTIONS

No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.

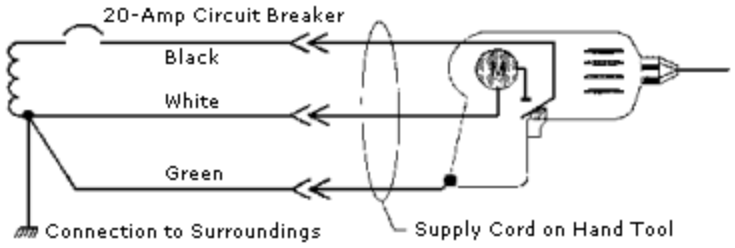
A grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug may not be used for purposes other than grounding.

The above two subparagraphs dealing with polarity of connections and use of grounding terminals and devices address one potentially dangerous aspect of alternating current: many pieces of equipment will operate properly even though the supply wires are not connected in the order designated by design or the manufacturer. Improper connection of these conductors is most prevalent on the smaller branch circuit typically associated with standard 120 volt receptacle outlets, lighting fixtures and cord- and plug-connected equipment.

When plugs, receptacles, and connectors are used in an electrical branch circuit, correct polarity between the ungrounded (hot) conductor, the grounded (neutral) conductor, and the grounding conductor must be maintained.

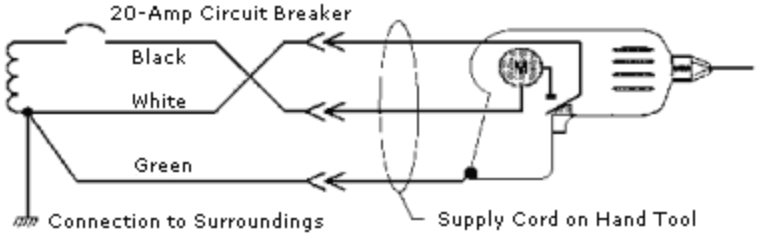
Reversed polarity is a condition when the identified circuit conductor (the grounded conductor or neutral) is incorrectly connected to the ungrounded or "hot" terminal of a plug, receptacle, or other type of connector.

The figure below shows the correct wiring for the common 120-volt outlet with a portable hand tool attached.



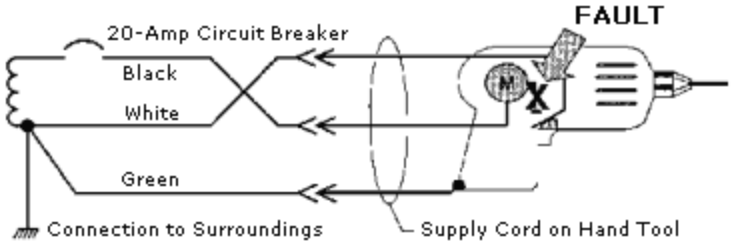
Typical 120 Volt Branch Circuit with Correct Wiring

Suppose now that the black (ungrounded) and white (grounded) conductors are reversed as shown in the figure below. This is the traditional *reversed polarity*. Although a shock hazard may not exist, there are other mechanical hazards that can occur.



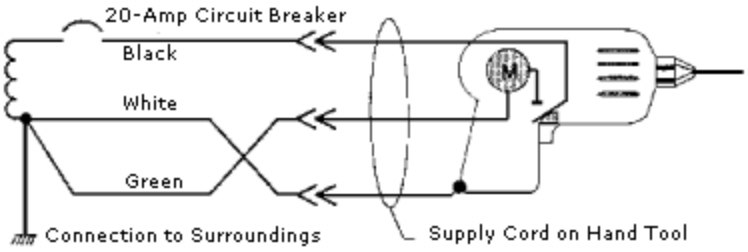
120 Volt Branch Circuit with Black and White Wires Reversed

For example, if an internal fault should occur in the wiring as shown in the figure below, the equipment would not stop when the switch is released or would start as soon as a person plugs the supply cord into the improperly wired outlet. This could result in serious injury.



120 Volt Branch Circuit with Black and White Wires Reversed
Internal Fault in Equipment Wiring

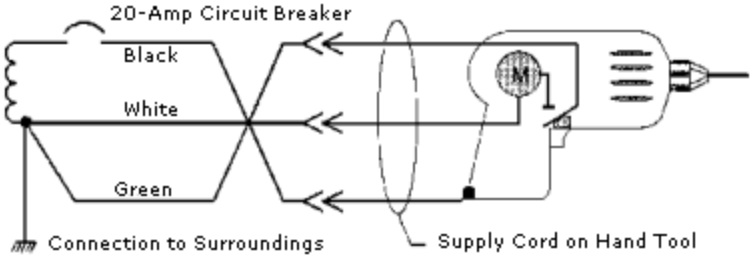
The figure below shows the white (grounded) and green (grounding) conductors reversed. Although it is not fitting, considering OSHA or code terminology, to call this *reversed polarity*, a hazard can still exist. In this case, due to the wiring error, the white wire is being used to provide equipment grounding. Under certain conditions, this could be dangerous.



White and Green Wires Reversed

The figure below shows an *extremely* dangerous situation. In this example, the black (ungrounded) and green (grounding) conductors have been reversed. The metal case of the equipment is at 120 volts with reference to the surroundings. As soon as a person picks up the equipment and touches a conductive surface in their surrounding, they will receive a serious, or even deadly, shock.

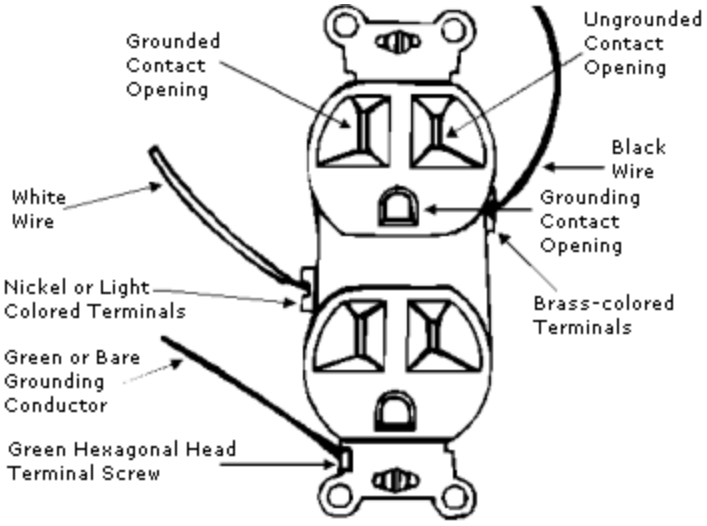
Although the equipment will not work with this wiring error, it would not be unusual for a person to pick up the equipment before realizing this. The person may even attempt to troubleshoot the problem before unplugging the power cord.



Black and Green Wires Reversed

Correct polarity is achieved when the grounded conductor is connected to the corresponding grounded terminal and the ungrounded conductor is connected to the corresponding ungrounded terminal. The reverse of the designated polarity is prohibited. The figure below illustrates a duplex receptacle correctly wired. Terminals are designated and identified to avoid confusion. An easy way to remember the correct polarity is "white to light" - the white (grounded) wire should be connected to the light or nickel-colored terminal; "black to brass" - the black or multi-colored (ungrounded) wire should be connected to the brass terminal; and

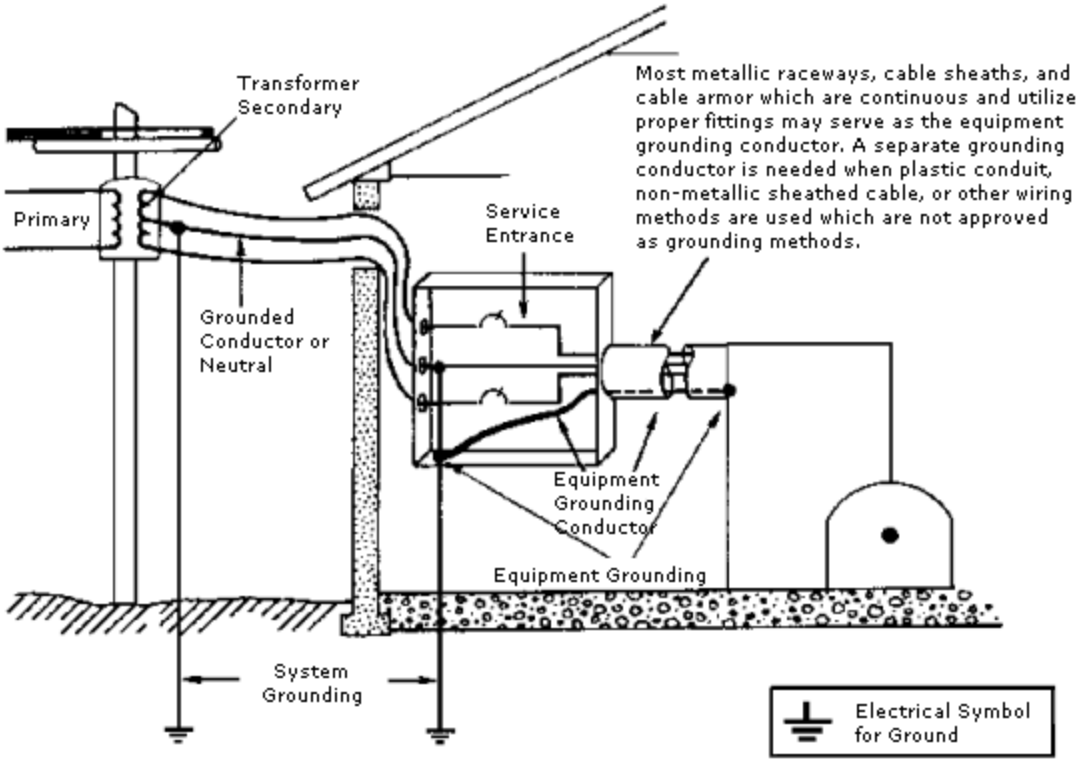
"green to green" - the green or bare (grounding) wire should be connected to the green hexagonal head terminal screw.



Duplex Receptacle Correctly Wired to Designated Terminals

GROUNDING

This section contains grounding requirements for systems, circuits, and equipment. Grounding electrical circuits and electrical equipment is required to protect employees against electrical shock, safeguard against fire, and protect against damage to electrical equipment. There are two kinds of grounding: (1) electrical circuit or system grounding, and (2) electrical equipment grounding. Electrical system grounding is accomplished when one conductor of the circuit is intentionally connected to earth. This is done to protect the circuit should lightning strike or other high voltage contact occur. Grounding a system also stabilizes the voltage in the system so "expected voltage levels" are not exceeded under normal conditions. The second kind of ground is equipment grounding. This is accomplished when all metal frames of equipment and enclosures containing electrical equipment or conductors are grounded by means of a permanent and continuous connection or bond. The equipment grounding conductor provides a path for dangerous fault current to return to the system ground at the supply source of the circuit should an insulation failure take place. If installed properly, the equipment grounding conductor is the current path that enables protective devices, such as circuit breakers and fuses, to operate when a fault occurs. The figure below illustrates both types of grounding.



SYSTEM AND EQUIPMENT GROUNDING

GROUNDING PATH

The path to ground from circuits, equipment, and enclosures shall be permanent and continuous.

This requirement was extracted from NEC 250-51, *Effective Grounding Path*, which is more complete and fundamental to the understanding of electrical safety. It states that the path to ground:

1. "shall be permanent and continuous." (If the path is installed in such a way that damage, corrosion, loosening, etc. may impair the continuity during the life of the installation, then shock and burn hazards will develop.)
2. "shall have capacity to conduct safely any fault current likely to be imposed on it." (Fault currents may be many times normal currents, and such high currents may melt or burn metal at points of poor conductivity. These high temperatures may be a hazard in themselves, and they may destroy the continuity of the ground-fault path.)
3. "shall have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of the circuit protective devices in the circuit." (If the ground-fault path has a high

impedance, there will be hazardous voltages whenever fault currents attempt to flow. Also, if the impedance is high, the fault current will be limited to some value so low that the fuse or circuit breaker will not operate promptly, if at all.)

It is important to remember the following regarding safe grounding paths:

1. The fault current in A-C circuits will be limited by the sum of resistance and reactance, and the only low-reactance path is that which closely follows the circuit conductors.
2. If a metallic raceway system is used, make sure that the metallic system is continuous and permanent.
3. In cases where a metallic raceway system is not used, provide a green or bare equipment-grounding conductor close to the supply conductors to assure that all enclosures are bonded together and to the source.

GROUNDING OF EQUIPMENT CONNECTED BY CORD AND PLUG

Under any of the conditions described below, exposed non-current-carrying metal parts of cord- and plug-connected equipment which may become energized shall be grounded.

a. If in a hazardous (classified) location.

b. If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.

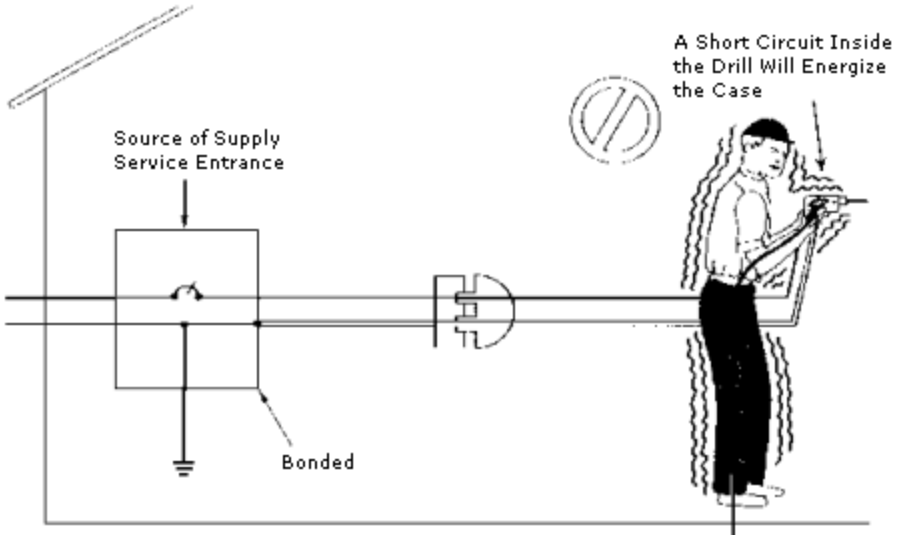
c. If the equipment is of the following types:

- Refrigerators, freezers, and air conditioners;
- Clothes-washing, clothes-drying and dishwashing machines, sump pumps, and electrical aquarium equipment;
- Hand-held motor-operated tools;
- Motor-operated appliances of the following types: hedge clippers, 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; and

- Portable hand lamps.

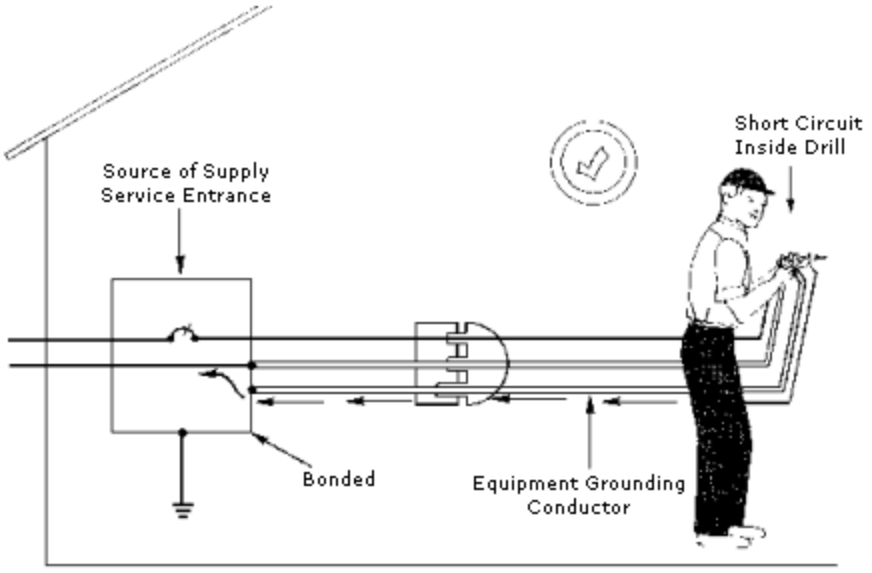
Under the conditions described above, exposed non-current-carrying metal parts of cord- and plug-connected equipment must be grounded. Grounding metal parts is not required where the equipment is supplied through an isolating transformer with an ungrounded secondary of not over 50 volts or if portable tools are protected by an approved system of double insulation. To ground cord- and plug-connected equipment, a third wire is commonly provided in the cord set and a third prong in the plug. The third wire serves as an equipment grounding conductor which is connected to the metal housing of a portable tool and a metal grounding bus inside the service entrance equipment. The service entrance equipment is located at the entrance point of the electric supply for a building or plant and contains, or serves other panelboards which contain, branch circuit protective devices such as fuses and circuit breakers. The third wire provides a path for fault current should an insulation failure occur. In this manner, dangerous fault current will be directed back to the source, the service entrance, and will enable circuit breakers or fuses to operate, thus opening the circuit and stopping the current flow.

The figure below illustrates the potential shock hazard that exists when no third wire, grounding conductor, is used. If a fault occurs, most of the current will follow the path of least resistance. If the worker provides a path to ground as shown, some portion of the current will flow away from the grounded white conductor (neutral) and return to ground through the worker. The severity of the shock received will depend on the amount of current that flows through the worker.



CORD- AND PLUG-CONNECTED EQUIPMENT
WITHOUT A GROUNDING CONDUCTOR

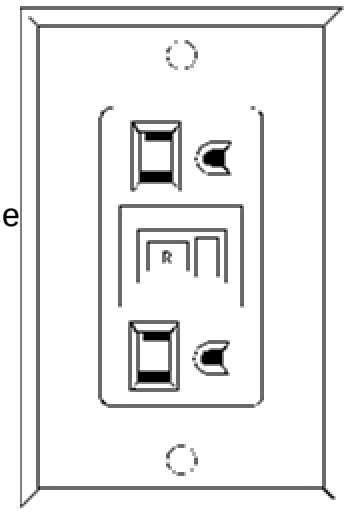
The figure below illustrates the advantage of a properly connected grounded conductor. It should be noted that properly bonded conduit and associated metal enclosures can also serve as a grounding conductor.



CORD- AND PLUG-CONNECTED EQUIPMENT
WITH A GROUNDING CONDUCTOR

Tools likely to be used in wet and conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts. Listed or labeled portable tools and appliances protected by an approved system of double insulation, or its equivalent, need not be grounded. If such a system is employed, the equipment shall be distinctively marked to indicate that the tool or appliance utilizes an approved system of double insulation.

GROUND-FAULT CIRCUIT-INTERRUPTERS



Introduction

In most cases, *insulation* and *grounding* are used to prevent injury from electrical wiring systems or equipment. However, there are instances when these recognized methods do not provide the degree of protection required. To help appreciate this, let's consider a few examples of where ground fault circuit interrupters would provide additional protection.

- Many portable hand tools, such as electric

drills, are now manufactured with non-metallic cases. If approved, we refer to such tools as *double insulated*. Although this design method assists in reducing the risk from grounding deficiencies, a shock hazard can still exist. In many cases, persons must use such electrical equipment where there is considerable moisture or wetness. Although the person is *insulated* from the electrical wiring and components, there is still the possibility that water can enter the tool housing. Ordinary water is a conductor of electricity. Therefore, if the water contacts energized parts, a path will be provided from inside the housing to the outside, bypassing the *double insulation*. When a person holding a hand tool under these conditions touches another conductive surface in their work environment, an electric shock will result.

- Double-insulated equipment or equipment with non-metallic housings, that does not require grounding under the National Electrical Code, is frequently used around sinks or in situations where the equipment could be dropped into water. Frequently, the initial human response is to grab for the equipment. If a person's hand is placed in the water and another portion of their body is in contact with a conductive surface, a serious or deadly electric shock can occur.
- In construction work and regular factory maintenance work, it is frequently necessary to use extension cord sets with portable equipment. These cords are regularly exposed to physical damage. Although safe work procedures require adequate protection, it is not possible to prevent all damage. Frequently, the damage is only to the insulation, exposing energized conductors. It is not unusual for a person to handle the cord often with the possibility of contacting the exposed wires while holding a metal case tool or while in contact with other conductive surfaces.

  The amount of current which flows under such conditions will be enough to cause serious human response. This can result in falls or other physical injury and in many cases death.

Since neither *insulation* (double insulation) nor *grounding* can provide protection under these conditions, it is necessary to use other protective measures. One acceptable method is a ground fault circuit interrupter, commonly referred to as a GFCI.

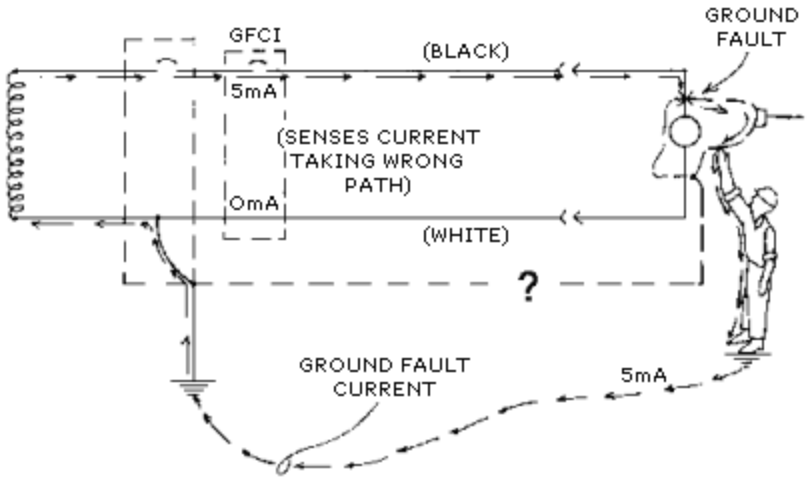
How Ground-Fault Circuit-Interrupters Work

A ground-fault circuit-interrupter is <u>not</u> an overcurrent device like a fuse or circuit breaker. GFCI's are designed to sense an imbalance in current

flow over the normal path.

The GFCI contains a special sensor that monitors the strength of the magnetic field around each wire in the circuit when current is flowing. The magnetic field around a wire is directly proportional to the amount of current flow, thus the circuitry can accurately translate the magnetic information into current flow.

If the current flowing in the *black (ungrounded) wire* is within 5 (plus or minus 1) milliamperes (mA) of the current flowing in the *white (grounded) wire* at any given instant, the circuitry considers the situation normal. All the current is flowing in the normal path. If, however, the current flow in the two wires differs by more than 5 mA, the GFCI will quickly open the circuit. This is illustrated in the figure below.



HOW THE GFCI PROTECTS PEOPLE

(BY OPENING THE CIRCUIT WHEN CURRENT FLOWS THROUGH A GROUND-FAULT PATH)

Note that the GFCI will open the circuit if 5 mA or more of current returns to the service entrance by any path other than the intended white (grounded) conductor. If the equipment grounding conductor is properly installed and maintained, this will happen *as soon as the faulty tool is plugged in*. If by chance this grounding conductor is not intact and of low-impedance, the GFCI may not trip out *until a person provides a path*. In this case, the person will receive a shock, but the GFCI should trip out so quickly that the shock will not be harmful.

Types of Ground-Fault Circuit-Interrupters

There are several types of GFCI's available, with some variations to each type. Although all types will provide ground-fault protection, the specific

application may dictate one type over another.

- **Circuit-Breaker Type**
  The circuit-breaker type includes the functions of a standard circuit breaker with the additional functions of a GFCI. It is installed in a panelboard and can protect an entire branch circuit with multiple outlets. It is a direct replacement for a standard circuit breaker of the same rating.
- **Receptacle Type**
  The receptacle style GFCI incorporates within one device one or more receptacle outlets, protected by the GFCI. Such devices are becoming very popular because of their low cost. Most are of the duplex receptacle configuration and can provide GFCI protection for additional non-GFCI type receptacles connected "down stream" from the GFCI unit.
- **Permanently Mounted Type**
  The permanently mounted types are mounted in an enclosure and designed to be permanently wired to the supply. Frequently they are used around large commercial swimming pools or similar wet locations.
- **Portable Type**
  Several styles of portable GFCI's are available. The portable types are designed to be easily transported from one location to another. They usually contain one or more integral receptacle outlets protected by the GFCI module. Some models are designed to plug into existing non-GFCI protected outlets, or in some cases, are connected with a cord and plug arrangement. The portable type also incorporate a no-voltage release device which will disconnect power to the outlets if any supply conductor is open. Units approved for use outdoors will be in enclosures suitable for the environment. If exposed to rain, they must be listed as rainproof.
- **Cord Connected Type**
  The power supply cord type GFCI consists of an attachment plug which incorporates the GFCI module. It provides protection for the cord and any equipment attached to the cord. The attachment plug has a non-standard appearance and is equipped with test and reset buttons. Like the portable type, it incorporates a no-voltage release device which will disconnect power to the load if any supply conductor is open.

Classes of Ground-Fault Circuit-Interrupters

Ground-Fault Circuit-Interrupters are divided into two classes: Class A and Class B. The Class A device is designed to trip when current flow, in

other than the normal path, is 6 milliamperes or greater. The specification is 5 milliamperes ± 1 milliampere. The Class B device will trip when current flow, in other than the normal path, is 20 milliamperes or greater. Class B devices are approved for use on underwater swimming pool lighting installed prior to the adoption of the 1965 National Electrical Code.

Testing Ground-Fault Circuit-Interrupters

Due to the complexity of a GFCI, it is necessary to test the device on a regular basis. For permanently wired devices, a monthly test is recommended. Portable type GFCI's should be tested each time before use. GFCI's have a built-in test circuit which imposes an artificial ground fault on the load circuit to assure that the ground-fault protection is still functioning. Test and reset buttons are provided for testing.

CABINETS, BOXES, AND FITTINGS

Conductors Entering Boxes, Cabinets, or Fittings

Since conductors can be damaged if they rub against the sharp edges of cabinets, boxes, or fittings, they must be protected from damage where they enter. To protect the conductors, some type of clamp or rubber grommet must be used. The device used must close the hole through which the conductor passes as well as provide protection from abrasion. If the conductor is in a conduit and the conduit fits tightly in the opening, additional sealing is not required.

The knockouts in cabinets, boxes, and fittings should be removed only if conductors are to be run through them. However, if a knockout is missing or if there is another hole in the box, the hole or opening must be closed.

Covers and Canopies

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. In completed installations, each outlet box shall have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear.

FLEXIBLE CORDS AND CABLES

This standard for safe use of flexible cords is one of the most frequently violated electrical standards, particularly in smaller plants. There is a definite need and place for cords, but there is also a temptation to misuse them because they seem to offer a quick and easy way to carry electricity to where it is needed. The basic problem is that flexible cords in general are more vulnerable than the fixed wiring of the building. Therefore, cords should not be used if one of the recognized wiring methods could be used instead.

Use of Flexible Cords and Cables

Flexible cords and cables shall be approved and suitable for conditions of use and location. The standard lists specific situations in which flexible cords may be used. Flexible cords and cables shall be used only for:

a. Pendants (a lampholder or cord-connector body suspended by a length of cord properly secured and terminated directly above the suspended device);

b. Wiring of fixtures;

c. Connection of portable lamps or appliances;

d. Elevator cables;

e. Wiring of cranes and hoists (where flexibility is necessary);

f. Connection of stationary equipment to facilitate their frequent interchange (equipment which is not normally moved from place to place, but might be on occasion);

g. Prevention of the transmission of noise or vibration. (In some cases vibration might fatigue fixed wiring and result in a situation more hazardous than flexible cord.)

h. Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair (e.g. water coolers, exhaust fans);

i. Data processing cables approved as a part of the data processing system.

Note that all of the above situations involve conditions where flexibility is necessary. Unless specifically permitted by one of these situations,

flexible cords and cables may not be used:

a. As a substitute for the fixed wiring of the structure;

b. Where run through holes in walls, ceilings, or floors;

c. Where run through doorways, windows, or similar openings;

d. Where attached to building surfaces; or

e. Where concealed behind building walls, ceilings, or floors.

There is usually not much question about use of the short length of cord which is furnished as part of an approved appliance or tool; there is usually no question about an extension cord used temporarily to permit use of the appliance or tool in its intended manner at some distance from a fixed outlet; but there are questions when the usage is not obviously temporary, and when the cord is extended to some distant outlet in order to avoid providing a fixed outlet where needed.

Flexible cord used in violation of this standard is likely to be damaged by activities in the area; by door or window edges; by staples or fastenings; by abrasion from adjacent materials; or simply by aging. If the conductors become partially exposed over a period of time, there will be danger of shocks, burns, or fire.

Identification, Splices and Terminations

Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords, No. 12 or larger, may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

Flexible cords shall be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.

Discussion - 1.9 MB

Overhead - 1.83 MB

Student Handouts - 668 K

Self-Inspection Checklist

The Effects of Electricity

• More than 3 mA (Note: GFCI trips at 5 to 6 mA)	• Painful shock
• More than 10 mA	• No-let-go threshold
• More than 30 mA	• Breathing affected, stops
• More than 4 Amps	• Heart stops during current passage
• More than 5-20 Amps	• Tissue burning
• More than 20 Amps	• Tissue & organ damage

Note: 1mA = 1/1000 Amp

Note: A hair dryer operating at 120 volts & may require 10 Amps. Of Electricity to operate it.
A circuit breaker trips at 15 to 20 Amps.

NATIONAL ELECTRICAL CODE® 2002*

Article 527

527.6 Ground-Fault Protection for Personnel. Ground-fault protection for personnel for all temporary wiring installations shall be provided to comply with 527.6(A) and (B). This section shall apply only to temporary wiring installations used to supply temporary power to equipment used by personnel during construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities.

(A) Receptacle Outlets. All 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are not a part of the permanent wiring of the building or structure and that are in use by personnel shall have ground-fault circuit interrupter protection for personnel. If a receptacle(s) is installed or exists as part of the permanent wiring of the building or structure and is used for temporary electric power, ground-fault circuit-interrupter protection for personnel shall be provided. For the purposes of this section, cord sets or devices incorporating listed ground-fault circuit interrupter protection for personnel identified for portable use shall be permitted.

Exception: In industrial establishments only, where conditions of maintenance and supervision ensure that only qualified personnel are involved, an assured equipment grounding conductor program as specified in 527.6 (B)(2) shall be permitted for only those receptacle outlets used to supply equipment that would create a greater hazard if power was interrupted or having a design that is not compatible with GFCI protection.

(B) Use of Other Outlets. Receptacles other than 125-volt, single-phase, 15-, 20-, and 30-ampere receptacles shall have protection in accordance with (1) or, the assured equipment grounding conductor program in accordance with (2).

(1) GFCI Protection. Ground-fault circuit interrupter protection for personnel.

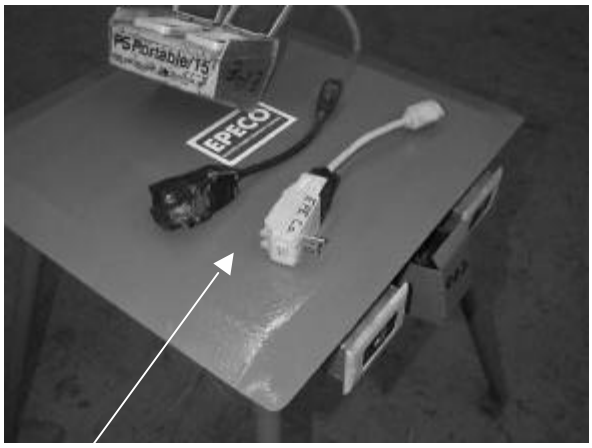
(2) Assured Equipment Grounding Conductor Program. A written assured equipment grounding conductor program continuously enforced at the site by one or more designated persons to ensure that equipment grounding conductors for all cord sets, receptacles that are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug are installed and maintained in accordance with the applicable requirements of 250.114, 250.138, 406.3(C), and 527.4(D).

(a) The following tests shall be performed on all cord sets, receptacles that are not part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded:

(1) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.
(2) Each receptacle and attachment plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.
(3) All required tests shall be performed as follows:
   a. Before first use on site
   b. When there is evidence of damage
   c. Before equipment is returned to service following any repairs
   d. At intervals not exceeding 3 months

(b) The tests required in item (2)(a) shall be recorded and made available to the authority having jurisdiction.

Examples of equipment



Raintight GFCI with open neutral protection

Temporary power outlet commonly used on construction sites with a variety of configurations. Some units are available with GFCI protection.

Watertight plugs and connectors

GFCI tester (‘standard’ outlet type)

GFCI circuit test

1. If you plug your Woodhead circuit tester into a GFCI protected receptacle, which indicates correct wiring, and you push the black test button on your circuit tester, & the GFCI Does Not trip, this would indicate that the GFCI is faulty. A qualified electrician should inspect the GFCI & make repairs as needed.

   HOWEVER, you should press the test button on the GFCI to confirm your finding. If the GFCI does not trip, it's a faulty GFCI, and should be replaced. If it does trip, & your Woodhead tester indicated correct wiring, a qualified electrician should still be notified of the problem. The GFCI should have tripped out.

2. If you plug your Woodhead circuit tested into a GFCI protected receptacle & it indicates incorrect wiring (i.e., reverse polarity, open ground), STOP at that point. A qualified electrician should inspect the GFCI & make repairs as needed.

See CO-765 for Reverse Polarity

Note:	Your Woodhead circuit tester will not trip the GFCI if you push the black test button. The Woodhead can only diagnose one (1) problem. Therefore, it will not trip the GFCI. Please note the attached page E, in all but one incorrect wiring method, the GFCI will still offer protection to an employee. The test button on the GFCI should be pushed. The GFCI should trip even if it has reverse polarity or an open ground.

SUPPLEMENTARY TESTER

Tests by "Leaking" 6mA to GREEN Wire
[Note that if the grounding path is not complete this test will not trip the GFCI]

The recommended method of testing is the use of the self-test button as above. The supplementary test devises can also be used, but their indications are not always dependable. This is because the supplementarty7 test requires a ground fault path from the ground pin in the tester back to the white wire at the service entrance. Therefore, the tester will not trip the GFCI under the following conditions of mis-wiring.

TABLE f

Polarity of Wiring		Equipment Ground		Test Indication		GFCI Protects	
NORMAL	REVERSED	YES	NO	OK	BAD	YES	NO
	X	X			X	X	
	X		X		X	X	
X			X		X	X	

SELF-TEST

Tests by "Leaking" 6mA to WHITE Wire
[1mA – 1/1000 Ampere]

Most GFCI devices are dependable and will continue to function properly for years, as can be indicated by pressing the "Test" button..

GFCIs of the circuit breaker type, usually installed in a panelboard, are not likely to be subjected to the possibility of mis-wiring; therefore, the recommended use of the "test" button will usually indicate proper functioning of the GFCI as installed.

The receptacle or portable [plug-in] type of GFCI is sometimes used in cases where the ring between the panel and the point of application has errors [mis-wiring].

The test button on a GFCI tests only the device, NOT the wiring or the application. However, this test does indicate that protection will be provided if connections and system are proper, and even in most cases of mis-wiring, as follows:

TABLE D							
Polarity of Wiring		Equipment Ground		Test Indication		GFCI Protects	
NORMAL	REVERSED	YES	NO	OK	BAD	YES	NO
	X	X		X		X	
	X		X	X		X	
X			X	X		X	

Bob! You fool … don't plug that in!!!!

NEW
Arc Blast Field Marking

www.arcflash.com

Arc Flash
Arc Blast Field Marking. Article 110.16
2005 NEC
www.electrical-experts.com/Arcblast.html

NFPA 70 – E

OSHA 29 CFR 1910 .332-333

Arc Blast Field Marking

Arc Blast Field Marking 2005 *NEC* 110.16

Article 110.16 of the 2005 *NEC* requires all switchboards, panel boards, industrial control panels, and motor control centers that are likely to be subject to examination, adjustment, servicing or maintenance while energized be field marked to warn qualified personnel of potential electric arc flash hazards.

Arc Blast Field Marking

Implementing This Regulation

This article will require the electrician to place appropriate warning signs on all equipment that falls into this category.

Arc Blast Field Marking

Personal Protective Equipment (PPE) is required for the qualified employees

NFPA 70E Table 3-3.9.1)

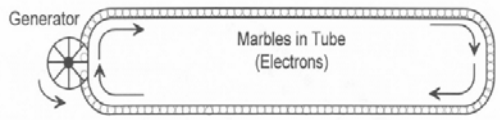
29 CFR 1910 .333

29 CFR 1910 .337

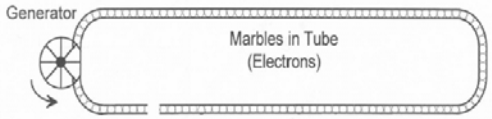
4 Causes of Electrical Injuries

- Contact to Overhead Power Lines
- Failure to properly lockout equipment
- Defective grounding methods
- Working in a wet location

Current Flow Diagrams



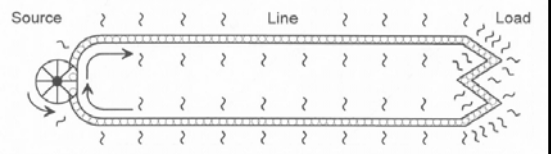
No current flows unless there is a complete loop. The generator cannot force electrons to move thru the tube unless they are returning to the generator.



If the loop (circuit) is **not complete** no electrons can return to the generator, therefore electrons cease moving thru the conductor.

Current Flow Diagrams

Friction (resistance) inside of a conductor produces heat. The more electrons per second the more heat will be produced.



A well-designed system has minimum resistance in lines, so that maximum effort is available to produce useful heat or work in the load.

Effects of Electricity

More than 3 mA	⇨	Painful Shock
More than 10 mA	⇨	No Let Go Threshold
More than 30 mA	⇨	Breathing Stops
More than 4 Amps	⇨	Heart Stops
More than 5-20 Amps	⇨	Tissue Burns
More than 20 Amps	⇨	Tissue & Organ Damage

NEC 1996 Article 305-6 Ground Fault Protection

Ground fault protection for personnel for all temporary wiring installations **SHALL** be provided. This **SHALL** apply only to temporary wiring installations utilized to supply temporary power to equipment used by personnel during construction, remodeling, **MAINTAINANCE**, **REPAIR** or demolition of buildings, structures, equipment...**REFER Page 23**

NEC 1996 Article 305-6 Ground Fault Protection

- GFCI – Receptacle outlets that are not part of the permanent wiring of the building & are used by personnel shall have GFCI protection. Permanent wiring used for temporary power shall be protected by GFCI. Cord sets incorporating GCFI protection shall be permitted.
- Assured Equipment Grounding Conductor Program – Written procedures shall be enforced at the site by a designated person to ensure equipment grounding for all equipment.

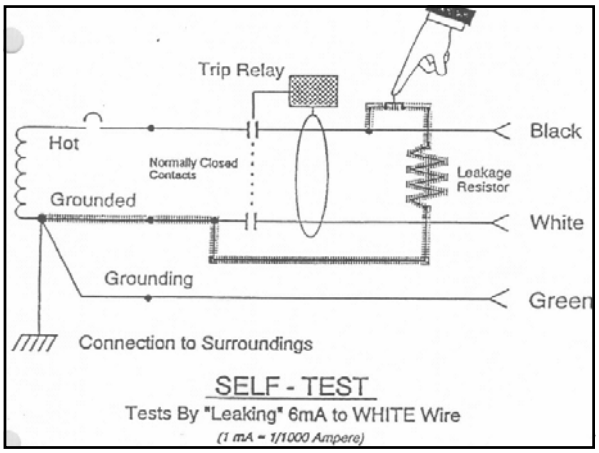
NEC for 2005

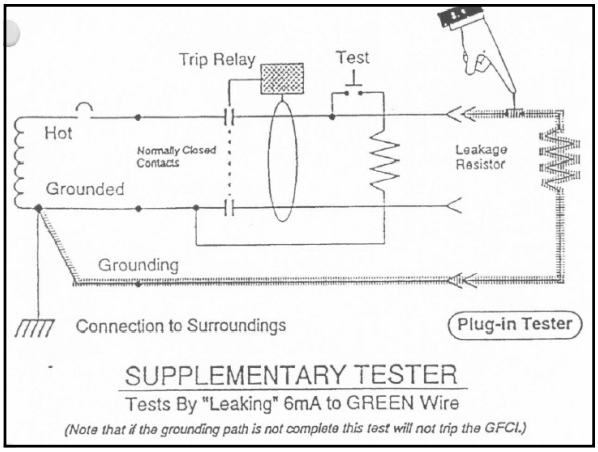
Article 305-6

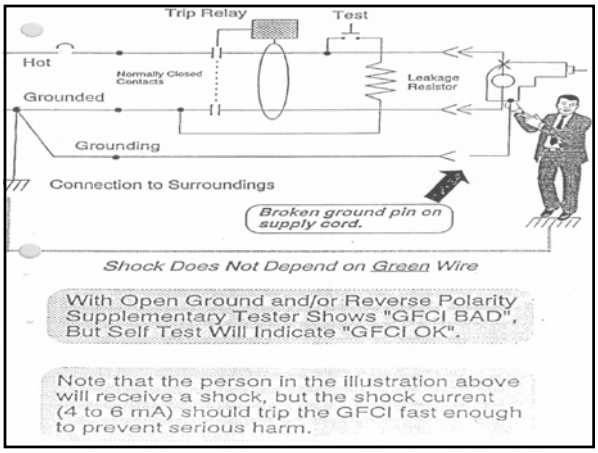
Ground Fault Protection

2005 NEC

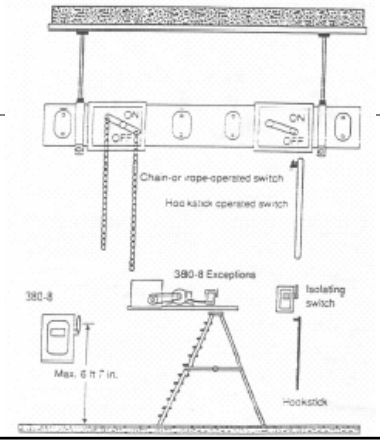
Refer to Article 590 .6

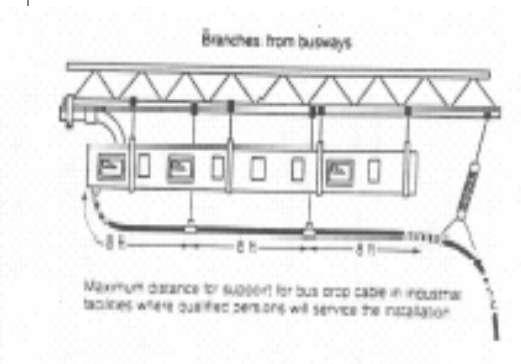

Trip Relay
Hot
Normally Closed Contacts
Grounded
Leakage Resistor
Black
White
Grounding
Green
Connection to Surroundings
SELF - TEST
Tests By "Leaking" 6mA to WHITE Wire
(1 mA = 1/1000 Ampere)


Trip Relay
Test
Hot
Normally Closed Contacts
Leakage Resistor
Grounded
Grounding
Connection to Surroundings
Plug-in Tester
SUPPLEMENTARY TESTER
Tests By "Leaking" 6mA to GREEN Wire
(Note that if the grounding path is not complete this test will not trip the GFCI.)


Trip Relay
Test
Hot
Normally Closed Contacts
Leakage Resistor
Grounded
Grounding
Connection to Surroundings
Broken ground pin on supply cord.
Shock Does Not Depend on Green Wire
With Open Ground and/or Reverse Polarity Supplementary Tester Shows "GFCI BAD", But Self Test Will Indicate "GFCI OK".
Note that the person in the illustration above will receive a shock, but the shock current (4 to 6 mA) should trip the GFCI fast enough to prevent serious harm.

The Benefit of a GFCI is that the GFCI Turns Off Before You DO!!!





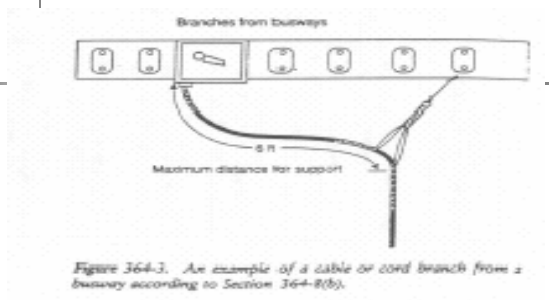


Figure 364-3. An example of a cable or cord branch from a busway according to Section 364-8(b).

29 CFR 1910 Subpart S

Electrical

1910.303 General Requirements

(b) Examination, installation, and use of equipment

(b)(1) Examination. **Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees.** Safety of equipment shall be determined using the following considerations:

(b)(1)(i) Suitability for installation and use in conformity with the provisions of this subpart. Suitability of equipment for an identified purpose may be evidenced by **listing or labeling for that identified purpose.**

1910.303 General Requirements

(e) Marking. Electrical equipment may not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.

1910.303 General Requirements

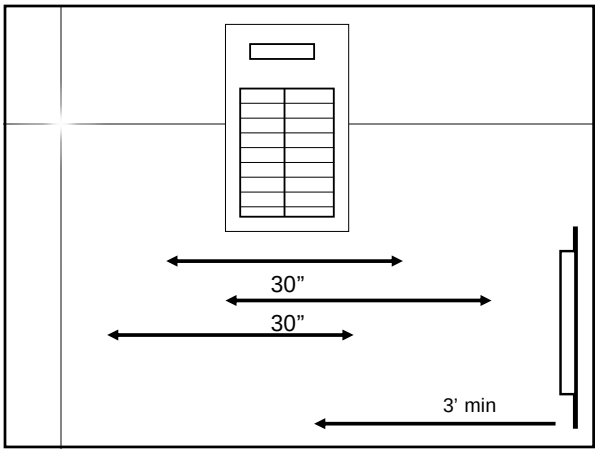
(g) 600 Volts, nominal, or less

(1) **Working space about electric equipment.** Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

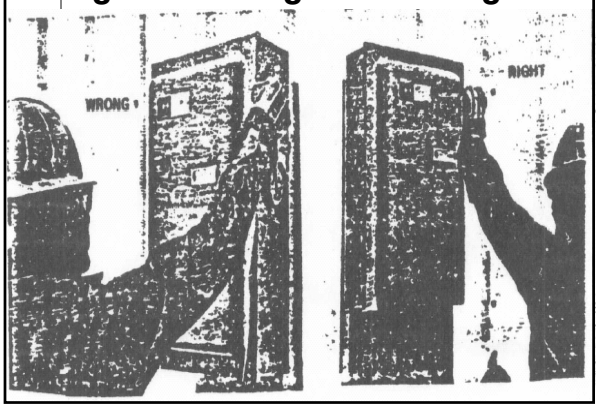
(a) Working clearances. **Workspace may not be less than 30 inches wide** in front of the electric equipment.

Distances shall be measured from the live parts if they are exposed, or from the enclosure front or opening if the live parts are enclosed.

Concrete, brick, or tile walls are considered to be grounded. **Minimum 3 Feet Distance**



Right is Wrong…Left is Right



1910.303 General Requirements

(g)(a)(ii) Clear spaces. **Working space** required by this subpart **may not be used for storage.**

(iii) Access and entrance to working space.

(iv) Front working space.

(v) Illumination.

(vi) Headroom.

1910.303 General Requirements

(g)(2) Guarding of live parts.

(i) Live parts of electric equipment operating at **50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures**, or by any of the following means:

(A) By location in a room, vault that is accessible only to qualified persons.

(B) By suitable permanent partitions

(C) By location

(D) By elevation

1910.303 General Requirements

(h) Over 600 volts, nominal

(1) General. Conductors and equipment used on circuits exceeding 600 volts, nominal, shall comply with all applicable provisions of paragraphs (a) through (g) of this section and with the following provisions which supplement or modify those requirements. The provisions of paragraphs (h)(2), (h)(3), and (h)(4) of this section do not apply to equipment on the supply side of the service conductors.

(2) Enclosure for electrical installations. Electrical installations in a vault, room, closet or in an area surrounded by a wall, screen, or fence, access to which is controlled by lock and key or other approved means, are considered to be accessible to qualified persons only.

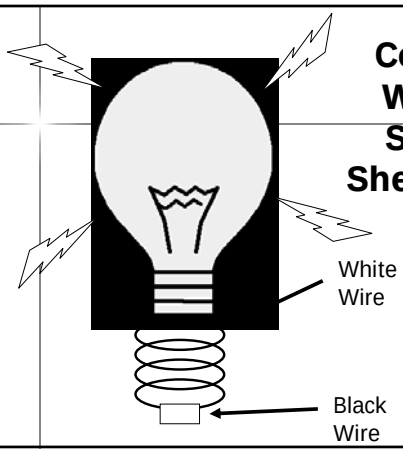
1910.304 Wiring Design

(a) Use and identification of grounded and grounding conductors.

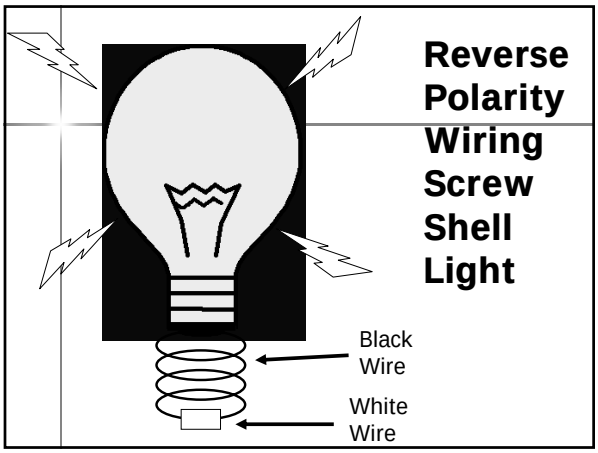
(1) Identification of conductors.

(2) **Polarity of connections. No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.**

(3) Use of grounding terminals and devices.



Correct Wiring Screw Shell Light



1910.304 Wiring Design

(f) Grounding

(4) Grounding path. The path to ground from circuits, equipment, and enclosures shall be permanent and continuous.

(5) (iv) **Fixed equipment**. Exposed non-current-carrying metal parts of fixed equipment which may become energized shall be grounded under any of the following conditions:

(v) **Equipment connected by cord and plug**. Exposed non-current-carrying metal parts of cord and plug-connected equipment which may become energized shall be grounded.

1910.304 Wiring Design

(f) Grounding

(C) If the equipment is of the following types:

{1} Refrigerators, freezers, air conditioners;

{2} Clothes-washing, clothes-drying, dishwashing machines, sump pumps, electrical aquarium equipment;

{3} Hand-held motor-operated tools;

{4} Motor-operated appliances i.e. hedge clippers, lawn mowers, snow blowers, wet scrubbers;

1910.304 Wiring Design

{5} Cord- and plug-connected appliances used in damp/wet locations or by employees standing on the ground or on metal floors or working inside of metal tanks or boilers;

{6} X-ray equipment;

{7} Tools to be used in wet/conductive locations;

{8} Portable hand lamps.

1910.304 Wiring Design

Tools likely to be used in wet and conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts. Listed or labeled portable tools and appliances protected by an **approved system of double insulation**, or its equivalent, need not be grounded. If such a system is employed, the equipment shall be distinctively marked to indicate that the tool or appliance utilizes an approved system of double insulation.

NOTE: Portable Ground Fault Circuit Interrupters (GFCI) Can Also Be Used.

1910.305 Wiring Methods

(a) Wiring methods. The provisions of this section do not apply to the conductors that are an integral part of factory-assembled equipment.

General requirements –

(i) **Electrical continuity of metal raceways and enclosures**. Metal raceways, cable armor, and other metal enclosures for conductors shall be metallically joined together into a **continuous electric conductor** and shall be so connected to all boxes, fittings, and cabinets as to provide effective electrical continuity.

1910.305 Wiring Methods

(c) Cabinets, boxes, and fittings

(1) Conductors entering boxes, cabinets, or fittings. Conductors entering boxes, cabinets, or fittings **shall also be protected from abrasion**, and openings through which conductors enter shall be effectively closed. **Unused openings** in cabinets, boxes, and fittings **shall be effectively closed**.

1910.305 Wiring Methods

NOTE: Circuit Breaker Panel Doors Shall Be Kept Closed.

(d) Covers and canopies. **All pull boxes, junction boxes, and fittings shall be provided with covers** approved for the purpose.

1910.305 Wiring Methods

(g) Flexible cords and cables

(1) Use of flexible cords and cables.

(i) Flexible cords and cables shall be approved and suitable for conditions of use and location. **Flexible cords and cables shall be used only for**:

(A) Pendants;

(B) Wiring of fixtures;

(C) Connection of portable lamps or appliances;

1910.305 Wiring Methods

(D) Elevator cables;
(E) Wiring of cranes and hoists;
(F) Connection of stationary equipment to facilitate their frequent interchange;
(G) Prevention of the transmission of noise or vibration;
(H) Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair; or

1910.305 Wiring Methods

(g)(1)(iii) Flexible cords and cables may not be used:
(A) As a **substitute for the fixed wiring** of a structure;
(B) Where **run through holes** in walls, ceilings, or floors;
(C) Where **run through doorways**, windows, or similar openings;
(D) Where attached to building surfaces; or
(E) Where concealed behind building walls, ceilings, or floors.

1910.305 Wiring Methods

(e) Identification, splices, and terminations.
(i) A conductor of a flexible cord or cable that is used as a grounded conductor or an equipment grounding conductor shall be distinguishable from other conductors. Types SJ, SJO, SJT, SJTO, S, SO, ST, and STO shall be durably marked on the surface with the type designation, size, and number of conductors.

1910.305 Wiring Methods

(ii) Flexible cords shall be used only in continuous lengths without splice or tap. Hard service **flexible cords No. 12 or larger may be repaired** if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

(iii) Flexible cords shall be connected to devices and fittings so that **strain relief is provided** which will prevent pull from being directly transmitted to joints or terminal screws.

Ohio Administrative Code

4123:1-5-23 Electrical conductors and equipment.

(A) Unless the electrical conductors or equipment to be worked on are isolated from all possible sources of voltage or are effectively grounded, the employer shall provide protective equipment approved for the voltage involved, such as rubber gloves with protectors, rubber sleeves, hot line tools, line hose, line guards, insulator hoods, blankets, and access boards. Employees shall be instructed in the use of such tools and equipment and, when working on or when working within contact distance of an energized conductor, shall use such tools and equipment.

1910.331 Safety Related Work Practices

(a) Covered work by both qualified and unqualified persons.

qualified persons (those who have training in avoiding the electrical hazards of working on or near exposed energized parts) and

unqualified persons (those with little or no such training) working on, near, or with the following installations:

1910.332 Safety-Related Work Practices

1910.332 Training

(a) Scope. The training requirements contained in this section apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308.

Note: Employees in occupations listed in Table S-4 face such a risk and are required to be trained. Other employees who also may reasonably be expected to face comparable risk of injury due to electric shock or other electrical hazards must also be trained.

Occupation
Blue collar supervisors.(1)
Electrical and electronic engineers.(1)
Electrical and electronic equipment assemblers.(1)
Electrical and electronic technicians.(1)
Electricians Industrial machine operators.(1)
Material handling equipment operators.(1)
Mechanics and repairers.(1)
Painters.(1)
Riggers and roustabouts.(1)
Stationary engineers.(1)
Welders.

1910.332 Safety-Related Work Practices

(b) Content of training.

(1) Practices addressed in this standard. Employees shall be trained in and familiar with the safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments.

(2) Additional requirements for unqualified persons. Employees who are covered by paragraph (a) of this section but who are not qualified persons shall also be trained in and familiar with any electrically related safety practices not specifically addressed by 1910.331 through 1910.335 but which are necessary for their safety.

1910.332 Safety-Related Work Practices

(3) Additional requirements for qualified persons. Qualified persons (i.e. those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:

(i) The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.

(ii) The skills and techniques necessary to determine the nominal voltage of exposed live parts, and

(iii) The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.

1910.332 Safety-Related Work Practices

(iii) The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.

(b) **Type of training**.

The training required by this section shall be of: classroom or on-the-job type.

The degree of training provided shall be determined

by the risk to the employee.

1910.333 Lockout/Tagout

1910.333 Selection and use of work practices

(a) General. Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.

1910.333 Lockout/Tagout

(1) De-energized parts. Live parts to which an employee any be exposed shall be de-energized before the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

- Live parts that operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

1910.333 Lockout/Tagout

(2) Energized parts. If the exposed live parts are not de-energized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved.

- Such work practices shall protect employees against contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object.

1910.333 Lockout/Tagout

(b) Working on or near exposed de-energized parts.

(b)(2)(i) "Procedures."

The employer shall maintain a written copy of the procedures outlined in paragraph (b)(2) and shall make it available for inspection by employees and by the Assistant Secretary of Labor and his or her authorized representatives.

Note: The written procedures may be in the form of a copy of paragraph (b) of this section.

1910.333 Lockout/Tagout

(b)(2)(ii) "Deenergizing equipment."

(b)(2)(ii)(A) Safe procedures for deenergizing circuits and equipment shall be determined before circuits or equipment are deenergized.

(b)(2)(ii)(B) **Control circuit devices, such as push buttons, selector switches, and interlocks, may not be used as the sole means for deenergizing circuits or equipment.** Interlocks for electric equipment may not be used as a substitute for lockout and tagging procedures.

1910.334 Use of Equipment

(a) Portable electric equipment. This paragraph applies to the use of cord and plug connected equipment, including flexible cord sets (extension cords).

(1) Handling. Portable equipment shall be handled in a manner which will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment. Flexible cords may not be fastened with staples or otherwise hung in such a fashion as could damage the outer jacket or insulation.

1910.334 Use of Equipment

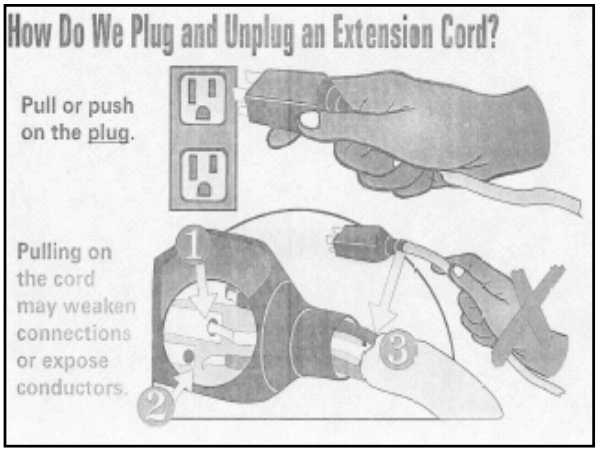
1910 .334 (a) (2) (i) **Visual inspection**

Portable cord and plug connected equipment and flexible cord sets (extension cords) shall be visually inspected before use on any shift for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket). Cord and plug connected equipment and flexible cord sets (extension cords) which remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated.

1910.334 Use of Equipment

(ii) If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

(iii) When an attachment plug is to be connected to a receptacle (including an on a cord set), the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of proper mating configurations.



1910.334 Use of Equipment

~~(3) Grounding type equipment.~~

(i) A flexible cord used with grounding type equipment shall contain an equipment grounding conductor.

1910 .334 (a) (3) (ii) Attachment plugs and receptacles may not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles.

(iii) Adapters which interrupt the continuity of the equipment grounding connection may not be used.

1910.334 Use of Equipment

1910 .334 Use of Equipment

(c) Test instruments and equipment.

(1) Use. Only qualified persons may perform testing work on electric circuits or equipment.

(2) Visual inspection.

(3) Rating of equipment.

1910.335 Personnel Protection

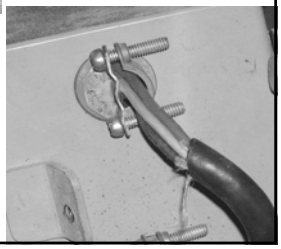
(a) Use of protective equipment.

(1) Personal protective equipment.

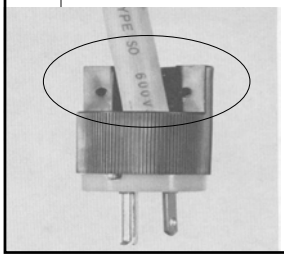
(i) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

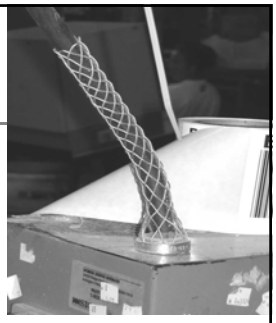
Frayed, cracked insulation

Cord pulled out of strain relief

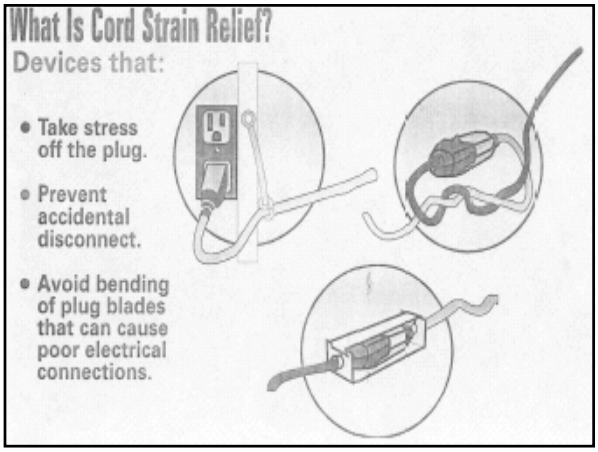


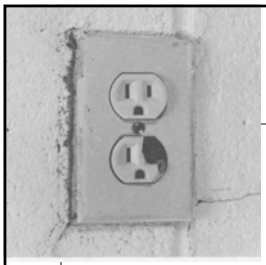
Strain relief missing or needing repair





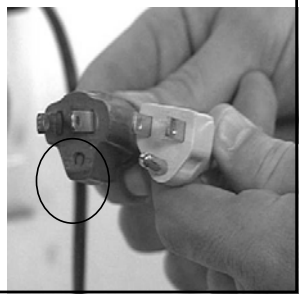
Example of strain relief in place



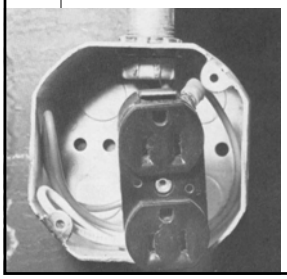


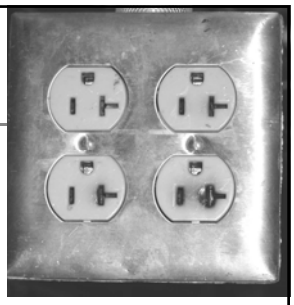
Broken outlet

Missing ground plug



Missing outlet cover





Burned outlets

29 CFR 1910

Subpart S

Electrical

Safety-Related Work Practices

29 CFR 1910

Subpart S

Electrical

1910.301 Introduction

This subpart addresses electrical safety requirements that are necessary for the practical safeguarding of employees in their workplaces and is divided into four major divisions as follows:

(a) Design safety standards for electrical systems. These regulations are contained in 1910.302 through 1910.330. Sections 1910.302 through 1910.308 contain design safety standards for electric utilization systems. Included in this category are all electric equipment and installations used to provide electric power and light for employee workplaces. Sections 1910.309 through 1910.330 are reserved for possible future design safety standards for other electrical systems.

(b) Safety-related work practices. These regulations will be contained in 1910.331 through 1910.360.

(c) Safety-related maintenance requirements. These regulations will be contained in 1910.361 through 1910.380.

(d) Safety requirements for special equipment. These regulations will be contained in 1910.381 through 1910.398.

(e) Definitions. Definitions applicable to each division are contained in 1910.399.

29 CFR 1910

Subpart S

Electrical

1910.302 Electric Utilization Systems

Sections 1910.302 through 1910.308 contain design safety standards for electric utilization systems.

(a) Scope - (1) Covered. The provisions of 1910.302 through 1910.308 of this subpart cover electrical installations and utilization equipment installed or used within or on buildings, structures, and other premises including:

(i) Yards,

(ii) Carnivals,

(iii) Parking and other lots,

(iv) Mobile homes,

(v) Recreational vehicles,

(vi) Industrial substations,

(vii) Conductors that connect the installations to a supply of electricity, and

(viii) Other outside conductors on the premises.

(2) Not covered. The provisions of 1910.302 through 1910.308 of this subpart do not cover:

(i) Installations in ships, watercraft, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles.

(ii) Installations underground in mines.

(iii) Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communication purposes.

(iv) Installations of communication equipment under the exclusive control of communication utilities, located outdoors or in building spaces used exclusively for such installations.

(v) Installations under the exclusive control of electric utilities for the purpose of communication or metering; or for the generation, control, transformation, transmission, and distribution of electric energy located in buildings used exclusively by utilities for such purposes or located outdoors on property owned or leased by the utility or on public highways, streets, roads, etc., or outdoors by established rights on private property.

(b) Extent of application. (1) The requirements contained in the sections listed below shall apply to all electrical installations and utilization equipment, regardless of when they were designed or installed.

Sections:

1910.303(b).....	Examination, installation, and use of equipment.
1910.303(c).....	Splices.
1910.303(d).....	Arcing parts.
1910.303(e).....	Marking.
1910.303(f).....	Identification of disconnecting means.
1910.303(g)(2).....	Guarding of live parts.
1910.304(e)(1)(i).....	Protection of conductors and equipment.
1910.304(e)(1)(iv).....	Location in or on premises.
1910.304(e)(1)(v).....	Arcing or suddenly moving parts.
1910.304(f)(1)(ii).....	2-Wire DC systems to be grounded:
1910.304(f)(1)(iii) and 1910.304(f)(1)(iv).....	AC Systems to be grounded.
1910.304(f)(1)(v).....	AC Systems 50 to 1000 volts not required to be grounded.
1910.304(f)(3).....	Grounding connections.
1910.304(f)(4).....	Grounding path.
1910.304(f)(5)(iv)(a) through 1910.304(f)(5)(iv)(d)..	Fixed equipment required to be grounded.
1910.304(f)(5)(v).....	Grounding of equipment connected by cord & plug.
1910.304(f)(5)(vi).....	Grounding of non-electrical equipment.

1910.304(f)(6)(i).....	Methods of grounding fixed equipment.
1910.305(g)(1)(i) and 1910.305(g)(1)(ii).....	Flexible cords and cables, uses.
1910.305(g)(1)(iii).....	Flexible cords and cables prohibited.
1910.305(g)(2)(ii).....	Flexible cords and cables, splices.
1910.305(g)(2)(iii).....	Pull at joints & terminals of flexible cords/cables.
1910.307.....	Hazardous (classified) locations.

(2) Every electric utilization system and all utilization equipment installed after March 15, 1972, and every major replacement, modification, repair, or rehabilitation, after March 15, 1972, of any part of any electric utilization system or utilization equipment installed before March 15, 1972, shall comply with the provisions of 1910.302 through 1910.308.

NOTE: "Major replacements, modifications, repairs, or rehabilitations" include work similar to that involved when a new building or facility is built, a new wing is added, or an entire floor is renovated.

(3) The following provisions apply to electric utilization systems and utilization equipment installed after April 16, 1981:

1910.303(h)(4) (i) and (ii)...	Entrance and access to workspace (over 600 volts).
1910.304(e)(1)(vi)(b).....	Circuit breakers operated vertically.
1910.304(e)(1)(vi)(c).....	Circuit breakers used as switches.
1910.304(f)(7)(ii).....	Grounding of systems of 1000 volts or more supplying portable or mobile equipment.
1910.305(j)(6)(ii)(b).....	Switching series capacitors over 600 volts.
1910.306(c)(2).....	Warning signs for elevators and escalators.
1910.306(i).....	Electrically controlled irrigation machines.
1910.306(j)(5).....	Ground-fault circuit interrupters for fountains.
1910.308(a)(1)(ii).....	Physical protection of conductors over 600 volts.
1910.308(c)(2).....	Marking of Class 2 and Class 3 power supplies.
1910.308(d).....	Fire protective signaling circuits.

29 CFR 1910

Subpart S

Electrical General

1910.303 General Requirements

(a) Approval. The conductors and equipment required or permitted by this subpart shall be acceptable only if approved.

(b) Examination, installation, and use of equipment - (1) Examination. Electrical equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined using the following considerations:

(i) Suitability for installation and use in conformity with the provisions of this subpart. Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that identified purpose.

(ii) Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.

(iii) Electrical insulation.

(iv) Heating effects under conditions of use.

(v) Arcing effects.

(vi) Classification by type, size, voltage, current capacity, specific use.

(vii) Other factors which contribute to the practical safeguarding of employees using or likely to come in contact with the equipment.

(2) Installation and use. Listed or labeled equipment shall be used or installed in accordance with any instructions included in the listing or labeling.

(c) Splices. Conductors shall be spliced or joined with splicing devices suitable for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be so spliced or joined as to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device suitable for the purpose.

(d) Arcing parts. Parts of electric equipment which in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

(e) Marking. Electrical equipment may not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.

(f) Identification of disconnecting means and circuits. Each disconnecting means required by this subpart for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident. These markings shall be of sufficient durability to withstand the environment involved.

(g) 600 Volts, nominal, or less - (1) Working space about electric equipment. Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

(i) Working clearances. Except as required or permitted elsewhere in this subpart, the dimension of the working space in the direction of access to live parts operating at 600 volts or less and likely to require examination, adjustment, servicing, or maintenance while alive may not be less than indicated in Table S-1. In addition to the dimensions shown in Table S-1, workspace may not be less than 30 inches wide in front of the electric equipment. Distances shall be measured from the live parts if they are exposed, or from the enclosure front or opening if the live parts are enclosed. Concrete, brick, or tile walls are considered to be grounded. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts such as fuses or switches on the back and where all connections are accessible from locations other than the back.

TABLE S-1 - WORKING CLEARANCES

Nominal voltage to ground	Minimum clear distance for condition (2)(ft)		
	(a)	(b)	(c)
0-150	(1) 3	(1)3	3
151-600	(1) 3	3 ½	4

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

Footnote (2) Conditions (a), (b), and (c), are as follows: {a} Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts. {b} Exposed live parts on one side and grounded parts on the other side. {c} Exposed live parts on both sides of the workspace [not guarded as provided in Condition (a)] with the operator between.

(ii) Clear spaces. Working space required by this subpart may not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded.

(iii) Access and entrance to working space. At least one entrance of sufficient area shall be provided to give access to the working space about electric equipment.

(iv) Front working space. Where there are live parts normally exposed on the front of switchboards or motor control centers, the working space in front of such equipment may not be less than 3 feet.

(v) Illumination. Illumination shall be provided for all working spaces about service equipment, switchboards, panelboards, and motor control centers installed indoors.

(vi) Headroom. The minimum headroom of working spaces about service equipment, switchboards, panel-boards, or motor control centers shall be 6 feet 3 inches.

NOTE: As used in this section a motor control center is an assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

(2) Guarding of live parts. (i) Except as required or permitted elsewhere in this subpart, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:

(A) By location in a room, vault, or similar enclosure that is accessible only to qualified persons.

(B) By suitable permanent, substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them.

(C) By location on a suitable balcony, gallery, or platform so elevated and arranged as to exclude unqualified persons.

(D) By elevation of 8 feet or more above the floor or other working surface.

(ii) In locations where electric equipment would be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

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

(h) Over 600 volts, nominal - (1) General. Conductors and equipment used on circuits exceeding 600 volts, nominal, shall comply with all applicable provisions of paragraphs (a) through (g) of this section and with the following provisions which supplement or modify those requirements. The provisions of paragraphs (h)(2), (h)(3), and (h)(4) of this section do not apply to equipment on the supply side of the service conductors.

(2) Enclosure for electrical installations. Electrical installations in a vault, room, closet or in an area surrounded by a wall, screen, or fence, access to which is controlled by lock and key or other approved means, are considered to be accessible to qualified persons only. A wall, screen, or fence less than 8 feet in height is not considered to prevent access unless it has other features that

provide a degree of isolation equivalent to an 8 foot fence. The entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 volts, nominal, shall be kept locked or shall be under the observation of a qualified person at all times.

{i} Installations accessible to qualified persons only. Electrical installations having exposed live parts shall be accessible to qualified persons only and shall comply with the applicable provisions of paragraph (h)(3) of this section.

{ii} Installations accessible to unqualified persons. Electrical installations that are open to unqualified persons shall be made with metal-enclosed equipment or shall be enclosed in a vault or in an area, access to which is controlled by a lock. If metal-enclosed equipment is installed so that the bottom of the enclosure is less than 8 feet above the floor, the door or cover shall be kept locked. Metal-enclosed switchgear, unit substations, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs. If equipment is exposed to physical damage from vehicular traffic, suitable guards shall be provided to prevent such damage. Ventilating or similar openings in metal-enclosed equipment shall be designed so that foreign objects inserted through these openings will be deflected from energized parts.

(3) Workspace about equipment. Sufficient space shall be provided and maintained about electric equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear workspace may not be less than 6 feet 6 inches high (measured vertically from the floor or platform), or less than 3 feet wide (measured parallel to the equipment). The depth shall be as required in Table S-2. The workspace shall be adequate to permit at least a 90-degree opening of doors or hinged panels.

{i} Working space. The minimum clear working space in front of electric equipment such as switchboards, control panels, switches, circuit breakers, motor controllers, relays, and similar equipment may not be less than specified in Table S-2 unless otherwise specified in this subpart. Distances shall be measured from the live parts if they are exposed, or from the enclosure front or opening if the live parts are enclosed. However, working space is not required in back of equipment such as deadfront switchboards or control assemblies where there are no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back. Where rear access is required to work on de-energized parts on the back of enclosed equipment, a minimum working space of 30 inches horizontally shall be provided.

TABLE S-2 - MINIMUM DEPTH OF CLEAR WORKING SPACE IN FRONT OF ELECTRIC EQUIPMENT

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

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

Footnote(2) Conditions (a), (b), and (c) are as follows: {a} Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated busbars operating at not over 300 volts are not considered liveparts. {b} Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces. {c} Exposed live parts on both sides of the workspace not guarded as provided in Condition (a) with the operator between.

{ii} Illumination. Adequate illumination shall be provided for all working spaces about electric equipment. The lighting outlets shall be so arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment. The points of control shall be so located that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights.

{iii} Elevation of unguarded live parts. Unguarded live parts above working space shall be maintained at elevations not less than specified in Table S-3.

TABLE S-3

ELEVATION OF UNGUARDED ENERGIZED PARTS ABOVE WORKING SPACE

Nominal voltage between phases	Minimum elevation
601 to 7,500	*8 feet 6 inches.
7,501 to 35,000	9 feet.
Over 35kV	9 feet + 0.37 inches per kV above 35kV.

*Note. Minimum elevation may be 8 feet 0 inches for installations built prior to April 16, 1981 if the nominal voltage between phases is in the range of 601-6600 volts.

(4) Entrance and access to workspace. (See 1910.302(b)(3).)

{i} At least one entrance not less than 24 inches wide and 6 feet 6 inches high shall be provided to give access to the working space about electric equipment. On switchboard and control panels exceeding 48 inches in width, there shall be one entrance at each end of such board where practicable. Where bare energized parts at any voltage or insulated energized parts above 600 volts are located adjacent to such entrance, they shall be suitably guarded.

{ii} Permanent ladders or stairways shall be provided to give safe access to the working space around electric equipment installed on platforms, balconies, mezzanine floors, or in attic or roof rooms or spaces.

[46 FR 4056, Jan. 16, 1981; 46 FR 40185, Aug. 7, 1981]

29 CFR 1910

Subpart S

Electrical

1910.304 Wiring Design and Protection.

(a) Use and identification of grounded and grounding conductors. (1) Identification of conductors. A conductor used as a grounded conductor shall be identifiable and distinguishable from all other conductors. A conductor used as an equipment grounding conductor shall be identifiable and distinguishable from all other conductors.

(2) Polarity of connections. No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.

(3) Use of grounding terminals and devices. A grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug may not be used for purposes other than grounding.

(b) Branch circuits - (1) [Reserved]

(2) Outlet devices. Outlet devices shall have an ampere rating not less than the load to be served.

(c) Outside conductors, 600 volts, nominal, or less. Paragraphs ©(1), ©(2), ©(3), and ©(4) of this section apply to branch circuit, feeder, and service conductors rated 600 volts, nominal, or less and run outdoors as open conductors. Paragraph ©(5) applies to lamps installed under such conductors.

(1) Conductors on poles. Conductors supported on poles shall provide a horizontal climbing space not less than the following:

(i) Power conductors below communication conductors - 30 inches.

(ii) Power conductors alone or above communication conductors: 300 volts or less - 24 inches; more than 300 volts - 30 inches.

(iii) Communication conductors below power conductors with power conductors 300 volts or less - 24 inches; more than 300 volts - 30 inches.

(2) Clearance from ground. Open conductors shall conform to the following minimum clearances:

(i) 10 feet - above finished grade, sidewalks, or from any platform or projection from which they might be reached.

(ii) 12 feet - over areas subject to vehicular traffic other than truck traffic.

(iii) 15 feet - over areas other than those specified in paragraph (c)(2)(iv) of this section that are subject to truck traffic.

(iv) 18 feet - over public streets, alleys, roads, and driveways. 1910.304(c)(3)

(3) Clearance from building openings. Conductors shall have a clearance of at least 3 feet from windows, doors, porches, fire escapes, or similar locations. Conductors run above the top level of a window are considered to be out of reach from that window and, therefore, do not have to be 3 feet away.

(4) Clearance over roofs. Conductors shall have a clearance of not less than 8 feet from the highest point of roofs over which they pass, except that:

(I) Where the voltage between conductors is 300 volts or less and the roof has a slope of not less than 4 inches in 12, the clearance from roofs shall be at least 3 feet, or

(ii) Where the voltage between conductors is 300 volts or less and the conductors do not pass over more than 4 feet of the overhang portion of the roof and they are terminated at a through-the-roof raceway or approved support, the clearance from roofs shall be at least 18 inches.

(5) Location of outdoor lamps. Lamps for outdoor lighting shall be located below all live conductors, transformers, or other electric equipment, unless such equipment is controlled by a disconnecting means that can be locked in the open position or unless adequate clearances or other safeguards are provided for relamping operations.

(d) Services - (1) Disconnecting means - (i) General. Means shall be provided to disconnect all conductors in a building or other structure from the service-entrance conductors. The disconnecting means shall plainly indicate whether it is in the open

or closed position and shall be installed at a readily accessible location nearest the point of entrance of the service-entrance conductors.
(ii) Simultaneous opening of poles. Each service disconnecting means shall simultaneously disconnect all ungrounded conductors.

(2) Services over 600 volts, nominal. The following additional requirements apply to services over 600 volts, nominal.

(i) Guarding. Service-entrance conductors installed as open wires shall be guarded to make them accessible only to qualified persons.

(ii) Warning signs. Signs warning of high voltage shall be posted where other than qualified employees might come in contact with live parts.

(e) Overcurrent protection. (1) 600 volts, nominal, or less. The following requirements apply to overcurrent protection of circuits rated 600 volts, nominal, or less.

(i) Protection of conductors and equipment. Conductors and equipment shall be protected from overcurrent in accordance with their ability to safely conduct current.

(ii) Grounded conductors. Except for motor running overload protection, overcurrent devices may not interrupt the continuity of the grounded conductor unless all conductors of the circuit are opened simultaneously.

(iii) Disconnection of fuses and thermal cutouts. Except for service fuses, all cartridge fuses which are accessible to other than qualified persons and all fuses and thermal cutouts on circuits over 150 volts to ground shall be provided with disconnecting means. This disconnecting means shall be installed so that the fuse or thermal cutout can be disconnected from its supply without disrupting service to equipment and circuits unrelated to those protected by the overcurrent device.

(iv) Location in or on premises. Overcurrent devices shall be readily accessible to each employee or authorized building management personnel. These overcurrent devices may not be located where they will be exposed to physical damage nor in the vicinity of easily ignitable material.

(v) Arcing or suddenly moving parts. Fuses and circuit breakers shall be so located or shielded that employees will not be burned or otherwise injured by their operation.

(vi) Circuit breakers. (A) Circuit breakers shall clearly indicate whether they are in the open (off) or closed (on) position.

(B) Where circuit breaker handles on switchboards are operated vertically rather than horizontally or rotationally, the up position of the handle shall be the closed (on) position. (See 1910.302(b)(3).) 1910.304(e)(1)(vi)(c)

(C) If used as switches in 120-volt, fluorescent lighting circuits, circuit breakers shall be approved for the purpose and marked "SWD." (See 1910.302(b)(3).)

(2) Over 600 volts, nominal. Feeders and branch circuits over 600 volts, nominal, shall have short-circuit protection.

(f) Grounding. Paragraphs (f)(1) through (f)(7) of this section contain grounding requirements for systems, circuits, and equipment.

(1) Systems to be grounded. The following systems which supply premises wiring shall be grounded:

(i) All 3-wire DC systems shall have their neutral conductor grounded.

(ii) Two-wire DC systems operating at over 50 volts through 300 volts between conductors shall be grounded unless:

(A) They supply only industrial equipment in limited areas and are equipped with a ground detector; or

(B) They are rectifier-derived from an AC system complying with paragraphs (f)(1)(iii), (f)(1)(iv), and (f)(1)(v) of this section; or

(C) They are fire-protective signaling circuits having a maximum current of 0.030 amperes.

(iii) AC circuits of less than 50 volts shall be grounded if they are installed as overhead conductors outside of buildings or if they are supplied by transformers and the transformer primary supply system is ungrounded or exceeds 150 volts to ground.

(iv) AC systems of 50 volts to 1000 volts shall be grounded under any of the following conditions, unless exempted by paragraph (f)(1)(v) of this section:

(A) If the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts;

(B) If the system is nominally rated 480Y/277 volt, 3-phase, 4-wire in which the neutral is used as a circuit conductor;

(C) If the system is nominally rated 240/120 volt, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor; or

(D) If a service conductor is uninsulated.

(v) AC systems of 50 volts to 1000 volts are not required to be grounded under any of the following conditions:

(A) If the system is used exclusively to supply industrial electric furnaces for melting, refining, tempering, and the like.

(B) If the system is separately derived and is used exclusively for rectifiers supplying only adjustable speed industrial drives.

(C) If the system is separately derived and is supplied by a transformer that has a primary voltage rating less than 1000 volts, provided all of the following conditions are met:

{1} The system is used exclusively for control circuits,

{2} The conditions of maintenance and supervision assure that only qualified persons will service the installation,

{3} Continuity of control power is required, and

{4} Ground detectors are installed on the control system.

(D) If the system is an isolated power system that supplies circuits in health care facilities.

(2) Conductors to be grounded. For AC premises wiring systems the identified conductor shall be grounded.

(3) Grounding connections. (i) For a grounded system, a grounding electrode conductor shall be used to connect both the equipment grounding conductor and the grounded circuit conductor to the grounding electrode. Both the equipment grounding conductor and the grounding electrode conductor shall be connected to the grounded circuit conductor on the supply side of the service disconnecting means, or on the supply side of the system disconnecting means or overcurrent devices if the system is separately derived.

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

(iii) On extensions of existing branch circuits which do not have an equipment grounding conductor, grounding-type receptacles may be grounded to a grounded cold water pipe near the equipment.

(4) Grounding path. The path to ground from circuits, equipment, and enclosures shall be permanent and continuous.

(5) Supports, enclosures, and equipment to be grounded - (i) Supports and enclosures for conductors. Metal cable trays, metal raceways, and metal enclosures for conductors shall be grounded, except that:

(A) Metal enclosures such as sleeves that are used to protect cable assemblies from physical damage need not be grounded; or

(B) Metal enclosures for conductors added to existing installations of open wire, knob-and-tube wiring, and nonmetallic-sheathed cable need not be grounded if all of the following conditions are met: {1} Runs are less than 25 feet; {2} enclosures are free from probable contact with ground, grounded metal, metal laths, or other conductive materials; and {3} enclosures are guarded against employee contact.

(ii) Service equipment enclosures. Metal enclosures for service equipment shall be grounded.

(iii) Frames of ranges and clothes dryers. Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and metal outlet or junction boxes which are part of the circuit for these appliances shall be grounded.

(iv) Fixed equipment. Exposed non-current-carrying metal parts of fixed equipment which may become energized shall be grounded under any of the following conditions:
(A) If within 8 feet vertically or 5 feet horizontally of ground or grounded metal objects and subject to employee contact.

(B) If located in a wet or damp location and not isolated.

(C) If in electrical contact with metal.

(D) If in a hazardous (classified) location.

(E) If supplied by a metal-clad, metal-sheathed, or grounded metal raceway wiring method.

(F) If equipment operates with any terminal at over 150 volts to ground; however, the following need not be grounded:

{1} Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only;

{2} Metal frames of electrically heated appliances which are permanently and effectively insulated from ground; and

{3} The cases of distribution apparatus such as transformers and capacitors mounted on wooden poles at a height exceeding 8 feet above ground or grade level.

(v) Equipment connected by cord and plug. Under any of the conditions described in paragraphs (f)(5)(v)(A) through (f)(5)(v)(C) of this section, exposed non-current-carrying metal parts of cord - and plug-connected equipment which may become energized shall be grounded.

(A) If in hazardous (classified) locations (see 1910.307).

(B) If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground.

(C) If the equipment is of the following types:

{1} Refrigerators, freezers, and air conditioners;

{2} Clothes-washing, clothes-drying and dishwashing machines, sump pumps, and electrical aquarium equipment;

{3} Hand-held motor-operated tools;

{4} Motor-operated appliances of the following types: hedge clippers, lawn mowers, snow blowers, and wet scrubbers;

{5} Cord- and plug-connected appliances used in damp or wet locations or by employees standing on the ground or on metal floors or working inside of metal tanks or boilers;

{6} Portable and mobile X-ray and associated equipment;

{7} Tools likely to be used in wet and conductive locations; and

{8} Portable hand lamps.
Tools likely to be used in wet and conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts. Listed or labeled portable tools and appliances protected by an approved system of double insulation, or its equivalent, need not be grounded. If such a system is employed, the equipment shall be distinctively marked to indicate that the tool or appliance utilizes an approved system of double insulation.

(vi) Nonelectrical equipment. The metal parts of the following nonelectrical equipment shall be grounded: frames and tracks of electrically operated cranes; frames of nonelectrically driven elevator cars to which electric conductors are attached; hand operated metal shifting ropes or cables of electric elevators, and metal partitions, grill work, and similar metal enclosures around equipment of over 750 volts between conductors.

(6) Methods of grounding fixed equipment. (i) Non-current-carrying metal parts of fixed equipment, if required to be grounded by this subpart, shall be grounded by an equipment grounding conductor which is contained within the same raceway, cable, or cord, or runs with or encloses the circuit conductors. For DC circuits only, the equipment grounding conductor may be run separately from the circuit conductors.

(ii) Electric equipment is considered to be effectively grounded if it is secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack or structure is grounded by the method specified for the non-current-carrying metal parts of fixed equipment in paragraph (f)(6)(i) of this section. For installations made before April 16, 1981, only, electric equipment is also considered to be effectively grounded if it is secured to, and in metallic contact with, the grounded structural metal frame of a building. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or drums of grounded elevator machines are also considered to be effectively grounded.

(7) Grounding of systems and circuits of 1000 volts and over (high voltage.) (i) General. If high voltage systems are grounded, they shall comply with all applicable provisions of paragraphs (f)(1) through (f)(6) of this section as supplemented and modified by this paragraph (f)(7).

(ii) Grounding of systems supplying portable or mobile equipment. (See 1910.302(b)(3).) Systems supplying portable or mobile high voltage equipment, other than substations installed on a temporary basis, shall comply with the following:

(A) Portable and mobile high voltage equipment shall be supplied from a system having its neutral grounded through an impedance. If a delta-connected high voltage system is used to supply the equipment, a system neutral shall be derived.

(B) Exposed non-current-carrying metal parts of portable and mobile equipment shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.

(C) Ground-fault detection and relaying shall be provided to automatically de-energize any high voltage system component which has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to de-energize automatically the high voltage feeder to the portable equipment upon loss of continuity of the equipment grounding conductor.

(D) The grounding electrode to which the portable or mobile equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 20 feet from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as buried pipe, fence, etc.

(iii) Grounding of equipment. All non-current-carrying metal parts of portable equipment and fixed equipment including their associated fences, housings, enclosures, and supporting structures shall be grounded. However, equipment which is guarded by location and isolated from ground need not be grounded. Additionally, pole-mounted distribution apparatus at a height exceeding 8 feet above ground or grade level need not be grounded.

29 CFR 1910

Subpart S

Electrical

1910.305 Wiring methods, components, and equipment for general use.

Wiring methods, components, and equipment for general use.

(a) Wiring methods. The provisions of this section do not apply to the conductors that are an integral part of factory-assembled equipment.

(1) General requirements - (i) Electrical continuity of metal raceways and enclosures. Metal raceways, cable armor, and other metal enclosures for conductors shall be metallically joined together into a continuous electric conductor and shall be so connected to all boxes, fittings, and cabinets as to provide effective electrical continuity.

(ii) Wiring in ducts. No wiring systems of any type shall be installed in ducts used to transport dust, loose stock or flammable vapors. No wiring system of any type may be installed in any duct used for vapor removal or for ventilation of commercial-type cooking equipment, or in any shaft containing only such ducts.

(2) Temporary wiring. Temporary electrical power and lighting wiring methods may be of a class less than would be required for a permanent installation. Except as specifically modified in this paragraph, all other requirements of this subpart for permanent wiring shall apply to temporary wiring installations.

(i) Uses permitted, 600 volts, nominal, or less. Temporary electrical power and lighting installations 600 volts, nominal, or less may be used only:

(A) During and for remodeling, maintenance, repair, or demolition of buildings, structures, or equipment, and similar activities;

(B) For experimental or development work, and

(C) For a period not to exceed 90 days for Christmas decorative lighting, carnivals, and similar purposes.

(ii) Uses permitted, over 600 volts, nominal. Temporary wiring over 600 volts, nominal, may be used only during periods of tests, experiments, or emergencies.

(iii) General requirements for temporary wiring. (A) Feeders shall originate in an approved distribution center. The conductors shall be run as multiconductor cord or cable assemblies, or, where not subject to physical damage, they may be run as open conductors on insulators not more than 10 feet apart.

(B) Branch circuits shall originate in an approved power outlet or panelboard. Conductors shall be multiconductor cord or cable assemblies or open conductors. If run as open conductors they shall be fastened at ceiling height every 10 feet. No branch-circuit conductor may be laid on the floor. Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor if run as open conductors.

(C) Receptacles shall be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit shall contain a separate equipment grounding conductor and all receptacles shall be electrically connected to the grounding conductor.

(D) No bare conductors nor earth returns may be used for the wiring of any temporary circuit.

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

(F) Lamps for general illumination shall be protected from accidental contact or breakage. Protection shall be provided by elevation of at least 7 feet from normal working surface or by a suitable fixture or lampholder with a guard.

(G) Flexible cords and cables shall be protected from accidental damage. Sharp corners and projections shall be avoided. Where passing through doorways or other pinch points, flexible cords and cables shall be provided with protection to avoid damage.

(3) Cable trays. (i) Uses permitted. (A) Only the following may be installed in cable tray systems:

{1} Mineral-insulated metal-sheathed cable (Type MI);

{2} Armored cable (Type AC);

{3} Metal-clad cable (Type MC);

{4} Power-limited tray cable (Type PLTC);

{5} Nonmetallic-sheathed cable (Type NM or NMC);

{6} Shielded nonmetallic-sheathed cable (Type SNM);

{7} Multiconductor service-entrance cable (Type SE or USE);

{8} Multiconductor underground feeder and branch-circuit cable (Type UF);

{9} Power and control tray cable (Type TC);

{10} Other factory-assembled, multiconductor control, signal, or power cables which are specifically approved for installation in cable trays; or

{11} Any approved conduit or raceway with its contained conductors.

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

{1} Single conductor cables which are 250 MCM or larger and are Types RHH, RHW, MV, USE, or THW, and other 250 MCM or larger single conductor cables if specifically approved for installation in cable trays. Where exposed to direct rays of the sun, cables shall be sunlight-resistant.

{2} Type MV cables, where exposed to direct rays of the sun, shall be sunlight-resistant.

(C) Cable trays in hazardous (classified) locations shall contain only the cable types permitted in such locations.

(ii) Uses not permitted. Cable tray systems may not be used in hoistways or where subjected to severe physical damage.

(4) Open wiring on insulators - (i) Uses permitted. Open wiring on insulators is only permitted on systems of 600 volts, nominal, or less for industrial or agricultural establishments and for services.

(ii) Conductor supports. Conductors shall be rigidly supported on non-combustible, nonabsorbent insulating materials and may not contact any other objects.

(iii) Flexible nonmetallic tubing. In dry locations where not exposed to severe physical damage, conductors may be separately enclosed in flexible nonmetallic tubing. The tubing shall be in continuous lengths not exceeding 15 feet and secured to the surface by straps at intervals not exceeding 4 feet 6 inches.

(iv) Through walls, floors, wood cross members, etc. Open conductors shall be separated from contact with walls, floors, wood cross members, or partitions through which they pass by tubes or bushings of non-combustible, nonabsorbent insulating material. If the bushing is shorter than the hole, a waterproof sleeve of nonconductive material shall be inserted in the hole and an insulating bushing slipped into the sleeve at each end in such a manner as to keep the conductors absolutely out of contact with the sleeve. Each conductor shall be carried through a separate tube or sleeve.

(v) Protection from physical damage. Conductors within 7 feet from the floor are considered exposed to physical damage. Where open conductors cross ceiling joints and wall studs and are exposed to physical damage, they shall be protected.

(b) Cabinets, boxes, and fittings - (1) Conductors entering boxes, cabinets, or fittings. Conductors entering boxes, cabinets, or fittings shall also be protected from abrasion, and openings through which conductors enter shall be effectively closed. Unused openings in cabinets, boxes, and fittings shall be effectively closed.

(2) Covers and canopies. 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. In completed installations each outlet box shall have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear.

(3) Pull and junction boxes for systems over 600 volts, nominal. In addition to other requirements in this section for pull and junction boxes, the following shall apply to these boxes for systems over 600 volts, nominal:

(i) Boxes shall provide a complete enclosure for the contained conductors or cables.

(ii) Boxes shall be closed by suitable covers securely fastened in place. Underground box covers that weigh over 100 pounds meet this requirement. Covers for boxes shall be permanently marked "HIGH VOLTAGE." The marking shall be on the outside of the box cover and shall be readily visible and legible.

(c) Switches - (1) Knife switches. Single-throw knife switches shall be so connected that the blades are dead when the switch is in the open position. Single-throw knife switches shall be so placed that gravity will not tend to close them. Single-throw knife switches approved for use in the inverted position shall be provided with a locking device that will ensure that the blades remain in the open position when so set. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal. However, if the throw is vertical a locking device shall be provided to ensure that the blades remain in the open position when so set.

(2) Faceplates for flush-mounted snap switches. Flush snap switches that are mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces shall be provided with faceplates of non-conducting, non-combustible material.

(d) Switchboards and panelboards. Switchboards that have any exposed live parts shall be located in permanently dry locations and accessible only to qualified persons. Panelboards shall be mounted in cabinets, cutout boxes, or enclosures approved for the purpose and shall be dead front. However, panelboards other than the dead front externally-operable type are permitted where accessible only to qualified persons. Exposed blades of knife switches shall be dead when open.

(e) Enclosures for damp or wet locations. (1) Cabinets, cutout boxes, fittings, boxes, and panelboard enclosures in damp or wet locations shall be installed so as to prevent moisture or water from entering and accumulating within the enclosures. In wet locations the enclosures shall be weatherproof.

(2) Switches, circuit breakers, and switchboards installed in wet locations shall be enclosed in weatherproof enclosures.

(f) Conductors for general wiring. All conductors used for general wiring shall be insulated unless otherwise permitted in this Subpart. The conductor insulation shall be of a type that is approved for the voltage, operating temperature, and location of use. Insulated conductors shall be distinguishable by appropriate color or other suitable means as being grounded conductors, ungrounded conductors, or equipment grounding conductors.

(g) Flexible cords and cables - (1) Use of flexible cords and cables.

(i) Flexible cords and cables shall be approved and suitable for conditions of use and location. Flexible cords and cables shall be used only for:

(A) Pendants;

(B) Wiring of fixtures;

(C) Connection of portable lamps or appliances;

(D) Elevator cables;

(E) Wiring of cranes and hoists;

(F) Connection of stationary equipment to facilitate their frequent interchange;

(G) Prevention of the transmission of noise or vibration;

(H) Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair; or

{i} Data processing cables approved as a part of the data processing system.

(ii) If used as permitted in paragraphs (g)(1)(i)(c), (g)(1)(i)(f), or (g)(1)(i)(h) of this section, the flexible cord shall be equipped with an attachment plug and shall be energized from an approved receptacle outlet.

(iii) Unless specifically permitted in paragraph (g)(1)(i) of this section, flexible cords and cables may not be used:

(A) As a substitute for the fixed wiring of a structure;

(B) Where run through holes in walls, ceilings, or floors;

(C) Where run through doorways, windows, or similar openings;

(D) Where attached to building surfaces; or

(E) Where concealed behind building walls, ceilings, or floors.

(iv) Flexible cords used in show windows and showcases shall be Type S, SO, SJ, SJO, ST, STO, SJT, SJTO, or AFS except for the wiring of chain-supported lighting fixtures and supply cords for portable lamps and other merchandise being displayed or exhibited.

(2) Identification, splices, and terminations. (i) A conductor of a flexible cord or cable that is used as a grounded conductor or an equipment grounding conductor shall be distinguishable from other conductors. Types SJ, SJO, SJT, SJTO, S, SO, ST, and STO shall be durably marked on the surface with the type designation, size, and number of conductors.

(ii) Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

(iii) Flexible cords shall be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.

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

(i) Fixture wires - (1) General. Fixture wires shall be approved for the voltage, temperature, and location of use. A fixture wire which is used as a grounded conductor shall be identified.

(2) Uses permitted. Fixture wires may be used:

(i) For installation in lighting fixtures and in similar equipment where enclosed or protected and not subject to bending or twisting in use; or

(ii) For connecting lighting fixtures to the branch-circuit conductors supplying the fixtures.

(3) Uses not permitted. Fixture wires may not be used as branch-circuit conductors except as permitted for Class 1 power limited circuits.

(j) Equipment for general use - (1) Lighting fixtures, lampholders, lamps, and receptacles. (i) Fixtures, lampholders, lamps, rosettes, and receptacles may have no live parts normally exposed to employee contact. However, rosettes and cleat-type lampholders and receptacles located at least 8 feet above the floor may have exposed parts.

(ii) Handlamps of the portable type supplied through flexible cords shall be equipped with a handle of molded composition or other material approved for the purpose, and a substantial guard shall be attached to the lampholder or the handle.

(iii) Lampholders of the screw-shell type shall be installed for use as lampholders only. Lampholders installed in wet or damp locations shall be of the weatherproof type.

(iv) Fixtures installed in wet or damp locations shall be approved for the purpose and shall be so constructed or installed that water cannot enter or accumulate in wireways, lampholders, or other electrical parts.

(2) Receptacles, cord connectors, and attachment plugs (caps). (i) Receptacles, cord connectors, and attachment plugs shall be constructed so that no receptacle or cord connector will accept an attachment plug with a different voltage or current rating than that for which the device is intended. However, a 20-ampere T-slot receptacle or cord connector may accept a 15-ampere attachment plug of the same voltage rating.

(ii) A receptacle installed in a wet or damp location shall be suitable for the location.

(3) Appliances. (i) Appliances, other than those in which the current-carrying parts at high temperatures are necessarily exposed, may have no live parts normally exposed to employee contact.

(ii) A means shall be provided to disconnect each appliance.

(iii) Each appliance shall be marked with its rating in volts and amperes or volts and watts.

(4) Motors. This paragraph applies to motors, motor circuits, and controllers.

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

(ii) Disconnecting means. (A) A disconnecting means shall be located in sight from the controller location. However, a single disconnecting means may be located adjacent to a group of coordinated controllers mounted adjacent to each other on a multi-motor continuous process machine.

The controller disconnecting means for motor branch circuits over 600 volts, nominal, may be out of sight of the controller, if the controller is marked with a warning label giving the location and identification of the disconnecting means which is to be locked in the open position.

(B) The disconnecting means shall disconnect the motor and the controller from all ungrounded supply conductors and shall be so designed that no pole can be operated independently.

(C) If a motor and the driven machinery are not in sight from the controller location, the installation shall comply with one of the following conditions:

{1} The controller disconnecting means shall be capable of being locked in the open position.

{2} A manually operable switch that will disconnect the motor from its source of supply shall be placed in sight from the motor location.

(D) The disconnecting means shall plainly indicate whether it is in the open (off) or closed (on) position.

(E) The disconnecting means shall be readily accessible. If more than one disconnect is provided for the same equipment, only one need be readily accessible.

(F) An individual disconnecting means shall be provided for each motor, but a single disconnecting means may be used for a group of motors under any one of the following conditions:

{1} If a number of motors drive special parts of a single machine or piece of apparatus, such as a metal or woodworking machine, crane, or hoist;

{2} If a group of motors is under the protection of one set of branch-circuit protective devices; or

{3} If a group of motors is in a single room in sight from the location of the disconnecting means.

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

(iv) Protection of live parts - all voltages. (A) Stationary motors having commutators, collectors, and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground need not have such parts guarded. Exposed live parts of motors and controllers operating at 50 volts or more between terminals shall be guarded against accidental contact by any of the following:

{1} By installation in a room or enclosure that is accessible only to qualified persons;

{2} By installation on a suitable balcony, gallery, or platform, so elevated and arranged as to exclude unqualified persons; or

{3} By elevation 8 feet or more above the floor.

(B) Where live parts of motors or controllers operating at over 150 volts to ground are guarded against accidental contact only by location, and where adjustment or other attendance may be necessary during the operation of the apparatus, suitable insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms.

(5) Transformers. (i) The following paragraphs cover the installation of all transformers except the following:

(A) Current transformers;

(B) Dry-type transformers installed as a component part of other apparatus;

(C) Transformers which are an integral part of an X-ray, high frequency, or electrostatic-coating apparatus;

(D) Transformers used with Class 2 and Class 3 circuits, sign and outline lighting, electric discharge lighting, and power-limited fire-protective signaling circuits; and

(E) Liquid-filled or dry-type transformers used for research, development, or testing, where effective safeguard arrangements are provided.

(ii) The operating voltage of exposed live parts of transformer installations shall be indicated by warning signs or visible markings on the equipment or structure.

(iii) Dry-type, high fire point liquid-insulated, and askarel-insulated transformers installed indoors and rated over 35kV shall be in a vault.

(iv) If they present a fire hazard to employees, oil-insulated transformers installed indoors shall be in a vault.

(v) Combustible material, combustible buildings and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires which may originate in oil-insulated transformers attached to or adjacent to a building or combustible material.

(vi) Transformer vaults shall be constructed so as to contain fire and combustible liquids within the vault and to prevent unauthorized access. Locks and latches shall be so arranged that a vault door can be readily opened from the inside.

(vii) Any pipe or duct system foreign to the vault installation may not enter or pass through a transformer vault.

(viii) Materials may not be stored in transformer vaults.

(6) Capacitors. (i) All capacitors, except surge capacitors or capacitors included as a component part of other apparatus, shall be provided with an automatic means of draining the stored charge after the capacitor is disconnected from its source of supply.

(ii) Capacitors rated over 600 volts, nominal, shall comply with the following additional requirements:

(A) Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load interrupting device or shall be provided with prominently displayed caution signs to prevent switching load current.

(B) For series capacitors (see 1910.302(b)(3)), the proper switching shall be assured by use of at least one of the following:

{1} Mechanically sequenced isolating and bypass switches,

{2} Interlocks, or

{3} Switching procedure prominently displayed at the switching location.

(7) Storage batteries. Provisions shall be made for sufficient diffusion and ventilation of gases from storage batteries to prevent the accumulation of explosive mixtures.

29 CFR 1910

Subpart S

Electrical

1910.306 Specific Purpose Equipment and Installations.

(a) Electric signs and outline lighting - (1) Disconnecting means. Signs operated by electronic or electromechanical controllers located outside the sign shall have a disconnecting means located inside the controller enclosure or within sight of the controller location, and it shall be capable of being locked in the open position. Such disconnecting means shall have no pole that can be operated independently, and it shall open all ungrounded conductors that supply the controller and sign. All other signs, except the portable type, and all outline lighting installations shall have an externally operable disconnecting means which can open all ungrounded conductors and is within the sight of the sign or outline lighting it controls.

(2) Doors or covers giving access to uninsulated parts of indoor signs or outline lighting exceeding 600 volts and accessible to other than qualified persons shall either be provided with interlock switches to disconnect the primary circuit or shall be so fastened that the use of other than ordinary tools will be necessary to open them.

(b) Cranes and hoists. This paragraph applies to the installation of electric equipment and wiring used in connection with cranes, monorail hoists, hoists, and all runways.

(1) Disconnecting means. A readily accessible disconnecting means - (i) shall be provided between the runway contact conductors and the power supply.

(ii) Another disconnecting means, capable of being locked in the open position, shall be provided in the leads from the runway contact conductors or other power supply on any crane or monorail hoist.

(A) If this additional disconnecting means is not readily accessible from the crane or monorail hoist operating station, means shall be provided at the operating station to open the power circuit to all motors of the crane or monorail hoist.

(B) The additional disconnect may be omitted if a monorail hoist or hand-propelled crane bridge installation meets all of the following:

{1} The unit is floor controlled;

{2} The unit is within view of the power supply disconnecting means; and

{3} No fixed work platform has been provided for servicing the unit.

(2) Control. A limit switch or other device shall be provided to prevent the load block from passing the safe upper limit of travel of any hoisting mechanism.

(3) Clearance. The dimension of the working space in the direction of access to live parts which may require examination, adjustment, servicing, or maintenance while alive shall be a minimum of 2 feet 6 inches. Where controls are enclosed in cabinets, the door(s) shall either open at least 90 degrees or be removable.

(c) Elevators, dumbwaiters, escalators, and moving walks - (1) Disconnecting means. Elevators, dumbwaiters, escalators, and moving walks shall have a single means for disconnecting all ungrounded main power supply conductors for each unit.

(2) Warning signs. If interconnections between control panels are necessary for operation of the system on a multicar installation that remains energized from a source other than the disconnecting means, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and shall read "Warning - Parts of the control panel are not de-energized by this switch." (See 1910.302(b)(3).)

(3) Control panels. If control panels are not located in the same space as the drive machine, they shall be located in cabinets with doors or panels capable of being locked closed.

(d) Electric welders - disconnecting means. (1) A disconnecting means shall be provided in the supply circuit for each motor-generator arc welder, and for each AC transformer and DC rectifier arc welder which is not equipped with a disconnect mounted as an integral part of the welder.

(2) A switch or circuit breaker shall be provided by which each resistance welder and its control equipment can be isolated from the supply circuit. The ampere rating of this disconnecting means may not be less than the supply conductor ampacity.

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

(f) X-Ray equipment. This paragraph applies to X-ray equipment for other than medical or dental use.

(1) Disconnecting means. (i) A disconnecting means shall be provided in the supply circuit. The disconnecting means shall be operable from a location readily accessible from the X-ray control. For equipment connected to a 120-volt branch circuit of 30 amperes or less, a grounding-type attachment plug cap and receptacle of proper rating may serve as a disconnecting means.

(ii) If more than one piece of equipment is operated from the same high-voltage circuit, each piece or each group of equipment as a unit shall be provided with a high-voltage switch or equivalent disconnecting means. This disconnecting means shall be constructed, enclosed, or located so as to avoid contact by employees with its live parts.

(2) Control - (i) Radiographic and fluoroscopic types. Radiographic and fluoroscopic-type equipment shall be effectively enclosed or shall have interlocks that de-energize the equipment automatically to prevent ready access to live current-carrying parts.

(ii) Diffraction and irradiation types. Diffraction- and irradiation-type equipment shall be provided with a means to indicate when it is energized unless the equipment or installation is effectively enclosed or is provided with interlocks to prevent access to live current-carrying parts during operation.

(g) Induction and dielectric heating equipment - (1) Scope. Paragraphs (g)(2) and (g)(3) of this section cover induction and dielectric heating equipment and accessories for industrial and scientific applications, but not for medical or dental applications or for appliances.

(2) Guarding and grounding. (i) Enclosures. The converting apparatus (including the DC line) and high-frequency electric circuits (excluding the output circuits and remote-control circuits) shall be completely contained within enclosures of non-combustible material.

(ii) Panel controls. All panel controls shall be of dead-front construction.

(iii) Access to internal equipment. Where doors are used for access to voltages from 500 to 1000 volts AC or DC, either door locks or interlocks shall be provided. Where doors are used for access to voltages of over 1000 volts AC or DC, either mechanical lockouts with a disconnecting means to prevent access until voltage is removed from the cubicle, or both door interlocking and mechanical door locks, shall be provided.

(iv) Warning labels. "Danger" labels shall be attached on the equipment and shall be plainly visible even when doors are open or panels are removed from compartments containing voltages of over 250 volts AC or DC.

(v) Work applicator shielding. Protective cages or adequate shielding shall be used to guard work applicators other than induction heating coils. Induction heating coils shall be protected by insulation and/or refractory materials. Interlock switches shall be used on all hinged access doors, sliding panels, or other such means of access to the applicator. Interlock switches shall be connected in such a manner as to remove all power from the applicator when any one of the access doors or panels is open. Interlocks on access doors or panels are not required if the applicator is an induction heating coil at DC ground potential or operating at less than 150 volts AC.

(vi) Disconnecting means. A readily accessible disconnecting means shall be provided by which each unit of heating equipment can be isolated from its supply circuit.

(3) Remote control. If remote controls are used for applying power, a selector switch shall be provided and interlocked to provide power from only one control point at a time. Switches operated by foot pressure shall be provided with a shield over the contact button to avoid accidental closing of the switch.

(h) Electrolytic cells. (1) Scope. These provisions for electrolytic cells apply to the installation of the electrical components and accessory equipment of electrolytic cells, electrolytic cell lines, and process power supply for the production of aluminum, cadmium, chlorine, copper, fluorine, hydrogen peroxide, magnesium, sodium, sodium chlorate, and zinc. Cells used as a source of electric energy and for electroplating processes and cells used for production of hydrogen are not covered by these provisions.

(2) Definitions applicable to this paragraph.

Cell line: An assembly of electrically interconnected electrolytic cells supplied by a source of direct-current power.

Cell line attachments and auxiliary equipment: Cell line attachments and auxiliary equipment include, but are not limited to: auxiliary tanks; process piping; duct work; structural supports; exposed cell line conductors; conduits and other raceways; pumps; positioning equipment and cell cutout or by-pass electrical devices. Auxiliary equipment also includes tools, welding machines, crucibles, and other portable equipment used for operation and maintenance within the electrolytic cell line working zone. In the cell line working zone, auxiliary equipment includes the exposed conductive surfaces of ungrounded cranes and crane-mounted cell-servicing equipment.

Cell line working zone: The cell line working zone is the space envelope wherein operation or maintenance is normally performed on or in the vicinity of exposed energized surfaces of cell lines or their attachments.

Electrolytic Cells: A receptacle or vessel in which electrochemical reactions are caused by applying energy for the purpose of refining or producing usable materials.

(3) Application. Installations covered by paragraph (h) of this section shall comply with all applicable provisions of this subpart, except as follows:

{i} Overcurrent protection of electrolytic cell DC process power circuits need not comply with the requirements of 1910.304(e).

{ii} Equipment located or used within the cell line working zone or associated with the cell line DC power circuits need not comply with the provisions of 1910.304(f).

{iii} Electrolytic cells, cell line conductors, cell line attachments, and the wiring of auxiliary equipment and devices within the cell line working zone need not comply with the provisions of 1910.303, and 1910.304 (b) and (c).

(4) Disconnecting means. (i) If more than one DC cell line process power supply serves the same cell line, a disconnecting means shall be provided on the cell line circuit side of each power supply to disconnect it from the cell line circuit.

(ii) Removable links or removable conductors may be used as the disconnecting means.

(5) Portable electric equipment. (i) The frames and enclosures of portable electric equipment used within the cell line working zone may not be grounded. However, these frames and enclosures may be grounded if the cell line circuit voltage does not exceed 200 volts DC or if the frames are guarded.

(ii) Ungrounded portable electric equipment shall be distinctively marked and may not be interchangeable with grounded portable electric equipment.

(6) Power supply circuits and receptacles for portable electric equipment. (i) Circuits supplying power to ungrounded receptacles for hand-held, cord- and plug-connected equipment shall be electrically isolated from any distribution system supplying areas other than the cell line working zone and shall be ungrounded. Power for these circuits shall be supplied through isolating transformers.

(ii) Receptacles and their mating plugs for ungrounded equipment may not have provision for a grounding conductor and shall be of a configuration which prevents their use for equipment required to be grounded.

(iii) Receptacles on circuits supplied by an isolating transformer with an ungrounded secondary shall have a distinctive configuration, shall be distinctively marked, and may not be used in any other location in the plant.

(7) Fixed and portable electric equipment. (i) AC systems supplying fixed and portable electric equipment within the cell line working zone need not be grounded.

(ii) Exposed conductive surfaces, such as electric equipment housings, cabinets, boxes, motors, raceways and the like that are within the cell line working zone need not be grounded.

(iii) Auxiliary electrical devices, such as motors, transducers, sensors, control devices, and alarms, mounted on an electrolytic cell or other energized surface, shall be connected by any of the following means:

(A) Multiconductor hard usage or extra hard usage flexible cord;

(B) Wire or cable in suitable raceways; or

(C) Exposed metal conduit, cable tray, armored cable, or similar metallic systems installed with insulating breaks such that they will not cause a potentially hazardous electrical condition.

(iv) Fixed electric equipment may be bonded to the energized conductive surfaces of the cell line, its attachments, or auxiliaries. If fixed electric equipment is mounted on an energized conductive surface, it shall be bonded to that surface.

(8) Auxiliary nonelectric connections. Auxiliary nonelectric connections, such as air hoses, water hoses, and the like, to an electrolytic cell, its attachments, or auxiliary equipment may not have continuous conductive reinforcing wire, armor, braids, and the like. Hoses shall be of a nonconductive material.

(9) Cranes and hoists. (i) The conductive surfaces of cranes and hoists that enter the cell line working zone need not be grounded. The portion of an overhead crane or hoist which contacts an energized electrolytic cell or energized attachments shall be insulated from ground.

(ii) Remote crane or hoist controls which may introduce hazardous electrical conditions into the cell line working zone shall employ one or more of the following systems:

(A) Insulated and ungrounded control circuit;

(B) Nonconductive rope operator;

(C) Pendant pushbutton with nonconductive supporting means and having nonconductive surfaces or ungrounded exposed conductive surfaces; or

(D) Radio.

(i) Electrically driven or controlled irrigation machines. (See 1910.302(b)(3).)

(1) Lightning protection. If an electrically driven or controlled irrigation machine has a stationary point, a driven ground rod shall be connected to the machine at the stationary point for lightning protection.

(2) Disconnecting means. The main disconnecting means for a center pivot irrigation machine shall be located at the point of connection of electrical power to the machine and shall be readily accessible and capable of being locked in the open position. A disconnecting means shall be provided for each motor and controller.

(j) Swimming pools, fountains, and similar installations - (1) Scope. Paragraphs (j)(2) through (j)(5) of this section apply to electric wiring for and equipment in or adjacent to all swimming, wading, therapeutic, and decorative pools and fountains, whether permanently installed or storable, and to metallic auxiliary equipment, such as pumps, filters, and similar equipment. Therapeutic pools in health care facilities are exempt from these provisions.

(2) Lighting and receptacles - (i) Receptacles. A single receptacle of the locking and grounding type that provides power for a permanently installed swimming pool recirculating pump motor may be located not less than 5 feet from the inside walls of a pool. All other receptacles on the property shall be located at least 10 feet from the inside walls of a pool. Receptacles which are located within 15 feet of the inside walls of the pool shall be protected by ground-fault circuit interrupters.

Note: In determining these dimensions, the distance to be measured is the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, or ceiling of a building or other effective permanent barrier.

(ii) Lighting fixtures and lighting outlets. (A) Unless they are 12 feet above the maximum water level, lighting fixtures and lighting outlets may not be installed over a pool or over the area extending 5 feet horizontally from the inside walls of a pool. However, a lighting fixture or lighting outlet which has been installed before April 16, 1981, may be located less than 5 feet measured horizontally from the inside walls of a pool if it is at least 5 feet above the surface of the maximum water level and shall be rigidly attached to the existing structure. It shall also be protected by a ground-fault circuit interrupter installed in the branch circuit supplying the fixture.

(B) Unless installed 5 feet above the maximum water level and rigidly attached to the structure adjacent to or enclosing the pool, lighting fixtures and lighting outlets installed in the area extending between 5 feet and 10 feet horizontally from the inside walls of a pool shall be protected by a ground-fault circuit interrupter.

(3) Cord- and plug-connected equipment. Flexible cords used with the following equipment may not exceed 3 feet in length and shall have a copper equipment grounding conductor with a grounding-type attachment plug.

(i) Cord- and plug-connected lighting fixtures installed within 16 feet of the water surface of permanently installed pools.

(ii) Other cord- and plug-connected, fixed or stationary equipment used with permanently installed pools.

(4) Underwater equipment. (i) A ground-fault circuit interrupter shall be installed in the branch circuit supplying underwater fixtures operating at more than 15 volts. Equipment installed underwater shall be approved for the purpose.

(ii) No underwater lighting fixtures may be installed for operation at over 150 volts between conductors.

(5) Fountains. All electric equipment operating at more than 15 volts, including power supply cords, used with fountains shall be protected by ground-fault circuit interrupters. (See 1910.302(b)(3)

29 CFR 1910

Subpart S

Electrical

Safety-Related Work Practices

Table of Contents

29 CFR 1910

Subpart S

Electrical

1910.331 Safety-Related Work Practices

1910.331 Scope

(a) Covered work by both qualified and unqualified persons. The provisions of 1910.331 through 1910.335 cover electrical safety work practices for both qualified persons (those who have training in avoiding the electrical hazards of working on or near exposed energized parts) and unqualified persons (those with little or no such training) working on, near, or with the following installations:

(1) Premises wiring. Installations of electric conductors and equipment within or on buildings or other structures, and on other premises such as yards, carnival, parking, and other lots, and industrial substations;

(2) Wiring for connection to supply. Installations of conductors that connect to the supply of electricity; and

(3) Other wiring. Installations of other outside conductors on the premises.

(4) Optical fiber cable. Installations of optical fiber cable where such installations are made along with electric conductors.

Note: See 1910.399 for the definition of "qualified person."

See 1910.332 for training requirements that apply to qualified and unqualified persons.

(b) Other covered work by unqualified persons. The provisions of 1910.331 through 1910.335 also cover work performed by unqualified persons on, near, or with the installations listed in paragraphs (c)(1) through (c)(4) of this section.

(c) Excluded work by qualified persons. The provisions of 1910.331 through 1910.335 do not apply to work performed by qualified persons on or directly associated with the following installations:

(1) Generation, transmission, and distribution of electric energy (including communication and metering) located in buildings used for such purposes or located outdoors.

Note 1: Work on or directly associated with installations of utilization equipment used for purposes other than generating, transmitting, or distributing electric energy (such as installations which are in office buildings, warehouses, garages, machine shops, or recreational buildings, or other utilization installations which are not an integral part of a generating installation, substation, or control center) is covered under paragraph (a)(1) of this section.

Note 2: For work on or directly associated with utilization installations, an employer who complies with the work practices of 1910.269 (electric power generation, transmission, and distribution) will be deemed to be in compliance with 1910.333(c) and 1910.335. However, the requirements of 1910.332, 1910.333(a), 1910.333(b), and 1910.334 apply to all work on or directly associated with utilization installations, regardless of whether the work is performed by qualified or unqualified persons.

Note 3: Work on or directly associated with generation, transmission, or distribution installations includes: 1) Work performed directly on such installations, such as repairing overhead or underground distribution lines or repairing a feed-water pump for the boiler in a generating plant. 2) Work directly associated with such installations, such as line-clearance tree trimming and replacing utility poles. 3) Work on electric utilization circuits in a generating plant provided that A) Such circuits are commingled with installations of power generation equipment or circuits, and B) The generation equipment or circuits present greater electrical hazards than those posed by the utilization equipment or circuits (such as exposure to higher voltages or lack of overcurrent protection).

1910.331(c)(2)

(2) Communications installations. Installations of communication equipment to the extent that the work is covered under 1910.268.

(3) Installations in vehicles. Installations in ships, watercraft, railway rolling stock, aircraft or automotive vehicles other than mobile homes and recreational vehicles.

(4) Railway installations. Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock or installations of railways used exclusively for signaling and communication purposes.

[55 FR 32016, Aug. 6, 1990]

29 CFR 1910

Subpart S

Electrical

1910.332 Safety-Related Work Practices

1910.332 Training

(a) Scope. The training requirements contained in this section apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308.

Note: Employees in occupations listed in Table S-4 face such a risk and are required to be trained. Other employees who also may reasonably be expected to face comparable risk of injury due to electric shock or other electrical hazards must also be trained.

(b) Content of training.

(1) Practices addressed in this standard. Employees shall be trained in and familiar with the safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments.

(2) Additional requirements for unqualified persons. Employees who are covered by paragraph (a) of this section but who are not qualified persons shall also be trained in and familiar with any electrically related safety practices not specifically addressed by 1910.331 through 1910.335 but which are necessary for their safety.

(3) Additional requirements for qualified persons. Qualified persons (i.e. those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:

(i) The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.

(ii) The skills and techniques necessary to determine the nominal voltage of exposed live parts, and

(iii) The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.

Note 1: For the purposes of 1910.331 through 1910.335, a person must have the training required by paragraph (b)(3) of this section in order to be considered a qualified person.
Note 2: Qualified persons whose work on energized equipment involves either direct contact or contact by means of tools or materials must also have the training needed to meet

(c) Type of training. The training required by this section shall be of the classroom or on-the-job type. The degree of training provided shall be determined by the risk to the employee.

Occupation
Blue collar supervisors.(1)
Electrical and electronic engineers.(1)
Electrical and electronic equipment assemblers.(1)
Electrical and electronic technicians.(1)
Electricians Industrial machine operators.(1)
Material handling equipment operators.(1)
Mechanics and repairers.(1)
Painters.(1)
Riggers and roustabouts.(1)
Stationary engineers.(1)
Welders.

Footnote(1) Workers in these groups do not need to be trained if their work or the work of those they supervise does not bring them or the employees the supervise close enough to exposed parts of electric circuits operating at 50 volts or more to ground for a hazard to exist.
[55 FR 32016, Aug. 6, 1990]

29 CFR 1910

Subpart S

Electrical

1910.333 Safety-Related Work Practices

1910.333 Selection and use of work practices

(a) General. Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.

(1) De-energized parts. Live parts to which an employee any be exposed shall be de-energized before the employee works on or near them, unless the employer can demonstrate that de-energizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Live parts tat operate at less than 50 volts to ground need not be de-energized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

Note 1: Examples of increased or additional hazards include interruption of life support equipment, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment, or removal of illumination for an area.
Note 2: Examples of work that may be performed on or near energized circuit parts because of infeasibility due to equipment design or operational limitations include testing of electric circuits that can only be performed with the circuit energized work on circuits that form an integral part of a continuous industrial process in a chemical plant that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.
Note 3: Work on or near de-energized parts is covered by paragraph (b) of this section.

(2) Energized parts. If the exposed live parts are not de-energized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved. Such work practices shall protect employees against contact with energized

circuit parts directly with any part of their body or indirectly through some other conductive object. The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electric conductors or circuit parts. Specific work practice requirements are detailed in paragraph (c) of this section.

(b) Working on or near exposed de-energized parts.

(1) Application. This paragraph applies to work on exposed de-energized parts or near enough to them to expose the employee to any electrical hazard they present. Conductors and parts of electric equipment that have been de-energized but have not been locked out or tagged in accordance with paragraph (b) of this section shall be treated as energized parts, and paragraph (c) of this section applies to work on or near them.

(2) Lockout and Tagging. While any employee is exposed to contact with parts of fixed electric equipment or circuits which have been de-energized, the circuits energizing the parts shall be locked out or tagged or both in accordance with the requirements of this paragraph. The requirements shall be followed in the order in which they are presented (i.e., paragraph (b)(2)(i) first, then paragraph (b)(2)(ii), etc.).
Note 1: As used in this section, fixed equipment refers to equipment fastened in place or connected by permanent wiring methods.

Note 2: Lockout and tagging procedures that comply with paragraphs (c) through (f) of 1910.147 will also be deemed to comply with paragraph (b)(2) of this section provided that:

[1] The procedures address the electrical safety hazards covered by this Subpart; and

[2] The procedures also incorporate the requirements of paragraphs (b)(2)(iii)(D) and (b)(2)(iv)(B) of this section.

(b)(2)(i)
"Procedures." The employer shall maintain a written copy of the procedures outlined in paragraph (b)(2) and shall make it available for inspection by employees and by the Assistant Secretary of Labor and his or her authorized representatives.

Note: The written procedures may be in the form of a copy of paragraph (b) of this section.

(b)(2)(ii)
"Deenergizing equipment."

(b)(2)(ii)(A)
Safe procedures for deenergizing circuits and equipment shall be determined before circuits or equipment are deenergized.

(b)(2)(ii)(B)
The circuits and equipment to be worked on shall be disconnected from all electric energy sources. Control circuit devices, such as push buttons, selector switches, and interlocks, may not be used as the sole means for deenergizing circuits or equipment. Interlocks for electric equipment may not be used as a substitute for lockout and tagging procedures.

(b)(2)(ii)(C)
Stored electric energy which might endanger personnel shall be released. Capacitors shall be discharged and high capacitance elements shall be short-circuited and grounded, if the stored electric energy might endanger personnel.

Note: If the capacitors or associated equipment are handled in meeting this requirement, they shall be treated as energized.

(b)(2)(ii)(D)
Stored non-electrical energy in devices that could reenergize electric circuit parts shall be blocked or relieved to the extent that the circuit parts could not be accidentally energized by the device.

(b)(2)(iii)
"Application of locks and tags."

(b)(2)(iii)(A)
A lock and a tag shall be placed on each disconnecting means used to deenergize circuits and equipment on which work is to be performed, except as provided in paragraphs (b)(2)(iii)(C) and (b)(2)(iii)(E) of this section. The lock shall be attached so as to prevent persons from operating the disconnecting means unless they resort to undue force or the use of tools.

(b)(2)(iii)(B)
Each tag shall contain a statement prohibiting unauthorized operation of the disconnecting means and removal of the tag.

(b)(2)(iii)(C)
If a lock cannot be applied, or if the employer can demonstrate that tagging procedures will provide a level of safety equivalent to that obtained by the use of a lock, a tag may be used without a lock.

(b)(2)(iii)(D)
A tag used without a lock, as permitted by paragraph (b)(2)(iii)(C) of this section, shall be supplemented by at least one additional safety measure that provides a level of safety equivalent to that obtained by use of a lock. Examples of additional safety measures include the removal of an isolating circuit element, blocking of a controlling switch, or opening of an extra disconnecting device.

(b)(2)(iii)(E)
A lock may be placed without a tag only under the following conditions:

(b)(2)(iii)(E)(1)
Only one circuit or piece of equipment is deenergized, and

(b)(2)(iii)(E)(2)
The lockout period does not extend beyond the work shift, and

(b)(2)(iii)(E)(3)
Employees exposed to the hazards associated with reenergizing the circuit or equipment are familiar with this procedure.

(b)(2)(iv)
Verification of deenergized condition. The requirements of this paragraph shall be met before any circuits or equipment can be considered and worked as deenergized.

(b)(2)(iv)(A)
A qualified person shall operate the equipment operating controls or otherwise verify that the equipment cannot be restarted.

(b)(2)(iv)(B)
A qualified person shall use test equipment to test the circuit elements and electrical parts of equipment to which employees will be exposed and shall verify that the circuit elements and equipment parts are deenergized. The test shall also determine if any energized condition
exists as a result of inadvertently induced voltage or unrelated voltage backfeed even though specific parts of the circuit have been deenergized and presumed to be safe. If the circuit to be tested is over 600 volts, nominal, the test equipment shall be checked for proper operation
immediately after this test.

(v) Reenergizing equipment. These requirements shall be met, in the order given, before circuits or equipment are re-energized, even temporarily.

(A) A qualified person shall conduct tests and visual inspections, as necessary, to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed, so that the circuits and equipment can be safely energized.

(B) Employees exposed to the hazards associated with Re-energizing the circuit or equipment shall be warned to stay clear of circuits and equipment.

(C) Each lock and tag shall be removed by the employee who applied it or under his or her direct supervision. However, if this employee is absent from the workplace,

then the lock or tag may be removed by a qualified person designated to perform this task provided that:

(1) The employer ensures that the employee who applied the lock or tag is not available at the workplace, and

(2) The employer ensures that the employee is aware that the lock or tag has been removed before he or she resumes work at that workplace.

(D) There shall be a visual determination that all employees are clear of the circuits and equipment.

(c) Working on or near exposed energized parts.
(1) Application. This paragraph applies to work performed on exposed live parts (involving either direct contact or by means of tools or materials) or near enough to them for employees to be exposed to any hazard they present.

(2) Work on energized equipment. Only qualified persons may work on electric circuit parts or equipment that have not been de-energized under the procedures of paragraph (b) of this section. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.

(3) Overhead lines. if work is to be performed near overhead lines, the lines shall be de-energized and grounded, or other protective measures shall be provided before work is started. If the lines are to be de-energized, arrangements shall be made with the person or organization that operates or controls the electric circuits involved to de-energize and ground them. If protective measures, such as guarding, isolating, or insulating, are provided, these precautions shall prevent employees from contacting such lines directly with any part of their body or indirectly through conductive materials, tools, or equipment.

Note: The work practices used by qualified persons installing insulating devices on overhead power transmission or distribution lines are covered by 1910.269 of this Part, not by 1910.332 through 1910.335 of this Part. Under paragraph (c)(2) of this section, unqualified persons are prohibited from performing this type of work.
1910.333(c)(3)(i)
(i) Unqualified persons.

(A) When an unqualified person is working in an elevated position near overhead lines, the location shall be such that the person and the longest conductive object he

or she may contact cannot come closer to any unguarded, energized overhead line than the following distances:

(1) For voltages to ground 50kV or below - 10 feet (305 cm);

(2) For voltages to ground over 50kV - 10 feet (305 cm) plus 4 inches (10 cm) for every 10kV over 50kV.

(B) When an unqualified person is working on the ground in the vicinity of overhead lines, the person may not bring any conductive object closer to unguarded, energized overhead lines than the distances given in paragraph (c)(3)(i)(A) of this section.
Note: For voltages normally encountered with overhead power line, objects which do not have an insulating rating for the voltage involved are considered to be conductive.

1910.333(c)(3)(ii)
(ii) Qualified persons. When a qualified person is working in the vicinity of overhead lines, whether in an elevated position or on the ground, the person may not approach or take any conductive object without an approved insulating handle closer to exposed energized parts than shown in Table S-5 unless:

(A) the person is insulated from the energized part (gloves, with sleeves if necessary, rated for the voltage involved are considered to be insulation of the person from the energized part on which work is performed), or

1910.333(c)(3)(ii)(B)
(B) The energized part is insulated from all conductive objects at a different potential and from the person, or

(C) The person is insulated from all conductive objects at a potential different from that of the energized part.

TABLE S-5 - APPROACH DISTANCES FOR QUALIFIED EMPLOYEES - ALTERNATING CURRENT

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

1910.333(c)(3)(iii)
(iii) Vehicular and mechanical equipment.
(A) Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 ft. (305 cm) is maintained. If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10kV over that voltage. However, under any of the following conditions, the clearance may be reduced:

(1) If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. (122 cm). If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10 kV over that voltage.

(2) If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.

(3) If the equipment is an aerial lift insulated for the voltage involved, and if the work is performed by a qualified person, the clearance (between the uninsulated portion of the aerial lift and the power line) may be reduced to the distance given in Table S-5.

(B) Employees standing on the ground may not contact the vehicle or mechanical equipment or any of the structure that provides a conductive path to employees on the ground) can come closer to the line than permitted in paragraph (c)(3)(iii) of this section.

(C) If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

(4) Illumination.
1910.333(c)(4)(i)
(i) Employees may not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely.

(ii) Where lack of illumination or an obstruction precludes observation of the work to be performed, employees may not perform tasks near exposed energized parts. Employees may not reach blindly into areas which may contain energized parts.

(5) Confined or enclosed work spaces. When an employee works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized parts, the employer shall provide, and the employee shall use, protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.

(6) 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. If an employee must handle long dimensional conductive objects (such as ducts and pipes) in areas with exposed live parts, the employer shall institute work practices (such as the use of insulation, guarding, and material handling techniques) which will minimize the hazard.

(7) Portable ladders. Portable ladders shall have nonconductive siderails if they are used where the employee or the ladder could contact exposed energized parts.

(8) Conductive apparel. Conductive articles of jewelry and clothing (such a watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear) may not be worn if they might contact exposed energized parts. However, such articles may be worn if they are rendered nonconductive by covering, wrapping, or other insulating means.

(9) Housekeeping duties. Where live parts present an electrical contact hazard, employees may not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.

(10) Interlocks. Only a qualified person following the requirements of paragraph (c) of this section may defeat an electrical safety interlock, and then only temporarily while he or she is working on the equipment. The interlock system shall be returned to its operable condition when this work is completed.
[55 FR 32016, Aug. 6, 1990; Nov. 1, 1990]

29 CFR 1910

Subpart S

Electrical

1910.334 Safety-Related Work Practices

1910.334 Use of equipment.
(a) Portable electric equipment. This paragraph applies to the use of cord and plug connected equipment, including flexible cord sets (extension cords).

(1) Handling. Portable equipment shall be handled in a manner which will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment. Flexible cords may not be fastened with staples or otherwise hung in such a fashion as could damage the outer jacket or insulation.

(2) Visual inspection.
(i) Portable cord and plug connected equipment and flexible cord sets (extension cords) shall be visually inspected before use on any shift for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket). Cord and plug connected equipment and flexible cord sets (extension cords) which remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated.

(ii) If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.
(iii) When an attachment plug is to be connected to a receptacle (including an on a cord set), the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of proper mating configurations.

(3) Grounding type equipment.
(i) A flexible cord used with grounding type equipment shall contain an equipment grounding conductor.

(ii) Attachment plugs and receptacles may not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. Additionally, these devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current-carrying conductors.

(iii) Adapters which interrupt the continuity of the equipment grounding connection may not be used.

(4) Conductive work locations. Portable electric equipment and flexible cords used in highly conductive work locations (such a those inundated with water or other conductive liquids), or in job locations where employees are likely to contact water or conductive liquids, shall be approved for those locations.

(5) Connecting attachment plugs.
(i) Employees' hands may not be wet when plugging and unplugging flexible cords and cord and plug connected equipment, if energized equipment is involved.

(ii) Energized plug and receptacle connections may be handled only with insulating protective equipment if the condition of the connection could provide a conducting path to the employee's hand (if, for example, a cord connector is wet from being immersed in water).

(iii) Locking type connectors shall be properly secured after connection.

(b) Electric power and lighting circuits.
(1) Routine opening and closing of circuits. Load rated switches, circuit breakers, or other devices specifically designed as disconnecting means shall be used for the opening, reversing, or closing of circuits under load conditions. Cable connectors not of the load break type, fuses, terminal lugs, and cable splice connections may not be used for such purposes, except in an emergency.

(2) Reclosing circuits after protective device operation. After a circuit is de-energized by a circuit protective device, the circuit protective device, the circuit may not be manually re-energized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or Re-energizing circuits through replaced fuses is prohibited.

Note: When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is re-energized.

(3) Overcurrent protection modification. Overcurrent protection of circuits and conductors may not be modified, even on a temporary basis, beyond that allowed by 1910.304(e), the installation safety requirements for overcurrent protection.

(c) Test instruments and equipment.

(1) Use. Only qualified persons may perform testing work on electric circuits or equipment.

(2) Visual inspection. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

(3) Rating of equipment. Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.

(d) Occasional use of flammable or ignitable materials. Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be used, unless measures are taken to prevent hazardous conditions from developing. Such materials include, but are not limited to: flammable gases, vapors, or liquids; combustible dust; and ignitable fibers or flyings.

Note: Electrical installation requirements for locations where flammable materials are present on a regular basis are contained in 1910.307.
[55 FR 32016, Aug. 6, 1990; 55 FR 46054, Nov. 1, 1990]

29 CFR 1910

Subpart S

Electrical

1910.335 Safety-Related Work Practices

1910.335 Safeguards for personnel protection.
(a) Use of protective equipment.
(1) Personal protective equipment.
(i) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

Note: Personal protective equipment requirements are contained in subpart I of this part.

(ii) Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested, as required by 1910.137.

(iii) If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected. (For example, an outer covering of leather is sometimes used for the protection of rubber insulating material.)

(iv) Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts.

(v) Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.

(2) General protective equipment and tools.
(i) When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment

might make contact with such conductors or parts. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.

(A) Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install fuses when the fuse terminals are energized.

(B) Ropes and handlines used near exposed energized parts shall be nonconductive.
(ii) Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur. When normally enclosed live parts are exposed for maintenance or repair, they shall be guarded to protect unqualified persons from contact with the live parts.

(b) Alerting techniques. The following alerting techniques. The following alerting techniques shall be used to warn and protect employees from hazards which could cause injury due to electric shock, burns, or failure of electric equipment parts:

(1) Safety signs and tags. Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards which may endanger them, as required by 1910.145.

(2) Barricades. Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas exposing employees to uninsulated energized conductors or circuit parts. Conductive barricades may not be used where they might cause an electrical contact hazard.

(3) Attendants. If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees.

[55 FR 32016, Aug. 6, 1990]

Definitions applicable to this subpart. - 1910.399

- **Part Number:** 1910
- **Part Title:** Occupational Safety and Health Standards
- **Subpart:** S
- **Subpart Title:** Electrical
- **Standard Number:** 1910.399
- **Title:** Definitions applicable to this subpart.

1910.399(a)

Definitions applicable to 1910.302 through 1910.330 -

Acceptable. An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this Subpart S:

(i) If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a nationally recognized testing laboratory; or

(ii) With respect to an installation or equipment of a kind which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, if it is inspected or tested by another Federal agency, or by a State, municipal, or other local authority responsible for enforcing occupational safety provisions of the National Electrical Code, and found in compliance with the provisions of the National Electrical Code as applied in this subpart; or

(iii) With respect to custom-made equipment or related installations which are designed, fabricated for, and intended for use by a particular customer, if it is determined to be safe for its intended use by its manufacturer on the basis of test data which the employer keeps and makes available for inspection to the Assistant Secretary and his authorized representatives. Refer to 1910.7 for definition of nationally recognized testing laboratory.

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

Accessible. (As applied to wiring methods.) Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building. (See "**concealed**" and "**exposed**.")

Accessible. (As applied to equipment.) Admitting close approach; not guarded by locked doors, elevation, or other effective means. (See "**Readily accessible**.")

Ampacity. Current-carrying capacity of electric conductors expressed in amperes.

Appliances. Utilization equipment, generally other than industrial, normally built in standardized sizes or types, which is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, deep frying, etc.

Approved. Acceptable to the authority enforcing this subpart. The authority enforcing this subpart is the Assistant Secretary of Labor for Occupational Safety and Health. The definition of "acceptable" indicates what is acceptable to the Assistant Secretary of Labor, and therefore approved within the meaning of this Subpart.

Approved for the purpose. Approved for a specific purpose, environment, or application described in a particular standard requirement.

Suitability of equipment or materials for a specific purpose, environment or application may be determined by a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation as part of its listing and labeling program. (See **"Labeled"** or **"Listed."**)

Armored cable. Type AC armored cable is a fabricated assembly of insulated conductors in a flexible metallic enclosure.

Askarel. A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. Askarels of various compositional types are used. Under arcing conditions the gases produced, while consisting predominantly of noncombustible hydrogen chloride, can include varying amounts of combustible gases depending upon the askarel type.

Attachment plug (Plug cap)(Cap). A device which, by insertion in a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

Automatic. Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature, or mechanical configuration.

Bare conductor. See **Conductor.**

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

Bonding jumper. A reliable conductor to assure the required electrical conductivity between metal parts required to be electrically connected.

Branch circuit. The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

Building. A structure which stands alone or which is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors.

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

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

Cablebus. Cablebus is an approved assembly of insulated conductors with fittings and conductor terminations in a completely enclosed, ventilated, protective metal housing.

Center pivot irrigation machine. A center pivot irrigation machine is a multi-motored irrigation machine which revolves around a central pivot and employs alignment switches or similar devices to control individual motors.

Certified. Equipment is "certified" if it (a) has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner, or (b) is of a kind whose production is periodically inspected by a nationally recognized testing laboratory, and (c) it bears a label, tag, or other record of certification.

Circuit breaker. (i) (600 volts nominal, or less). A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without injury to itself when properly applied within its rating.

(ii) (Over 600 volts, nominal). A switching device capable of making, carrying, and breaking currents under normal circuit conditions, and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions, such as those of short circuit.

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

(i) **Class I, Division 1.** A Class I, Division 1 location is a location: (a) in which hazardous concentrations of flammable gases or vapors may exist under normal operating conditions; or (b) in which hazardous concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (c) in which breakdown or faulty operation of equipment or processes might release hazardous concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

Note: This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another; interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used; locations containing open tanks or vats of volatile flammable liquids; drying rooms or compartments for the evaporation of flammable solvents; locations containing fat and oil extraction equipment using volatile flammable solvents; portions of cleaning and dyeing plants where flammable liquids are used; gas

generator rooms and other portions of gas manufacturing plants where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; the interiors of refrigerators and freezers in which volatile flammable materials are stored in open, lightly stoppered, or easily ruptured containers; and all other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(ii) **Class I, Division 2.** A Class I, Division 2 location is a location: (a) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or (b) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or (c) that is adjacent to a Class I, Division 1 location, and to which hazardous concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Note: This classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used, but which would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location.

Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Locations used for the storage of flammable liquids or a liquefied or compressed gases in sealed containers would not normally be considered hazardous unless also subject to other hazardous conditions.

Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier are classed as a Division 2 location if the outside of the conduit and enclosures is a nonhazardous location.

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

(i) **Class II, Division 1.** A Class II, Division 1 location is a location: (a) In which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures; or (b) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes, or (c) in which combustible dusts of an electrically conductive nature may be present.

Note: This classification may include areas of grain handling and processing plants, starch plants, sugar-pulverizing plants, malting plants, hay-grinding plants, coal pulverizing plants, areas where metal dusts and powders are produced or processed, and other similar locations which contain dust producing machinery and equipment (except where the equipment is dust-tight or vented to the outside). These areas would have combustible dust in the air, under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures. Combustible dusts which are electrically nonconductive include dusts produced in the handling and processing of grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and woodflour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Dusts containing magnesium or aluminum are particularly hazardous and the use of extreme caution is necessary to avoid ignition and explosion.

(ii) **Class II, Division 2.** A Class II, Division 2 location is a location in which: (a) combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus; or (b) dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment, and dust accumulations resulting therefrom may be ignitable by abnormal operation or failure of electrical equipment or other apparatus.

Note: This classification includes locations where dangerous concentrations of suspended dust would not be likely but where dust accumulations might form on or in the vicinity of electric equipment. These areas may contain equipment from which appreciable quantities of dust would escape under abnormal operating conditions or be adjacent to a Class II Division 1 location, as described above, into which an explosive or ignitable concentration of dust may be put into suspension under abnormal operating conditions.

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

(i) **Class III, Division 1.** A Class III, Division 1 location is a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

Note: Such locations usually include some parts of rayon, cotton, and other textile mills; combustible fiber manufacturing and processing plants; cotton gins and cotton-seed mills; flax-processing plants; clothing manufacturing plants; woodworking plants, and establishments; and industries involving similar hazardous processes or conditions.

Easily ignitable fibers and flyings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, and other materials of similar nature.

(ii) **Class III, Division 2.** A Class III, Division 2 location is a location in which easily ignitable fibers are stored or handled, except in process of manufacture.

Collector ring. A collector ring is an assembly of slip rings for transferring electrical energy from a stationary to a rotating member.

Concealed. Rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them. [See **Accessible. (As applied to wiring methods.)**]

Conductor. (i) Bare. A conductor having no covering or electrical insulation whatsoever.

(ii) **Covered.** A conductor encased within material of composition or thickness that is not recognized as electrical insulation.

(iii) **Insulated.** A conductor encased within material of composition and thickness that is recognized as electrical insulation.

Conduit body. A separate portion of a conduit or tubing system that provides access through a removable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.

Controller. A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

Cooking unit, counter-mounted. A cooking appliance designed for mounting in or on a counter and consisting of one or more heating elements, internal wiring, and built-in or separately mountable controls. (See **Oven, wall-mounted.**)

Covered conductor. See **Conductor**.

Cutout. (Over 600 volts, nominal.) An assembly of a fuse support with either a fuseholder, fuse carrier, or disconnecting blade. The fuseholder or fuse carrier may include a conducting element (fuse link), or may act as the disconnecting blade by the inclusion of a nonfusible member.

Cutout box. An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box proper. (See **Cabinet.**)

Damp location. See **Location.**

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

Device. A unit of an electrical system which is intended to carry but not utilize electric energy.

Dielectric heating. Dielectric heating is the heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field.

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

Disconnecting (or Isolating) switch. (Over 600 volts, nominal.) A mechanical switching device used for isolating a circuit or equipment from a source of power.

Dry location. See **Location.**

Electric sign. A fixed, stationary, or portable self-contained, electrically illuminated utilization equipment with words or symbols designed to convey information or attract attention.

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

Enclosure. The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts, or to protect the equipment from physical damage.

Equipment. A general term including material, fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electrical installation.

Equipment grounding conductor. See **Grounding conductor, equipment.**

Explosion-proof apparatus. Apparatus enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor which may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and which operates at such an external temperature that it will not ignite a surrounding flammable atmosphere.

Exposed. (As applied to live parts.) Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated, or insulated. (See **Accessible.** and **Concealed.**)

Exposed. (As applied to wiring methods.) On or attached to the surface or behind panels designed to allow access. [See **Accessible. (As applied to wiring methods.)**]

Exposed. (For the purposes of 1910.308(e), Communications systems.) Where the circuit is in such a position that in case of failure of supports or insulation, contact with another circuit may result.

Externally operable. Capable of being operated without exposing the operator to contact with live parts.

Feeder. All circuit conductors between the service equipment, or the generator switchboard of an isolated plant, and the final branch-circuit overcurrent device.

Fitting. An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.

Fuse. (Over 600 volts, nominal.) An overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it. A fuse comprises all the parts that

form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit.

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

Grounded. Connected to earth or to some conducting body that serves in place of the earth.

Grounded, effectively. (Over 600 volts, nominal.) Permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient ampacity that ground fault current which may occur cannot build up to voltages dangerous to personnel.

Grounded conductor. A system or circuit conductor that is intentionally grounded.

Grounding conductor. A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

Grounding conductor, equipment. The conductor used to connect the non-current-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor and/or the grounding electrode conductor at the service equipment or at the source of a separately derived system.

Grounding electrode conductor. The conductor used to connect the grounding electrode to the equipment grounding conductor and/or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system.

Ground-fault circuit-interrupter. A device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

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

Health care facilities. Buildings or portions of buildings and mobile homes that contain, but are not limited to, hospitals, nursing homes, extended care facilities, clinics, and medical and dental offices, whether fixed or mobile.

Heating equipment. For the purposes of 1910.306(g), the term "heating equipment" includes any equipment used for heating purposes if heat is generated by induction or dielectric methods.

Hoistway. Any shaftway, hatchway, well hole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate.

Identified. Identified, as used in reference to a conductor or its terminal, means that such conductor or terminal can be readily recognized as grounded.

Induction heating. Induction heating is the heating of a nominally conductive material due to its own I 2 R losses when the material is placed in a varying electromagnetic field.

Insulated conductor. See **Conductor.**

Interrupter switch. (Over 600 volts, nominal.) A switch capable of making, carrying, and interrupting specified currents.

Irrigation machine. An irrigation machine is an electrically driven or controlled machine, with one or more motors, not hand portable, and used primarily to transport and distribute water for agricultural purposes.

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

Isolated power system. A system comprising an isolating transformer or it equivalent, a line isolation monitor, and its ungrounded circuit conductors.

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

Lighting outlet. An outlet intended for the direct connection of a lampholder, a lighting fixture, or a pendant cord terminating in a lampholder.

Line-clearance tree trimming. The pruning, trimming, repairing, maintaining, removing, or clearing of trees or cutting of brush that is within 10 feet (305 cm) of electric supply lines and equipment.

Listed. Equipment is "listed" if it is of a kind mentioned in a list which, (a) is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment, and (b) states such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.

Location - (i) **Damp location.** Partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold-storage warehouses.

(ii) **Dry location.** A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.

(ii) **Wet location.** Installations underground or in concrete slabs or masonry in direct contact with the earth, and locations subject to saturation with water or other liquids, such as vehicle-washing areas, and locations exposed to weather and unprotected.

May. If a discretionary right, privilege, or power is abridged or if an obligation to abstain from acting is imposed, the word "may" is used with a restrictive "no," "not," or "only." (E.g., no employer may ...; an employer may not ...; only qualified persons may ...)

Medium voltage cable. Type MV medium voltage cable is a single or multiconductor solid dielectric insulated cable rated 2000 volts or higher.

Metal-clad cable. Type MC cable is a factory assembly of one or more conductors, each individually insulated and enclosed in a metallic sheath of interlocking tape, or a smooth or corrugated tube.

Mineral-insulated metal-sheathed cable. Type MI mineral-insulated metal-sheathed cable is a factory assembly of one or more conductors insulated with a highly compressed refractory mineral insulation and enclosed in a liquidtight and gastight continuous copper sheath.

Mobile X-ray. X-ray equipment mounted on a permanent base with wheels and/or casters for moving while completely assembled.

Nonmetallic-sheathed cable. Nonmetallic-sheathed cable is a factory assembly of two or more insulated conductors having an outer sheath of moisture resistant, flame-retardant, nonmetallic material. Nonmetallic sheathed cable is manufactured in the following types:

(i) **Type NM.** The overall covering has a flame-retardant and moisture-resistant finish.

(ii) **Type NMC.** The overall covering is flame-retardant, moisture-resistant, fungus-resistant, and corrosion-resistant.

Oil (filled) cutout. (Over 600 volts, nominal.) A cutout in which all or part of the fuse support and its fuse link or disconnecting blade are mounted in oil with complete immersion of the contacts and the fusible portion of the conducting element (fuse link), so that arc interruption by severing of the fuse link or by opening of the contacts will occur under oil.

Open wiring on insulators. Open wiring on insulators is an exposed wiring method using cleats, knobs, tubes, and flexible tubing for the protection and support of single insulated conductors run in or on buildings, and not concealed by the building structure.

Outlet. A point on the wiring system at which current is taken to supply utilization equipment.

Outline lighting. An arrangement of incandescent lamps or electric discharge tubing to outline or call attention to certain features such as the shape of a building or the decoration of a window.

Oven, wall-mounted. An oven for cooking purposes designed for mounting in or on a wall or other surface and consisting of one of more heating elements, internal wiring, and built-in or separately mountable controls. (See **Cooking unit, counter-mounted.**)

Overcurrent. Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload (see definition), short circuit, or ground fault. A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Hence the rules for overcurrent protection are specific for particular situations.

Overload. Operation of equipment in excess of normal, full load rating, or of a conductor in excess of rated ampacity which, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. (See **Overcurrent.**)

Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent devices, and with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front. (See **Switchboard.**)

Permanently installed decorative fountains and reflection pools. Those that are constructed in the ground, on the ground or in a building in such a manner that the pool cannot be readily disassembled for storage and are served by electrical circuits of any nature. These units are primarily constructed for their aesthetic value and not intended for swimming or wading.

Permanently installed swimming pools, wading and therapeutic pools. Those that are constructed in the ground, on the ground, or in a building in such a manner that the pool cannot be readily disassembled for storage whether or not served by electrical circuits of any nature.

Portable X-ray. X-ray equipment designed to be hand-carried.

Power and control tray cable. Type TC power and control tray cable is a factory assembly of two or more insulated conductors, with or without associated bare or covered grounding conductors under a nonmetallic sheath, approved for installation in cable trays, in raceways, or where supported by a messenger wire.

Power fuse. (Over 600 volts, nominal.) See **Fuse.**

Power-limited tray cable. Type PLTC nonmetallic-sheathed power limited tray cable is a factory assembly of two or more insulated conductors under a nonmetallic jacket.

Power outlet. An enclosed assembly which may include receptacles, circuit breakers, fuseholders, fused switches, buses and watt-hour meter mounting means; intended to supply and control power to mobile homes, recreational vehicles or boats, or to serve as a means for distributing power required to operate mobile or temporarily installed equipment.

Premises wiring system. That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of its associated hardware, fittings, and wiring devices, both permanently and temporarily installed, which extends from the load end of the service drop, or load end of the service lateral conductors to the outlet(s). Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment.

Qualified person. One familiar with the construction and operation of the equipment and the hazards involved.

Note 1: Whether an employee is considered to be a "qualified person" will depend upon various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered

qualified" with regard to certain equipment in the workplace, but "unqualified" as to other equipment.(See 1910.332(b)(3) for training requirements that specifically apply to qualified persons.)

Note 2: An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

Raceway. A channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this subpart. Raceways may be of metal or insulating material, and the term includes rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit,liquidtight flexible metal conduit, flexible metallic tubing, flexible metal conduit, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways.

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

Receptacle. A receptacle is a contact device installed at the outlet for the connection of a single attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.

Receptacle outlet. An outlet where one or more receptacles are installed.

Remote-control circuit. Any electric circuit that controls any other circuit through a relay or an equivalent device.

Sealable equipment. Equipment enclosed in a case or cabinet that is provided with a means of sealing or locking so that live parts cannot be made accessible without opening the enclosure. The equipment may or may not be operable without opening the enclosure.

Separately derived system. A premises wiring system whose power is derived from generator, transformer, or converter winding and has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system.

Service. The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

Service cable. Service conductors made up in the form of a cable.

Service conductors. The supply conductors that extend from the street main or from transformers to the service equipment of the premises supplied.

Service drop. The overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service-entrance conductors at the building or other structure.

Service-entrance cable. Service-entrance cable is a single conductor or multiconductor assembly provided with or without an overall covering, primarily used for services and of the following types:

(i) Type SE, having a flame-retardant, moisture-resistant covering, but not required to have inherent protection against mechanical abuse.

(ii) Type USE, recognized for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering or inherent protection against mechanical abuse. Single-conductor cables having an insulation specifically approved for the purpose do not require an outer covering.

Service-entrance conductors, overhead system. The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop.

Service entrance conductors, underground system. The service conductors between the terminals of the service equipment and the point of connection to the service lateral. Where service equipment is located outside the building walls, there may be no service-entrance conductors, or they may be entirely outside the building.

Service equipment. The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to constitute the main control and means of cutoff of the supply.

Service raceway. The raceway that encloses the service-entrance conductors.

Shielded nonmetallic-sheathed cable. Type SNM, shielded nonmetallic-sheathed cable is a factory assembly of two or more insulated conductors in an extruded core of moisture-resistant, flame-resistant nonmetallic material, covered with an overlapping spiral metal tape and wire shield and jacketed with an extruded moisture-, flame-, oil-, corrosion-, fungus-, and sunlight-resistant nonmetallic material.

Show window. Any window used or designed to be used for the display of goods or advertising material, whether it is fully or partly enclosed or entirely open at the rear and whether or not it has a platform raised higher than the street floor level.

Sign. See **Electric Sign.**

Signaling circuit. Any electric circuit that energizes signaling equipment.

Special permission. The written consent of the authority having jurisdiction.

Storable swimming or wading pool. A pool with a maximum dimension of 15 feet and a maximum wall height of 3 feet and is so constructed that it may be readily disassembled for storage and reassembled to its original integrity.

Switchboard. A large single panel, frame, or assembly of panels which have switches, buses, instruments, overcurrent and other protective devices mounted on the face or back or both.

Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. (See **Panelboard.**)

Switches.

General-use switch. A switch intended for use in general distribution and branch circuits. It is rated in amperes, and it is capable of interrupting its rated current at its rated voltage.

(ii) **General-use snap switch.** A form of general-use switch so constructed that it can be installed in flush device boxes or on outlet box covers, or otherwise used in conjunction with wiring systems recognized by this subpart.

(iii) **Isolating switch.** A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

(iv) **Motor-circuit switch.** A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

Switching devices. (Over 600 volts, nominal.) Devices designed to close and/or open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, interrupter switches, and oil (filled) cutouts.

Transportable X-ray. X-ray equipment installed in a vehicle or that may readily be disassembled for transport in a vehicle.

Utilization equipment. Utilization equipment means equipment which utilizes electric energy for mechanical, chemical, heating, lighting, or similar useful purpose.

Utilization system. A utilization system is a system which provides electric power and light for employee workplaces, and includes the premises wiring system and utilization equipment.

Ventilated. Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors.

Volatile flammable liquid. A flammable liquid having a flash point below 38 degrees C (100 degrees F) or whose temperature is above its flash point.

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

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

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

Watertight. So constructed that moisture will not enter the enclosure.

Weatherproof. So constructed or protected that exposure to the weather will not interfere with successful operation. Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor.

Wet location. See **Location.**

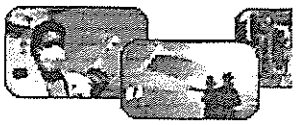
Wireways. Wireways are sheet-metal troughs with hinged or removable covers for housing and protecting electric wires and cable and in which conductors are laid in place after the wireway has been installed as a complete system.

(b) Definitions applicable to 1910.331 through 1910.360 [Reserved]

(c) Definitions applicable to 1910.360 through 1910.380 [Reserved]

(d) Definitions applicable to 1910.381 through 1910.398 [Reserved]

[46 FR 4056, Jan. 16, 1981; 46 FR 40185, Aug. 7, 1981; as amended at 53 FR 12123, Apr. 12, 1988; 55 FR 32020, Aug. 6, 1990; 55 FR 46054, Nov. 1, 1990]



Directives

STD 01-16-007 - STD 1-16.7 - Electrical Safety-Related Work Practices -- Inspection Procedures and Interpretation Guidelines

Directives - Table of Contents

• **Record Type:**	Instruction
• **Directive Number:**	STD 01-16-007
• **Old Directive Number:**	STD 1-16.7
• **Title:**	Electrical Safety-Related Work Practices -- Inspection Procedures and Interpretation Guidelines
• **Information Date:**	07/01/1991

U.S. Department of Labor Assistant Secretary for

Occupational Safety and Health Washington D.C. 20210

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

Subject: Electrical Safety-Related Work Practices--Inspection Procedures and Interpretive Guidelines

A. Purpose. This instruction establishes policies and provides interpretive guidelines to ensure uniform enforcement of the standard for Electrical Safety-Related Work Practices, 29 CFR 1910.331 through .335.

B. Scope. This instruction applies OSHA-wide.

C. References:

1. OSHA Instruction STD 1-7.3, September 11, 1990, 29 CFR 1910.147, the Control of Hazardous Energy (Lockout/Tagout)--Inspection Procedures and Interpretive Guidance.

2. General Industry Standards, 29 CFR 1910, Subpart S.

3. OSHA Instruction CPL 2.45B, June 15, 1989, the Revised Field Operations Manual (FOM).

4. NFPA 70E, 1983, Electrical Safety Requirements for Employee Workplaces.

D. Effective Dates of Requirements. All requirements of the standard for Electrical Safety-Related Work Practices have an effective date of December 4, 1990, except for 29 CFR 1910.332 (training), which will become effective on August 6, 1991.

E. Action. Regional Administrators and Area Directors shall ensure that the policies and interpretive guidelines in this instruction are followed as to the enforcement of the standard.

F. Federal Program Change. This instruction describes a Federal program change which affects State programs. Each Regional Administrator shall:

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

1. Ensure that this change is promptly forwarded to each State designee using a format consistent with the Plan Change Two-Way Memorandum in Appendix P, OSHA Instruction STP 2.22A, Ch-3.

2. Explain the technical content of this change to the State designee as required.

3. Ensure that State designees are asked to acknowledge receipt of this Federal program change in writing to the Regional Administrator as soon as the State's intention is known, but not later than 70 calendar days after the date of issuance (10 days for mailing and 60 days for response). This acknowledgment must include a description either of the State's plan to follow the guidelines in paragraphs H., Inspection guidelines, I., Interpretive Guidance, and J., Enforcement/Citation Guidance, to implement the change, or of the reasons why this change should not apply to that State.

4. Review policies, instructions and guidelines issued by the State to determine that this change has been communicated to State compliance personnel.

G. Background. The standard for Electrical Safety-Related Work Practices was promulgated on August 6, 1990, at Federal Register, Vol. 55, No. 151 (pages 31984-32020), and became effective December 4, 1990, except for 29 CFR 1910 .332, which becomes effective on August 6, 1991.

1. The current electrical standards in Subpart S of the General Industry Standards cover electrical equipment and installations rather than work practices. The electrical safety-related work practice standards that do exist are distributed in other subparts of 29 CFR 1910. Although unsafe work practices appear to be involved in most workplace electrocutions, OSHA has very few regulations addressing work practices necessary for electrical safety. Because of this, OSHA determined that standards were needed to minimize these hazards.

2. The new rule addresses practices and procedures that are necessary to protect employees working on or near exposed energized and deenergized parts of electric

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

equipment. The new rule also promotes uniformity and reduces redundancy among the general industry standards. The new rule is based largely on NFPA 70E, Part II.

3. On September 1, 1989, OSHA promulgated a generic standard on the control of hazardous energy, 29 CFR 1910.147 (lockout/tagout).

a. That standard addresses practices and procedures that are necessary to deenergize machinery or equipment and to prevent the release of potentially hazardous energy while maintenance and servicing activities are being performed.

b. Although that rule is related to electrical energy, it specifically excludes "exposure to electrical hazards from work on, near, or with conductors or equipment in electric utilization installations, which is covered by Subpart S of 29 CFR 1910." Therefore, the lockout/tagout standard does not cover electrical hazards.

c. The final electrical safety-related work practices standard has provisions to achieve maximum safety by deenergizing energized parts and, secondly, when lockout/tagout is used, it is done to ensure that the deenergized state is maintained.

H. Inspection Guidelines. In so far as possible the compliance officer shall integrate inspection procedures for this standard with those of 29 CFR 1910.147 (lockout/tagout standard).

1. The following guidance provides a general framework to assist the compliance officer during all inspections:

a. The employer's written procedures required under 29 CFR 1910.333(b)(2)(i) shall be reviewed to determine if they cover the hazards likely to be encountered.

(1) A copy of paragraph (b) of 1910.333 maintained by the employer will fulfill this requirement.

(2) A copy of the written procedures for locking and tagging required by 29 CFR 1910.147 will also comply with this requirement, provided those procedures address the electrical safety hazards covered by Subpart S and provided the procedures conform to 1910.333 (b).

(3) If the employer has chosen to utilize procedures developed to comply with 1910.147 for electrical as well as other hazards, the written procedures must include steps corresponding to requirements in Section 1910.333 for application of locks and tags and verification of deenergized conditions (29 CFR 1910.333(b)(2)(iii)(D) and (b)(2)(iv)(B)).

b. Beginning August 6, 1991, the training practices of the employer for qualified and unqualified employees shall be evaluated to assess whether the training provided is appropriate to the tasks being performed or to be performed.

(1) All employees who face a risk of electric shock, burns or other related injuries, not reduced to a safe level by the installation safety requirements of Subpart S, must be trained in safety-related work practices required by 29 CFR 1910.331-.335.

(2) In addition to being trained in and familiar with safety related work practices, unqualified employees must be trained in the inherent hazards of electricity, such as high voltages, electric current, arcing, grounding, and lack of guarding. Any electrically related safety practices not specifically addressed by Sections 1910.331 through 1910.335 but necessary for safety in specific workplace conditions shall be included.

(3) The training of qualified employees must include at the minimum the following:

(a) The ability to distinguish exposed live parts from other parts of electric equipment.

(b) The ability to determine the nominal voltage of live parts.

(c) The knowledge of clearance and/or approach distances specified in 1910.333(c).

(4) During walkaround inspections, compliance officers shall evaluate any electrical- related work being performed to ascertain conformance with the employer's written procedures as required by 1910.333(b)(2)(i) and all safety-related work practices in Sections 1910.333 through 1910.335. (See J. of this instruction for clarification.)

(5) Any violations found must be documented adequately, including the actual voltage level.

I. Interpretive Guidance. The following guidance is provided relative to specific provisions of the standard for Electrical Safety-Related Work Practices:

1. Definitions: Qualified/Unqualified Persons.

a. The standard defines a qualified person as one familiar with the 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.

(1) Whether an employee is considered to be a "qualified person" will depend on various circumstances in the workplace. It is possible and, in fact, likely for an individual to be considered "qualified" with regard to

certain equipment in the workplace, but "unqualified" as to other equipment. (See 29 CFR 1910.332(b)(3) for training

requirements that specifically apply to qualified persons.) Only qualified persons may place and remove locks and tags.

(2) An employee who is undergoing on-the-job training, who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training, and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

b. Where the term "may not" is used in these standards, the term bears the same meaning as "shall not".

c. Training requirements apply to all employees in occupations that carry a risk of injury due to electrical hazards that are not sufficiently controlled under 29 CFR 1910.303 through 1910.308.

2. Scope/Coverage of the Standard.

a. The provisions of the standard cover all employees working on, near or with premises wiring, wiring for connection to supply, other wiring, such as outside conductors on the premises and optical fiber cable, where the fiber cable installations are made along with electric conductors and the optical fiber cable types are those that contain noncurrent-carrying conductive members such as metallic strength members and metallic vapor barriers.

b. The standard does not cover qualified workers (but does cover unqualified workers) performing work on the following:

(1) Electric power generation, transmission, and distribution installations located in buildings used for such purposes or located outdoors.

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

NOTE: Work on the specified electrical installations is excluded, but work on other electric equipment in the buildings is not excluded.

(2) Communications installations covered under 29 CFR 1910.268.

(3) Installations in ships, watercraft, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles.

(4) Installations of railways for generation, transformation, transmission,

or distribution of electric power used exclusively for operation of rolling stock or installations of railways used exclusively for signaling and communication purposes.

c. The standard for Electrical Safety-Related Work Practices was developed to complement the existing electrical standards. The new standard includes requirements for work performed on or near exposed energized and deenergized parts of electric equipment, use of electrical protective equipment, and the safe use of electrical equipment.

d. Exposure to unexpected electrical energy release that could result in electric shock or burns or in an explosion caused by an electric arc is covered by the standard for Electrical Safety-Related Work Practices. Safeguarding workers from other hazards related to the unexpected release of hazardous energy during servicing and maintenance operations is covered by 29 CFR 1910.147, the lockout/tagout standard.

(1) 1910.333(a)(1) requires that live parts be deenergized before a potentially exposed employee works on or near them. OSHA believes that this is the preferred method for protecting employees from electrical hazards. The employer is permitted to allow employees to work on or near exposed live parts only:

(a) If the employer can demonstrate that deenergizing introduces additional or increased hazards, or

(b) If the employer can demonstrate that deenergizing is infeasible due to equipment design or operational limitations.

(2) Under 1910.333(a)(2) if the employer does not deenergize (under the conditions permitted in 1910.333(a)(1)), then suitable safe work practices for the conditions under which the work is to be performed shall be included in the written procedures and strictly enforced. These work practices are given in 1910.333(c) and 1910.335.

(3) Only qualified persons shall be allowed to work on energized parts or equipment.

3. Working on Deenergized Parts.

a. Circuit parts that cannot be deenergized using the procedures outlined in 1910.333(b)(2) must be treated as energized (as specified in 1910.333 (b)(1)), regardless of whether the parts are, in fact, deenergized.

b. Deenergized parts are required to be locked and tagged unless exempted under 1910.333(b)(2) (iii)(C) or 1910.333(b)(2)(iii)(E), as discussed below. If so exempted, either a lock or a tag is required.

(1) If a tag is used without a lock, it shall be supplemented by at least one additional safety measure that provides a level of safety equivalent to that obtained by the use of a lock. Examples of additional safety measures include the removal of an isolating circuit element, blocking of a controlling switch, or opening of an extra disconnecting device.

(2) A lock may be placed without a tag only under the following conditions:

(a) Only one circuit or piece of equipment is deenergized, and

(b) The lockout period does not extend beyond the work shift, and

(c) Employees exposed to the hazards associated with reenergizing the circuit or equipment are familiar with this procedure.

4. Verification of Deenergization Is Mandatory. This verification must be done by a qualified person.

a. The qualified person shall activate the equipment operating controls or otherwise verify that the equipment cannot be restarted.

b. Test equipment shall be used to ensure that electrical parts and circuit elements have been deenergized.

c. Testing instruments and equipment shall be visually inspected for external defects or damage before being used to determine deenergization (29 CFR 1910.334(c)(2)).

d. For circuits over 600 volts nominal, the test equipment shall be checked for proper operation immediately before and immediately after the test.

5. Reenergization. The following requirements shall be met, in the order given, before circuits or equipment are reenergized, even temporarily.

a. A qualified person shall conduct tests and visual inspections, as necessary, to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed so that the circuits and equipment can be safely energized.

b. Potentially exposed employees shall be warned to stay clear of circuits and equipment prior to reenergizing.

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

c. Each lock and tag shall be removed by the employee who applied it. However, if the employee is absent from the workplace, then the lock or tag may be

removed by a qualified person designated to perform this task provided that the employer ensures:

(1) That the employee who applied the lock or tag is not available at the workplace, and

(2) That the employee is informed that the lock or tag has been removed before he or she resumes work at the workplace.

(3) That there is to be a visual determination that all employees are clear of the circuits and equipment prior to lock and tag removal.

6. Working On or Near Overhead Power Lines, 29 CFR 1910.333(c)(3).

a. OSHA believes that the preferred method of protecting employees working near overhead power lines is to deenergize and ground the lines when work is to be performed near them.

b. In addition to other operations, this standard also applies to tree trimming operations performed by tree workers who are not "qualified persons". In this respect the exclusion in 1910.331(c)(1) applies only to "qualified persons" performing line-clearance tree trimming (trimming trees that are closer than 10 feet to overhead power lines).

c. The standard does not prohibit workers who are not "qualified persons" from working in a tree that is closer than 10 feet to power lines so long as that person or any object he or she may be using, does not come within 10 feet of a power line. However, it would require "qualified persons" to perform the work if the worker or any object he or she may be using will come within 10 feet of an exposed energized part or if a branch being cut may be expected to come within 10 feet of an exposed energized part while falling from the tree. (See 29 CFR 1910.333(c)(3)(ii).)

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

d. The purpose for the approach distance requirements is to prevent contact with, and/or arcing, from energized overhead power lines. The approach distance applies to tools used by employees as well as the employees themselves. Table S-5 calls for the following approach distances for qualified employees only:

Voltage Range (AC) Minimum Approach

(phase to phase) Distance

300V and less Avoid contact Over 300V, not over 750V 1 ft. 0 in. (30.5cm) Over 750, not over 2kV 1 ft. 6 in. (46cm) Over 2kV, not over 15kV 2 ft. 0 in. (61cm) Over 15kV, not over 37kV 3 ft. 0 in. (91cm) Over

37kV, not over 87.5kV 3 ft. 6 in. (107cm) Over 87.5kV, not over 121kV 4 ft. 0 in. (122cm) Over 121kV, not over 140kV 4 ft. 6 in. (137cm)

NOTE: Unqualified employees are required to adhere to the 10 ft. minimum.

e. Employees working on or around vehicles and mechanical equipment, such as gin-pole trucks, forklifts, cherry pickers, garbage trucks, cranes and elevating platforms, who are potentially exposed to hazards related to equipment component contact with overhead lines, shall have been trained by their employers in the inherent hazards of electricity and means of avoiding exposure to such hazards.

f. The standard for Electrical Safety-Related Work Practices can be applied with respect to electrical hazards related to any size, utilization or configuration of overhead power lines in general industry; e.g., residential power lines, remotely located overhead power lines, temporarily rigged overhead power lines, and overhead power lines along streets and alleys.

7. Portable Ladders. Such ladders may not have conductive siderails in situations where the employee or the ladder could contact exposed energized parts. All ladders shall be in compliance with requirements of the standards found elsewhere in Part 1910.

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

8. Conductive Apparel. Articles of jewelry and clothing such as watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear shall not be worn if there is a possibility of contacting exposed energized parts. However, such articles may be worn if they are rendered nonconductive by covering, wrapping, or other insulating means (29 CFR 1910.333(c)(8)).

9. Housekeeping Duties. The employer has the burden to provide adequate safeguards (such as insulating equipment or barriers) where live parts present an electrical contact hazard to employees who are performing housekeeping duties. Electrically conductive cleaning materials (such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.

10. Electrical Safety Interlocks. Interlocks found on panels, covers and guards are designed to deenergize circuits to prevent electric shock to persons using equipment or performing minor maintenance or adjustments and shall not be defeated or bypassed by an unqualified person.

11. Cord- and Plug-Connected Equipment. Energized equipment here means either the equipment being plugged or the receptacle into which it is being plugged, or both (29 CFR 1910.334(a)(5)(i)).

12. Eye and Face Protection. 29 CFR 1910.335(a)(1)(v) requires employees to wear

protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.

13. Insulated Tool. This means a tool encased within material of composition and thickness that is recognized as electrical insulation.

OSHA Instruction STD 1-16.7 JUL 1, 1991 Directorate of Compliance Programs

J. Enforcement/Citation Guidance.

1. A deficiency in the employer's program that could contribute to a potential exposure capable of producing serious physical harm or death shall be cited as a serious violation.

2. The failure to train "qualified" and "unqualified" employees as required for their respective classifications shall normally be cited as a serious violation.

3. Paperwork deficiencies in the safe work practice program where effective safe work practice procedures are in place shall be cited as other-than-serious.

Gerard F. Scannell Assistant Secretary

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Directives - Table of Contents

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Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210

CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT)

Introduction

Glossary

Scope and Application

Normal Production Operations

- Servicing and/or Maintenance Operations
- Minor Servicing Tools

Provisions of the Standard

- Energy Control Program
- Energy Control Procedure
- Energy-Isolating Devices
- Requirements for Lockout/Tagout Devices
- Employee Training
- Periodic Inspections
- Application of Controls and Lockout/Tagout Devices
- Removal of Locks and Tags
- Additional Safety Requirements

References:
29 CFR 1910.147, *Control of Hazardous Energy (Lockout/Tagout)*

Additional Source of Information:
Appendix A to 1910.147, *Typical Minimal Lockout Procedure*

Discussion/Overheads - 1.94 MB

Student Handouts - 216 K

Self-Inspection Checklist

CONTROL OF HAZARDOUS ENERGY (LOCKOUT/TAGOUT) - 1910.147

INTRODUCTION

This standard helps safeguard employees from hazardous energy while they are performing service or maintenance on machines and equipment. The standard identifies the practices and procedures necessary to shut down and lock out or tag out machines and equipment, requires that employees receive training in their role in the lockout/tagout program, and mandates that periodic inspections be conducted to maintain or enhance the energy control program.

In the early 1970's, OSHA adopted various lockout-related provisions of the then existing national consensus standards and Federal standards that were developed for specific types of equipment or industries. When the existing standards require lockout, the new rule supplements these existing standards(1) by requiring the development and utilization of written procedures, the training of employees, and periodic inspections of the use of the procedures. OSHA has determined that lockout is a more reliable means of de-energizing equipment than tagout and that it should always be the preferred method used by employees. The Agency believes that, except for limited situations, the use of lockout devices will provide a more secure and more effective means of protecting employees from the unexpected release of hazardous energy or start-up of machines and equipment.

FOOTNOTE(1) The following OSHA standards currently contain lockout/tagout related requirements: 1910.178 - Power Industrial Trucks; 1910,179 - Overhead and Gantry Cranes; 1910.181 - Derricks; 1910.213 - Woodworking Machinery; 1910.217 - Mechanical Power Presses; 1910.218 - Forging Machines; 1910.252 - Welding, Cutting and

Sawmills; 1910.272 - Grain Handling; and 1910.305 - Electrical.

This rule requires that, in general, before service or maintenance is performed on machinery or equipment, the machinery or equipment must be turned off and disconnected from the energy source, and the energy-isolating device must be either locked or tagged out. OSHA estimates that adherence to the requirements of this standard can eliminate nearly 2% of all workplace deaths in establishments affected by this rule and can have a significant impact on worker safety and health in the U.S.

GLOSSARY

Affected employee - An employee who performs the duties of his or her job in an area in which the energy control procedure is implemented and servicing or maintenance operations are performed. An affected employee does *not* perform servicing or maintenance on machines or equipment and, consequently, is not responsible for implementing the energy control procedure. An affected employee becomes an "authorized" employee whenever he or she performs servicing or maintenance functions on machines or equipment that must be locked or tagged.

Authorized employee - An employee who performs servicing or maintenance on machines and equipment. Lockout or tagout is used by these employees for their own protection.

Capable of being locked out - An energy-isolating device is considered capable of being locked out if it meets one of the following requirements:

- It is designed with a hasp to which a lock can be attached;
- It is designed with any other integral part through which a lock can be affixed;
- It has a locking mechanism built into it; or
- It can be locked without dismantling, rebuilding, or replacing the energy isolating device or permanently altering its energy control capability.

Energized - Machines and equipment are energized when (1) they are connected to an energy source or (2) they contain residual or stored

energy.

Energy-isolating device - Any mechanical device that physically prevents the transmission or release of energy. These include, but are not limited to, manually-operated electrical circuit breakers, disconnect switches, line valves, and blocks.

Energy source - Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Energy control procedure - A written document that contains those items of information an authorized employee needs to know in order to safely control hazardous energy during servicing or maintenance of machines or equipment. (A more comprehensive explanation is given beginning on page 6.)

Energy control program - A program intended to prevent the unexpected energizing or the release of stored energy in machines or equipment on which servicing and maintenance is being performed by employees. The program consists of energy control procedure(s), an employee training program, and periodic inspections.

Lockout - The placement of a lockout device on an energy - isolating device, in accordance with an established procedure, ensuring that the energy - isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout device - Any device that uses positive means such as a lock, either key or combination type, to hold an energy - isolating device in a safe position, thereby preventing the energizing of machinery or equipment. When properly installed, a blank flange or bolted slip blind are considered equivalent to lockout devices.

Tagout - The placement of a tagout device on an energy - isolating device, in accordance with an established procedure, to indicate that the energy - isolating device and the equipment being controlled may *not* be operated until the tagout device is removed.

Tagout device - Any prominent warning device, such as a tag and a means of attachment, that can be securely fastened to an energy - isolating device in accordance with an established procedure. The tag indicates that the machine or equipment to which it is attached is not to be operated until the tagout device is removed in accordance with the energy control procedure.

SCOPE AND APPLICATION

The lockout/tagout standard applies to general industry employment and covers the servicing and maintenance of machines and equipment in which the unexpected start-up or the release of stored energy could cause injury to employees. (If employees are performing service or maintenance tasks that do not expose them to the unexpected release of hazardous energy, the standard does not apply.)

The standard establishes minimum performance requirements for the control of hazardous energy.

The standard does not apply in the following situations:

- while servicing or maintaining **cord** and **plug** connected electrical equipment. (The hazards must be controlled by unplugging the equipment from the energy source; the plug must be under the exclusive control of the employee performing the service and/or maintenance.)
- during **hot tap operations** that involve transmission and distribution systems for gas, steam, water, or petroleum products when they are performed on pressurized pipelines; when continuity of service is essential, and shutdown of the system is impractical; and employees are provided with an alternative type of protection that is equally effective.

NORMAL PRODUCTION OPERATIONS

OSHA recognizes that machines and equipment present many hazardous situations during normal production operations - i.e., whenever machines and equipment are used to perform their usual production function. These production hazards are covered by rules in other General Industry Standards, such as the requirements in Subpart O of Part 1910 for general machine guarding and guarding power transmission apparatus (1910.212 and 1910.219). In certain circumstances, however, some hazards encountered during normal production operations may be covered by the lockout/tagout rule. The following paragraphs illustrate some of these instances.

Servicing and/or Maintenance Operations

If a servicing activity - such as lubricating, cleaning, or unjamming 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. Workers engaged in these operations are covered by lockout/tagout when any of the following conditions occurs:

- The employee must either remove or bypass machine guards or other safety devices, resulting in exposure to hazards at the point of operation;
- The employee is required to place any part of his or her body in contact with the point of operation of the operational machine or piece of equipment; or
- The employee is required to place any part of his or her body into a danger zone associated with a machine operating cycle.

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

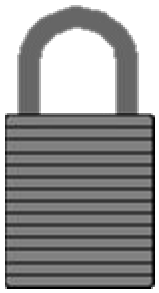
In addition, when normal servicing tasks - such as setting equipment up, and/or making significant adjustments to machines - do not occur during normal production operations, employees performing such tasks are required to lock out or tag out if they can be injured by unexpected energization of the equipment.

OSHA also recognizes that some servicing operations must be performed with the power on. Making many types of fine adjustments, such as centering the belt on conveyors, is one example. Certain aspects of troubleshooting, such as identifying the source of the problem as well as checking to ensure that it has been corrected, is another. OSHA requires the employer to provide effective protection for employees performing such operations. Although, in these cases, a power-on condition is essential either to accomplish the particular type of servicing or to verify that it was performed properly, lockout or tagout procedures are required when servicing or maintenance occurs with the power off.

Minor Servicing Tasks

Employees performing **minor** tool changes and adjustments and/or other **minor** service activities *during normal production operations* that are **routine, repetitive**, and **integral** to the use of the production equipment are not covered by the lockout/tagout standard, provided the work is performed using alternative measures that give effective protection.

PROVISIONS OF THE STANDARD



The standard requires employers to establish procedures for isolating machines or equipment from the input of energy and affixing appropriate locks or tags to energy-isolating devices to prevent any unexpected energization, start-up, or release of stored energy that would injure workers. When tags are used on energy-isolating devices capable of being locked out, the employer must provide additional means to assure a level of protection equivalent to that of locks. The standard also requires the training of employees, and periodic inspections of the procedures to maintain or improve their effectiveness.

Energy Control Program

The lockout/tagout rule requires that the employer establish an energy control program that includes (1) documented energy control procedures, (2) an employee training program, and (3) periodic inspections of the procedures. The standard requires employers to establish a program to ensure that machines and equipment are isolated and inoperative before any employee performs service or maintenance where the unexpected energization, start up, or release of stored energy could occur and cause injury.

The purpose of the energy control program is to ensure that, whenever the possibility of unexpected machine or equipment start-up exists or when the unexpected release of stored energy could occur and cause injury, the equipment is isolated from its energy source(s) and rendered inoperative prior to servicing or maintenance.

Employers have the flexibility to develop a program and procedures that meet the needs of their particular workplace and the particular types of machines and equipment being maintained or serviced.

Energy Control Procedure

This standard requires that energy control procedures be developed, documented, and used to control potentially hazardous energy sources whenever workers perform activities covered by the standard.

The written procedures must identify the information that authorized[(2)] employees must know in order to control hazardous energy during service or maintenance. If this information is the same for various machines or equipment or if other means of logical grouping exists, then a single energy control procedure may be sufficient. If there are other conditions - such as multiple energy sources, different connecting

means, or a particular sequence that must be followed to shut down the machine or equipment - then the employer must develop separate energy control procedures to protect employees.

FOOTNOTE(2) See section on "Employee Training."

The energy control procedure must outline the scope, purpose, authorization, rules and techniques that will be used to control hazardous energy sources as well as the means that will be used to enforce compliance. At a minimum, it includes, but is not limited to, the following elements:

- a statement on how the procedure will be used;
- the procedural steps needed to shut down, isolate, block, and secure machines or equipment;
- the steps designating the safe placement, removal, and transfer of lockout/tagout devices and who has the responsibility for them; and
- the specific requirements for testing machines or equipment to determine and verify the effectiveness of locks, tags, and other energy control measures.

The procedure must include the following steps: (1) preparing for shutdown, (2) shutting down the machine(s) or equipment, (3) isolating the machine or equipment from the energy source(s), (4) applying the lockout or tagout device(s) to the energy-isolating device(s), (5) safely releasing all potentially hazardous stored or residual energy, and (6) verifying the isolation of the machine(s) or equipment prior to the start of service or maintenance work.

In addition, before lockout or tagout devices are removed and energy is restored to the machines or equipment, certain steps must be taken to re-energize equipment after service is completed, including: (1) assuring that machines or equipment components are operationally intact; (2) notifying affected employees that lockout or tagout devices are removed from each energy-isolating device by the employee who applied the device. [See sections 6(e) and 6(f) of 29 CFR 1910.147 for specific requirements of the standard.]

Energy-Isolating Devices

The employer's primary tool for providing protection under the standard is the energy-isolating device, which is the mechanism that prevents the transmission or release of energy and to which all locks or tags are attached. (See glossary for a more complete definition.) This device guards against accidental machine or equipment start-up or the unexpected re-energization of equipment during servicing or maintenance. There are two types of energy-isolating devices: those capable of being locked and those that are not. The standard differentiates between the existence of these two conditions and the employer and employee responsibilities in each case.

When the energy-isolating device cannot be locked out, the employer must use tagout. Of course, the employer may choose to modify or replace the device to make it capable of being locked. When using tagout, the employer must comply with all tagout-related provisions of the standard and, in addition to the normal training required for all employees, must train his or her employees in the following limitations of tags:

- Tags are essentially warning devices affixed to energy-isolating devices and do not provide the physical restraint of a lock.
- When a tag is attached to an isolating means, it is not to be removed except by the person who applied it, and it is never to be bypassed, ignored, or otherwise defeated.
- Tags must be legible and understandable by all employees.
- Tags and their means of attachment must be made of materials that will withstand the environmental conditions encountered in the work-place.
- Tags may evoke a false sense of security. They are only one part of an overall energy control program.
- Tags must be securely attached to the energy-isolating devices so that they cannot be detached accidentally during use.

If the energy-isolating device is lockable, the employer shall use locks unless he or she can prove that the use of tags would provide protection **at least as effective as** locks and would assure "full employee protection."

Full employee protection includes complying with all tagout related provisions plus implementing additional safety measures that can provide

the level of safety equivalent to that obtained by using lockout. This might include removing and isolating a circuit element, blocking a controlling switch, opening an extra disconnecting device, or removing a valve handle to reduce the potential for any inadvertent energization.

Although OSHA acknowledges the existence of energy-isolating devices that cannot be locked out, the standard clearly states that whenever major replacement, repair, renovation or modification of machines or equipment is performed and whenever new machines or equipment are installed, the employer must ensure that the energy-isolating devices for such machines or equipment are lockable. Such modifications and/or new purchases are most effectively and efficiently made as part of the normal equipment replacement cycle. All newly purchased equipment must be lockable.

Requirements for Lockout/Tagout Devices

When attached to an energy-isolating device, both lockout and tagout devices are tools that the employer can use in accordance with the requirements of the standard to help protect employees from hazardous energy. The lockout device provides protection by holding the energy-isolating device in the safe position, thus preventing the machine or equipment from becoming energized. The tagout device does so by identifying the energy-isolating device as a source of potential danger; it indicates that the energy-isolating device and the equipment being controlled may not be operated until the tagout device is removed. Whichever devices are used, they must be singularly identified, must be the *only* devices used for controlling hazardous energy, and must meet the following requirements:

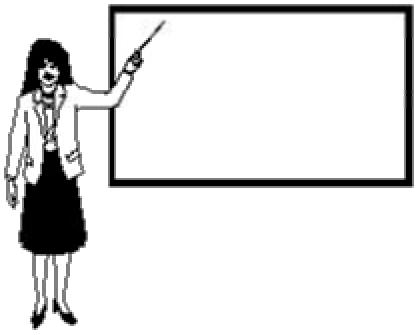
- **Durable** - *Lockout* and *tagout* devices must withstand the environment to which they are exposed for the maximum duration of the expected exposure. *Tagout* devices must be constructed and printed so that they do not deteriorate or become illegible, especially when used in corrosive (acid and alkali chemicals) or wet environments.
- **Standardized** - Both *lockout* and *tagout* devices must be standardized according to either **color, shape,** or **size**. *Tagout* devices must also be standardized according to **print** *and* **format**.
- **Substantial** - *Lockout* and *tagout* devices must be substantial enough to minimize early or accidental removal. *Locks* must be substantial to prevent removal except by excessive force of special tools such as bolt cutters or other metal cutting tools. *Tag means of attachment* must be non-reusable, attachable by hand, self-

locking and non-releasable, with a minimum unlocking strength of no less than 50 pounds.

The device for attaching the tag also must have the general design and basic characteristics equivalent to a one-piece nylon cable tie that will withstand all environments and conditions.

- **Identifiable** - *Locks* and *tags* must clearly identify the employee who applies them. *Tags* must also warn against hazardous conditions if the machine or equipment is energized and must include a legend such as the following: **DO NOT START, DO NOT OPEN, DO NOT CLOSE, DO NOT ENERGIZE, DO NOT OPERATE.**

Employee Training



The employer must provide effective initial training and retraining as necessary and must certify that such training has been given to all employees covered by the standard. The certification must contain each employee's name and dates of training.

For the purposes of the standard, there are three types of employees - **authorized, affected,** and **other.** The amount and kind of training that each employee receives is based upon (1) the relationship of that employee's job to the machine or equipment being locked or tagged out, and (2) the degree of knowledge relevant to hazardous energy that he or she must possess.

For example, the employer's training program for **authorized** employees (those who are charged with the responsibility for implementing the energy control procedures and performing the service and maintenance) must cover, at minimum, the following areas:

- details about the type and magnitude of the hazardous energy sources present in the workplace, and
- the methods and means necessary to isolate and control those energy sources (i.e., the elements of the energy control procedure(s).)

By contrast, **affected** employees (usually the machine operators or users) and all **other** employees need only be able to (1) recognize when

the control procedure is being implemented, and (2) understand the purpose of the procedure and the importance of not attempting to start up or use the equipment that has been locked or tagged out.

Because an "affected" employee is not one who is performing the service of maintenance, that employee's responsibilities under the energy control program are simple: Whenever there is a lockout or tagout device in place on an energy-isolating device, the affected employee leaves it alone and does not attempt to operate the equipment.

Every training program must ensure that **all** employees understand the purpose, function and restrictions of the energy control program and that **authorized** employees possess the knowledge and skills necessary for the safe application, use, and removal of energy controls.

Training programs used for compliance with this standard, which is performance-oriented, should deal with the equipment, type(s) of energy, and hazard(s) specific to the workplace being covered.

Retraining must be provided, as required, whenever there is a change in job assignments, a change in machines, equipment or processes that present a new hazard, or a change in energy control procedures. Additional retraining must be conducted whenever a periodic inspection reveals, or whenever the employer has reason to believe, that there are deviations from or inadequacies in the employee's knowledge or use of the energy control procedure.

Periodic Inspections

Periodic inspections must be performed at least annually to assure that the energy control procedures (locks and tags) continue to be implemented properly and that the employees are familiar with their responsibilities under those procedures. In addition, the employer must certify that the periodic inspections have been performed. The certification must identify the machine or equipment on which the energy control procedure was used, the date of the inspection, the employees included in the inspection, and the name of the person performing the inspection. For lockout procedures, the periodic inspection must include a review, between the inspector and each authorized employee, of that employee's responsibilities under the energy control procedure being inspected. When a tagout procedure is inspected, a review on the limitation of tags, in addition to the above requirements, must also be included with each affected and authorized employee.

Application of Controls and Lockout/Tagout Devices

The established procedure of applying energy controls includes the specific elements and actions that must be implemented in sequence.[(3)] These are briefly identified as follows:

(1) Prepare for shut down.

(2) Shut down the machine or equipment.

(3) Apply the lockout or tagout device.

(4) Render safe all stored or residual energy.

(5) Verify the isolation and de-energization of the machine or equipment.

FOOTNOTE(3) See 29 CFR 1910.147(d) for the detailed requirements and language of the OSHA standard.

Removal of Locks and Tags

Before lockout or tagout devices are removed and energy is restored to the machine or equipment, the authorized employee(s) must take the following actions or observe the following procedures:

(1) **Inspect** the work area to ensure that non-essential items have been removed and that machine or equipment components are intact and capable of operating properly;

(2) **Check** the area around the machine or equipment to ensure that all employees have been safely positioned or removed;

(3) **Notify** affected employees immediately *after* removing locks or tags and before starting equipment or machines; and

(4) **Make sure** that locks or tags are removed **ONLY** by those employees who attached them. (In the very few instances when this is not possible, the device may be removed under the direction of the employer, provided that he or she strictly adheres to the specific procedures outlined in the standard.)

Additional Safety Requirements

Special circumstances exist when (1) machines need to be tested or repositioned during servicing, (2) outside (contractor) personnel are at the worksite, (3) servicing or maintenance is performed by a group (rather than one specific person), and (4) shifts or personnel changes occur.

- **Testing or positioning of machines.** OSHA allows the temporary removal of locks or tags and the re-energization of the machine or equipment **ONLY** when necessary under special conditions - for example, when power is needed for the testing or positioning of machines, equipment, or components. The re-energization must be conducted in accordance with the sequence of steps listed below:

  (1) Clear the machines or equipment of tools and materials.

  (2) Remove employees from the machines or equipment area.

  (3) Remove the lockout or tagout devices as specified in the standard.

  (4) Energize and proceed with testing or positioning.

  (5) De-energize all systems, isolate the machine or equipment from the energy source, and reapply lockout or tagout devices as specified.

- **Outside personnel (contractors, etc.)** The onsite employer and the outside employer must inform each other of their respective lockout or tagout procedures. Each employer must ensure that his or her personnel must understand and comply with all restrictions and/or prohibitions of the other employer's energy control program.
- **Group lockout or tagout.** During all group lockout/tagout operations where the release of hazardous energy is possible, each authorized employee performing service or maintenance shall be protected by his/her personal lockout or tagout device or comparable mechanism that affords equivalent protection.
- **Shift or personnel changes.** Specific

procedures must ensure the continuity of lockout or tagout protection during shift or personnel changes.

Discussion / Overheads - 1.94 MB

Student Handouts -216 K

Self - Inspection Checklist

This information found July 24, 2002 at
http://www.osha-slc.gov/SLTC/smallbusiness/sec11.html

"So how long have you been a safety manager?"

The Control of Hazardous Energy (Lockout/ Tagout) 1910.147

Standard Implementation

- January 1990
- In response to:

122	Fatalities
28,400	Lost Workday Injuries
32,000	Non-Lost Workday Injuries

Caused Annually By Improper Shutdown of Machinery

Scope, Application & Purpose

- This standard covers the servicing and maintenance of machines and equipment in which the unexpected energization or start up of the machines or equipment, or release of stored energy could cause injury to employees.

Establishes minimum performance requirements

Scope, Application & Purpose

- **Does Not Cover**:
- **Construction**, agriculture, maritime (29 CFR 1910.20 & 21)
- Power generation, transmission, distribution (29 CFR 1910.269)
- Electrical hazards covered in Subpart S (Electric 29 CFR 1910.331 & OAC 4121:1-5-23)
- Oil & gas well drilling and servicing

Scope, Application & Purpose

Standard Does Not Apply To:

- **Work on cord and plug connected electric equipment** (unplug & plug is under exclusive control of employee)
- Hot tap operations

Scope, Application & Purpose

Standard applies during servicing or maintenance of equipment

Normal production operations are not covered by this standard.

Normal Production Operations are routine, repetitive, and integral to the production operation. Short in duration, occur frequently, do not involve extensive disassembly. The employer must implement alternative measures, which provide effective protection from hazards.

Subpart O - Machinery and Machine Guarding

Scope, Application & Purpose

Servicing and/or maintenance during normal production operations is covered if:

- **Remove or bypass a guard or other safety device**
- **Required to place any part of his or her body into the point of operation** or an associated danger zone exists during a machine operating cycle.

Definitions

- **Affected employee** - His/her job requires him/her to work in an area where lo/to (servicing or maintenance) is being performed.
- **Authorized employee** - Locks or tags out machines or equipment to perform servicing or maintenance.
- **Other employees** - All other employees.

Definitions

- **Energy Isolating Device -** Mechanical device that physically prevents the transmission or release of energy (disconnect switch, line valve, manually operated circuit breaker)
- **Lockout Device** – Device that utilizes a positive means to hold an energy isolating device in a safe position and prevent energization

Energy Control Program 1910.147(c)(1)

Employer shall establish a program consisting of:

- **energy control procedures**
- **employee training**
- **periodic inspections**

to ensure that before equipment maintenance is performed, the equipment's energy sources are isolated and rendered inoperative.

Energy Control Procedure 1910.147 (c)(4)

Written Program - Procedures shall be developed, documented and utilized for the control of potentially hazardous energy

Procedures shall clearly and specifically outline:

- **S**cope
- Purpose
- Authorization
- Rules
- Techniques for the control of hazardous energy

Does Your Company's Lockout Policy Address Violations For Failure to Lockout Equipment?

"I reckon everybody knows about this company's poor safety record by now !"

Protective Materials & Hardware 1910.147 (c)(5)

- The **employer shall provide** locks, tags, chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware

- Lockout/tagout devices shall be:
  a) Identifiable b) Durable
  c) The only device used for controlling energy
  d) Not be used for other purposes
  e) Standardized f) Substantial

Protective Materials & Hardware 1910.147 (c)(5)

Durable

- Capable of withstanding the environment for the maximum period of time
- Tagout devices constructed and printed to withstand wet/damp locations
- Tags shall not deteriorate when used in corrosive environments (acid and alkali chemicals)

Standardized

- Lockout/tagout devices shall be standardized by:
  a) Color
  b) Shape
  c) Size
  d) Print and format (tagout devices)

Protective Materials & Hardware 1910.147 (c)(5)

Substantial

- Lockout devices - prevent removal without use of excessive force (bolt cutters)
- Tagout devices - prevent inadvertent or accidental removal.

Identifiable

- Lockout/tagout devices indicate the identify of the employee applying the device(s).

Protective Materials & Hardware 1910.147 (c)(5)

- **Tagout attachment**:
  - a) non-reusable b) attachable by hand
  - c) self-locking d) non-releasable
  - e) unlocking strength $\geq$ 50 pounds
  - ** equivalent to an all environment-tolerant nylon cable tie
- Tagout devices include a legend such as the following: Do Not Start. Do Not Open. Do Not Close. Do Not Energize. Do Not Operate.

Protective Materials & Hardware 1910.147 (c)(5)




Protective Materials & Hardware 1910.147 (c)(5)


Full Employee Protection 1910.147 (c)(3) TAGOUT PROGRAM

Use of a tagout device on a lockable energy isolating device

- Tagout device attached at the same location as the lockout device
- Employer shall demonstrate that the tagout program will provide a level of safety equivalent to that obtained by using a lockout program.

Energy Control Procedure 1910.147 (c)(4)

Multiple Energy Source Equipment

- The means to enforce compliance including:
  - a) Specific statement of intended use
  - b) Specific steps for shutting down, isolating, blocking and securing equipment
  - c) Steps for the placement, removal and transfer of devices and the responsibility for them
  - d) Requirements for testing equipment to determine and verify the effectiveness of lockout/tagout devices

Energy Isolation 1910.147 (c)(8)

- Lockout/tagout shall be performed only by the **authorized employees** who are performing the servicing or maintenance.

Notification of Employees 1910.147(c)(9)

- Affected employees shall be notified by the employer or authorized employee
- Notification shall be given before the controls are applied, and after they are removed from the machine or equipment.

Equipment Shutdown 1910.147(d)(1-3)

Lockout/tagout procedures shall cover the following elements which will be done in the following sequence:

- Preparation for shutdown - authorized employee has knowledge of type and magnitude of the energy, hazards and method to control the energy
- Equipment shutdown - orderly shutdown
- Equipment isolation - energy isolating devices to be physically located and operated

Lockout Device Application 1910.147(d)(4)

- LO devices to be attached by authorized employees.
- LO devices will hold the energy isolating devices in a "safe" or "off" position.

Stored Energy 1910.147(d)(5)

- All potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, and otherwise rendered safe.

Verification of Isolation 1910.147(d)(6)

- Prior to starting work on equipment that have been locked/tagged out, the authorized employee shall verify that isolation and deenergization of the machine or equipment have been accomplished.

Release From Lockout or Tagout 1910.147 (e)(1-2)

Before lockout/tagout devices are removed the following actions must be taken:

- Work area inspected for tools, parts, equipment components
- Work area checked to ensure employees are in a safe location
- Notify affected employees of removal of LO/TO

Periodic Inspection 1910.147 (c)(6)

- Employer shall conduct a periodic inspection of the energy control procedure **at least annually**
- The inspection is performed by an authorized employee other than the one(s) utilizing the energy control procedure being inspected.
- The inspection shall be conducted to correct any deviations or inadequacies identified

Periodic Inspection 1910.147 (c)(6)

- Inspection shall include a review of each employee's responsibilities
- Employer shall certify that the periodic inspections have been performed
- Certification to include:
  a) Identity of the machine or equipment
  b) Date of the inspection
  c) Employees included in the inspection
  d) Person performing the inspection.
- Note: Refer To Handout Page 43 Appendix H

Training & Communication 1910.147 (c)(7)

The employer shall provide training

The training shall include the following:

a) **Authorized employees** - recognition, type and magnitude, and methods/ means for energy isolation and control.

b) **Affected employees** - purpose and use of the energy control procedure.

c) **Other employees** - about the procedure and the prohibition of restarting or reenergizing locked out equipment

Training & Communication 1910.147 (c)(7)

Employee retraining shall be provided for all authorized and affected employees when:

a) A change in their job assignments

b) A change in machines, equipment or processes that present a new hazard

c) A change in the energy control procedures.

Training & Communication 1910.147 (c)(7)

- Retraining shall also be conducted when a periodic inspection reveals that there are deviations from or inadequacies in the employee's knowledge or use of the energy control procedures.
- **Employer shall certify that training has been accomplished and is being kept up to date**

Lockout Device Removal 1910.147 (e)(3)

- Each device shall be removed by the employee who applied the device.
- **Exception:** If authorized employee is not available to remove device then device may be removed under the direction of the employer
- Employer must provide specific documented procedures and training for device removal

Lockout Device Removal 1910.147 (e)(3)

Procedure shall include the following elements:

- Verification by the employer that the authorized employee who applied the device is not at the facility
- Making all reasonable efforts to contact the authorized employee
- Ensuring that the authorized employee knows that the device was removed before resuming work at that facility

Testing/Positioning of Equipment 1910.147(f)(1)

Testing or positioning of equipment when devices must be removed - the following sequence of actions shall be followed:

- Clear the equipment of tools and materials
- Remove employees from the equipment
- Remove the lockout/tagout devices
- Energize and proceed with testing/positioning
- Deenergize and reapply energy control measures

Outside Personnel 1910.147(f)(2)

- Contractors, outside service personnel, etc.
- The on-site employer and the outside employer shall inform each other of their respective lockout or tagout procedures.
- The on-site employer shall ensure that his/her employees understand and comply with the restrictions and prohibitions of the outside employer's energy control program.

Group Lockout/Tagout 1910.147(f)(3)

- Service or maintenance performed by a crew, craft, department or other group, shall utilize a procedure which affords all the employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device

Shift or Personnel Changes 1910.147(f)(4)

- Specific procedures for shift or personnel changes including provision for the orderly transfer of lockout or tagout device protection between off-going and oncoming employees, to minimize exposure to hazards from the unexpected energization or start-up of the machine or equipment, or the release of stored energy.

Associated Hazards

ANSI/ASSE Z244.1-2003

- Control of Hazardous Energy
- Identifies acceptable alternative methods for controlling energy
- Has sample procedures for printing presses, plastics, robotic systems

Case Study : Automotive Robotics

- **Parts are transferred by a rotating tables from station to station while greasing and other operations are performed on the parts by robots.**
- **Employees can gain access to the robots by entering the cages through electrically interlocked gates. When the gates are opened, the energy sources that power the robots, rotating tables, and related machinery are turned off**
- **But are not deenergized or locked out.**

Case Study : Automotive Robotics

- An employee entered the robot cage without deenergizing or locking out any equipment.
- The employee was attempting to unjam a robot arm. In freeing the arm, the employee tripped an electric eye, causing the robot arm to cycle. The employee's arm was struck by the robot and injected with grease.

Case Study : Automotive Robotics

Does the unjamming operation take place during normal production operations?

YES NO

Case Study : Automotive Robotics

No.

- The unjamming operation does not take place during normal production operations. The operation takes place while the robot is shut down and the robot is not performing its intended production function. By opening the gate and entering the fenced area, the employee is bypassing the safety device and exposing himself to injury from the unexpected start up of the equipment.

Case Study : Automotive Robotics

In this situation, would the interlocked gate alone satisfy the employer's Lockout/Tagout obligations?

YES No.

The interlocked gate would not meet the requirements for an energy isolation device. In this case, the interlocked gate is considered to be control circuitry which is expressly prohibited by the rule. It does not protect employees who are inside the fenced area because it fails to de-energize the robot arm.

29 CFR 1910

Subpart J

General Environmental Controls

29 CFR 1910.147

Subpart J

General Environmental Controls

1910.147 The Control (Lockout/Tagout) of Hazardous Energy

(a) "Scope, application and purpose" –

(1) "Scope" (i) This standard covers the servicing and maintenance of machines and equipment in which the "unexpected" energization or start up of the machines or equipment, or release of stored energy could cause injury to employees. This standard establishes minimum performance requirements for the control of such hazardous energy.

(ii) This standard does not cover the following:

(A) Construction, agriculture and maritime employment;

(B) Installations under the exclusive control of electric utilities for the purpose of power generation, transmission and distribution, including related equipment for communication or metering; and

(C) Exposure to electrical hazards from work on, near, or with conductors or equipment in electric utilization installations, which is covered by Subpart S of this part; and

(D) Oil and gas well drilling and servicing.

(2) "Application." (i) This standard applies to the control of energy during servicing and/or maintenance of machines and equipment.

(ii) Normal production operations are not covered by this standard (See Subpart O of this Part). Servicing and/or maintenance which takes place during normal production operations is covered by this standard only if:

(A) An employee is required to remove or bypass a guard or other safety device; or

(B) An employee is required to place any part of his or her body into an area on a machine or piece of equipment where work is actually performed upon the material being processed (point of operation) or where an associated danger zone exists during a machine operating cycle.

Note: Exception to paragraph (a)(2)(ii): Minor tool changes and adjustments, and other minor servicing activities, which take place during normal production operations, are not covered by this standard if they are routine, repetitive, and integral to the use of the equipment for production, provided that the work is performed using alternative measures which provide effective protection (See Subpart O of this Part).

(iii) This standard does not apply to the following:

(A) Work on cord and plug connected electric equipment for which exposure to the hazards of unexpected energization or start up of the equipment is controlled by the unplugging of the equipment from the energy source and by the plug being under the exclusive control of the employee performing the servicing or maintenance.

(B) Hot tap operations involving transmission and distribution systems for substances such as gas, steam, water or petroleum products when they are performed on pressurized pipelines, provided that the employer demonstrates that (1) continuity of service is essential; (2) shutdown of the system is impractical; and (3) documented procedures are followed, and special equipment is used which will provide proven effective protection for employees.

(3) "Purpose." (i) This section requires employers to establish a program and utilize procedures for affixing appropriate lockout devices or tagout devices to energy isolating devices, and to otherwise disable machines or equipment to prevent unexpected energization, start up or release of stored energy in order to prevent injury to employees.

(ii) When other standards in this part require the use of lockout or tagout, they shall be used and supplemented by the procedural and training requirements of this section.

(b) "Definitions applicable to this section."

"*Affected employee.*" An employee whose job requires him/her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed.

"*Authorized employee.*" A person who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties include performing servicing or maintenance covered under this section.

"*Capable of being locked out.*" An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

"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 or energy, including but not limited to the following: A manually operated electrical circuit breaker, a disconnect switch, a manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors and, in addition, no pole can be operated independently; a line valve; a block; and any similar device used to block or isolate energy. Push buttons, selector switches and other control circuit type devices are not energy isolating devices.

"*Energy source.*" Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

"*Hot tap.*" A procedure used in the repair maintenance and services activities which involves welding on a piece of equipment (pipelines, vessels or tanks) under pressure, in order to install connections or appurtenances. it is commonly used to replace or add sections of pipeline without the interruption of service for air, gas, water, steam, and petrochemical distribution systems.

"*Lockout.*" The placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

"*Lockout device.*" A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy isolating device in the safe position and prevent the energizing of a machine or equipment. Included are blank flanges and bolted slip blinds.

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

"*Servicing and/or maintenance.*" Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, and maintaining and/or servicing machines or equipment.

These activities include lubrication, cleaning or unjamming of machines or equipment and making adjustments or tool changes, where the employee may be exposed to the *unexpected* energization or startup of the equipment or release of hazardous energy.

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

"*Tagout.*" The placement of a tagout device on an energy isolating device, in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

"*Tagout device.*" A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

(c) "General" - (1) "Energy control program." The employer shall establish a program consisting of energy control procedures, employee training and to periodic inspections to ensure that before any employee performs any servicing or maintenance on a machine or equipment where the unexpected energizing, startup or release of stored energy could occur and cause injury, the machine or equipment shall be isolated from the energy source and rendered inoperative.

(2) "Lockout/tagout." (i) If an energy isolating device is not capable of being locked out, the employer's energy control program under paragraph ©(1) of this section shall utilize a tagout system.

(ii) If an energy isolating device is capable of being locked out, the employer's energy control program under paragraph ©(1) of this section shall utilize lockout, unless the employer can demonstrate that the utilization of a tagout system will provide full employee protection as set forth in paragraph ©(3) of this section.

(iii) After January 2, 1990, whenever replacement or major repair, renovation or modification of a machine or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for such machine or equipment shall be designed to accept a lockout device.

(3) "Full employee protection." (i) When a tagout device is used on an energy isolating device which is capable of being locked out, the tagout device shall be attached at the same location that the lockout device would have been attached, and the employer shall demonstrate that the tagout program will provide a level of safety equivalent to that obtained by using a lockout program.

(ii) In demonstrating that a level of safety is achieved in the tagout program which is equivalent to the level of safety obtained by using a lockout program, the employer shall demonstrate full compliance with all tagout-related provisions of this standard together with such additional elements as are necessary to provide the equivalent safety available from the use of a lockout device. Additional means to be considered as part of the demonstration of full employee protection shall include the implementation of additional safety measures such as the removal of an isolating circuit element, blocking of a controlling switch, opening of an extra disconnecting device, or the removal of a valve handle to reduce the likelihood of inadvertent energization.

(4) "Energy control procedure." (i) Procedures shall be developed, documented and utilized for the control of potentially hazardous energy when employees are engaged in the activities covered by this section.

Note: "Exception:" The employer need not document the required procedure for a particular machine or equipment, when all of the following elements exist: [1] The machine or equipment has no potential for stored or residual energy or re-accumulation of stored energy after shut down which could endanger employees: [2] the machine or equipment has a single energy source which can be readily identified and isolated: [3] the isolation and locking out of that energy source will completely de-energize and deactivate the machine or equipment: [4] the machine or equipment is isolated from that energy source and locked out during servicing or maintenance: [5] a single lockout device will achieve a locker-out condition: [6] the lockout device is under the exclusive control of the authorized employee performing the servicing or maintenance: [7] the servicing or maintenance does not create hazards for other employees; and [8] the employer, in utilizing this exception, has had no accidents involving the unexpected activation or re-energization of the machine or equipment during servicing or maintenance.

(ii) The procedures shall clearly and specifically outline the scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy, and the means to enforce compliance including, but not limited to, the following:

(A) A specific statement of the intended use of the procedure;

(B) Specific procedural steps for shutting down, isolating, blocking and securing machines or equipment to control hazardous energy;

(C) Specific procedural steps for the placement, removal and transfer of lockout devices or tagout devices and the responsibility for them; and

(D) Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures.

(5) “Protective materials and hardware.” (i) Locks, tags, chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware shall be provided by the employer for isolating, securing or blocking of machines or equipment from energy sources.

(ii) Lockout devices and tagout devices shall be singularly identified; shall be the only device(s) used for controlling energy; shall not be used for other purposes; and shall meet the following requirements:

(A) “Durable.” (1) Lockout and tagout devices shall be capable of withstanding the environment to which they are exposed for the maximum period of time that exposure is expected.

(2) Tagout devices shall be constructed and printed so that exposure to weather conditions or wet and damp locations will not cause the tag to deteriorate or the message on the tag to become illegible.

(3) Tags shall not deteriorate when used in corrosive environments such as areas where acid and alkali chemicals are handled land stored.

(B) “Standardized.” Lockout and tagout devices shall be standardized within the facility in at least one of the following criteria: Color; shape; or size; and additionally, in the case of tagout devices, print and format shall be standardized.

(C) "Substantial" - (1) "Lockout devices." Lockout devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques, such as with the use of bolt cutters or other metal cutting tools.

(2) “Tagout devices.” Tagout devices, including their means of attachment, shall be substantial enough to prevent inadvertent or accidental removal. Tagout device attachment means shall be of a non-reusable type, attachable by hand, self-locking, and non-releasable with a minimum unlocking strength of no less than 50 pounds and having the general design and basic characteristics of being at least equivalent to a one-piece, all environment-tolerant nylon cable tie.

(D) “Identifiable.” Lockout devices and tagout devices shall indicate the identify of the employee applying the device(s).

(iii) Tagout devices shall warn against hazardous conditions if the machine or equipment is energized and shall include a legend such as the following: “Do Not Start. Do Not Open. Do Not Close. Do Not Energize. Do Not Operate.”

(6) “Periodic inspection.” (i) The employer shall conduct a periodic inspection of the energy control procedure at least annually to ensure that the procedure and the requirements of this standard are being followed.

(A) The periodic inspection shall be performed by an authorized employee other than the one(s) utilizing the energy control procedure being inspected.

(B) The periodic inspection shall be conducted to correct any deviations or inadequacies identified.

(C) Where lockout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized employee, of that employee's responsibilities under the energy control procedure being inspected.

(D) Where tagout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized and affected employee, of that employee's responsibilities under the energy control procedure being inspected, and the elements set forth in paragraph ©(7)(ii) of this section.

(ii) The employer shall certify that the periodic inspections have been performed. The certification shall identify the machine or equipment on which the energy control procedure was being utilized, the date of the inspection, the employees included in the inspection, and the person performing the inspection.

(7) “Training and communication.” (i) The employer shall provide training to ensure that the purpose and function of the energy control program are understood by employees and that the knowledge and skills required for the safe application, usage, and removal of the energy controls are acquired by employees. The training shall include the following:

(A) Each authorized employee shall receive training in the recognition of applicable hazardous energy sources, the type and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control.

(B) Each affected employee shall be instructed in the purpose and use of the energy control procedure.

(C) All other employees whose work operations are or may be in an area where energy control procedures may be utilized, shall be instructed about the procedure, and about the prohibition relating to attempts to restart or re-energize machines or equipment which are locked out or tagged out.

(ii) When tagout systems are used, employees shall also be trained in the following limitations of tags:

(A) Tags are essentially warning devices affixed to energy isolating devices, and do not provide the physical restraint on those devices that is provided by a lock.

(B) When a tag is attached to an energy isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.

(C) Tags must be legible and understandable by all authorized employees, affected employees, and all other employees whose work operations are or may be in the area, in order to be effective.

(D) Tags and their means of attachment must be made of materials which will withstand the environmental conditions encountered in the workplace.

(E) Tags may evoke a false sense of security, and their meaning needs to be understood as part of the overall energy control program.

(F) Tags must be securely attached to energy isolating devices so that they cannot be inadvertently or accidentally detached during use.

(iii) Employee retraining.

(A) Retraining shall be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in machines, equipment or processes that present a new hazard, or when there is a change in the energy control procedures.

(B) Additional retraining shall also be conducted whenever a periodic inspection under paragraph ©(6) of this section reveals, or whenever the employer has reason to believe that there are deviations from or inadequacies in the employee's knowledge or use of the energy control procedures.

(C) The retraining shall reestablish employee proficiency and introduce new or revised control methods and procedures, as necessary.

(iv) The employer shall certify that employee training has been accomplished and is being kept up to date. The certification shall contain each employee's name and dates of training.

(8) "Energy isolation." Lockout or tagout shall be performed only by the authorized employees who are performing the servicing or maintenance.

(9) "Notification of employees." Affected employees shall be notified by the employer or authorized employee of the application and removal of lockout devices or tagout devices. Notification shall be given before the controls are applied, and after they are removed from the machine or equipment.

(d) "**Application of control.**" The established procedures for the application of energy control (the lockout or tagout procedures) shall cover the following elements and actions and shall be done in the following sequence:

(1) "Preparation for shutdown." Before an authorized or affected employee turns off a machine or equipment, the authorized employee shall have knowledge of the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means to control the energy.

(2) "Machine or equipment shutdown." The machine or equipment shall be turned off or shut down using the procedures established for the machine or equipment. An orderly shutdown must be utilized to avoid any additional or increased hazard(s) to employees as a result of the equipment stoppage.

(3) "Machine or equipment isolation." All energy isolating devices that are needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from the energy source(s).

(4) "Lockout or tagout device application." (i) Lockout or tagout devices shall be affixed to each energy isolating device by authorized employees.

(ii) Lockout devices, where used, shall be affixed in a manner to that will hold the energy isolating devices in a "safe" or "off" position.

(iii) Tagout devices, where used, shall be affixed in such a manner as will clearly indicate that the operation or movement of energy isolating devices from the "safe" or "off" position is prohibited.

(A) Where tagout devices are used with energy isolating devices designed with the capability of being locked, the tag attachment shall be fastened at the same point at which the lock would have been
attached.

(B) Where a tag cannot be affixed directly to the energy isolating device, the tag shall be located as close as safely possible to the device, in a position that will be immediately obvious to anyone attempting to operate the device.

(5) "Stored energy." (i) Following the application of lockout or tagout devices to energy isolating devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, and otherwise rendered safe.

(ii) If there is a possibility of re-accumulation of stored energy to a hazardous level, verification of isolation shall be continued until the servicing or maintenance is completed, or until the possibility of such accumulation no longer exists.

(6) "Verification of isolation." Prior to starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and de-energization of the machine or equipment have been accomplished.

(e) "**Release from lockout or tagout.**" Before lockout or tagout devices are removed and energy is restored to the machine or equipment, procedures shall be followed and actions taken by the authorized employee(s) to ensure the following:
(1) "The machine or equipment." The work area shall be inspected to ensure that nonessential items have been removed and to ensure that machine or equipment components are operationally intact.

(2) "Employees." (i) The work area shall be checked to ensure that all employees have been safely positioned or removed.

(ii) Before lockout or tagout devices are removed and before machines or equipment are energized, affected employees shall be notified that the lockout or tagout devices have been removed.

(iii) After lockout or tagout devices have been removed and before a machine or equipment is started, affected employees shall be notified that the lockout or tagout device(s) have been removed.

(3) “Lockout or tagout devices removal.” Each lockout or tagout device shall be removed from each energy isolating device by the employee who applied the device. Exception to paragraph (e)(3). When the authorized employee who applied the lockout or tagout device is not available to remove it, that device may be removed under the direction of the employer, provided that specific procedures and training for such removal have been developed, documented and incorporated into the employer’s energy control program. The employer shall demonstrate that the specific procedure shall include at least the following elements:

(i) Verification by the employer that the authorized employee who applied the device is not at the facility:

(ii) Making all reasonable efforts to contact the authorized employee to inform him/her that his/her lockout or tagout device has been removed; and

(iii) Ensuring that the authorized employee has this knowledge before he/she resumes work at that facility.

(f) "**Additional requirements.**" (1) "Testing or positioning of machines, equipment or components thereof." In situations in which lockout or tagout devices must be temporarily removed from the energy isolating device and the machine or equipment energized to test or position the machine, equipment or component thereof, the following sequence of actions shall be followed:

(i) Clear the machine or equipment of tools and materials in accordance with paragraph (e)(1) of this section;

(ii) Remove employees from the machine or equipment area in accordance with paragraph (e)(2) of this section;

(iii) Remove the lockout or tagout devices as specified in paragraph (e)(3) of this section;

(iv) Energize and proceed with testing or positioning;

(v) De-energize all systems and reapply energy control measures in accordance with paragraph (d) of this section to continue the servicing and/or maintenance.

(2) "Outside personnel (contractors, etc.)." (i) Whenever outside servicing personnel are to be engaged in activities covered by the scope and application of this standard, the on-site employer and the outside employer shall inform each other of their respective lockout or tagout procedures.

(ii) The on-site employer shall ensure that his/her employees understand and comply with the restrictions and prohibitions of the outside employer's energy control program.

(3) “Group lockout or tagout.” (i) When servicing and/or maintenance is performed by a crew, craft, department or other group, they shall utilize a procedure which affords the employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device.

(ii) Group lockout or tagout devices shall be used in accordance with the procedures required by paragraph ©(4) of this section including, but not necessarily limited to, the following specific requirements:

(A) Primary responsibility is vested in an authorized employee for a set number of employees working under the protection of a group lockout or tagout device (such as an operations lock);

(B) Provision for the authorized employee to ascertain the exposure status of individual group members with regard to the lockout or tagout of the machine or equipment and

(C) When more than one crew, craft, department, etc. is involved, assignment of overall job-associated lockout or tagout control responsibility to an authorized employee designated to coordinate affected work forces and ensure continuity of protection; and

(D) Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work, and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained.

(4) “Shift or personnel changes.” Specific procedures shall be utilized during shift or personnel changes to ensure the continuity of lockout or tagout protection, including provision for the orderly transfer of lockout or tagout device protection between off-going and oncoming employees, to minimize exposure to hazards from the unexpected energization or start-up of the machine or equipment, or the release of stored energy.

Note: The following Appendix to 1910.147 services as a non-mandatory guideline to assist employers and employees in complying with the requirements of this section, as well as to provide other helpful information. Nothing in the appendix adds to or detracts from any of the requirements of this section.

[61 FR 5507, Feb. 13, 1996]

Appendix A To 1910.147

Typical Minimal Lockout Procedures

General

The following simple lockout procedure is provided to assist employers in developing their procedures so they meet the requirements of this standard. When the energy isolating devices are not lockable, tagout may be used, provided the employer complies with the provisions of the standard which require additional training and more rigorous periodic inspections. When tagout is used and the energy isolating devices are lockable, the employer must provide full employee protection (see paragraph (c)(3)) and additional training and more rigorous periodic inspections are required. For more complex systems, more comprehensive procedures may need to be developed, documented, and utilized.

Lockout Procedure

Lockout Procedure for

(Name of Company for single procedure or identification of equipment if multiple procedures are used).

Purpose

This procedure establishes the minimum requirements for the lockout of energy isolating devices whenever maintenance or servicing is done on machines or equipment. It shall be used to ensure that the machine or equipment is stopped, isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance where the unexpected energization, start-up of the machine or equipment, or release of stored energy could cause injury.

Compliance With This Program

All employees are required to comply with the restrictions and limitations imposed upon them during the use of lockout. The authorized employees are required to perform the lockout in accordance with this procedure.

All employees, upon observing a machine or piece of equipment which is locked out to perform servicing or maintenance shall not attempt to start, energize, or use that machine or equipment.

Type of compliance enforcement to be taken for violation of the above

Sequence of Lockout

(1) Notify all affected employees that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the servicing or maintenance.

Name(s)/Job Title(s) of affected employees and how to notify.

(2) The authorized employee shall refer to the company procedure to identify the type and magnitude of the energy that the machine or equipment utilizes, shall understand the hazards of the energy, and shall know the methods to control the energy.

Type(s) and magnitude(s) of energy, its hazards and the methods to control the energy.

(3) If the machine or equipment is operating, shut it down by the normal stopping procedure (depress the stop button, open switch, close valve, etc.).

Type(s) and location(s) of machine or equipment operating controls.

(4) De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).

Type(s) and location(s) of energy isolating devices

(5) Lock out the energy isolating device(s) with assigned individual lock(s).

(6) Stored or residual energy (such as that in capacitors, springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.

Type(s) of stored energy - methods to dissipate or restrain

(7) Ensure that the equipment is disconnected from the energy source(s) by first checking that no personnel are exposed, then verify the isolation of the equipment by operating the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.

Caution: Return operating control(s) to neutral or "off" position after verifying the isolation of the equipment.

Method of verifying the isolation of the equipment through testing

(8) The machine or equipment is now locked out.

Restoring Equipment to Service

When the servicing or maintenance is completed and the machine or equipment is ready to return to normal operating condition, the following steps shall be taken.

(1) Check the machine or equipment and the immediate area around the machine to ensure that nonessential items have been removed and that the machine or equipment components are operationally intact.

(2) Check the work area to ensure that all employees have been safely positioned or removed from the area.

(3) Verify that the controls are in neutral.

(4) Remove the lockout devices and re-energize the machine or equipment. Note: The removal of some forms of blocking may require re-energization of the machine before safe removal.

(5) Notify affected employees that the servicing or maintenance is completed and the machine or equipment is ready for used.

[54 FR 36687, Sept. 1, 1989 as amended at 54 FR 42498, Oct. 17, 1989; 55 FR 38685, Sept. 20, 1990]

Equipment Specific Control Procedure Exception

The employer need not document the required procedure for a particular machine or equipment, when all of the following elements exist:

[1] the machine or equipment has no potential for stored or residual energy or re-accumulation of stored energy after shut down which could endanger employees

[2] the machine or equipment has a single energy source which can be readily identified and isolated

[3] the isolation and locking out of that energy source will completely de-energize and deactivate the machine or equipment

[4] the machine or equipment is isolated from that energy source and locked out during servicing or maintenance

[5] a single lockout device will achieve a locker-out condition

[6] the lockout device is under the exclusive control of the authorized employee performing the servicing or maintenance

[7] the servicing or maintenance does not create hazards for other employees

[8] the employer, in utilizing this exception, has had no accidents involving the unexpected activation or re-energization of the machine or equipment during servicing or maintenance.

A Sample

Lockout/Tagout Procedure

A good Lockout/Tagout Procedure, at a minimum, should contain the following elements:

1. All maintenance personnel shall be provided with a good lock. The lock shall have the individual workers' name and other identification on it. Each worker shall have the only key to the lock.

2. The worker shall check to be sure that no one is operating the machinery BEFORE turning -off the power. The machine operator shall be informed before the power is turned off. Sudden loss of power could cause an accident

3. Steam, air and hydraulic lines shall be bled, drained, and cleaned out. There shall be no pressure in these lines or in reservoir tanks.

4. Any mechanism under tension or pressure, such as springs, shall be released and blocked.

5. Each person who will be working on the machinery shall put a lock on the machine's lock-out device(s). Each lock shall remain on the machine until that worker's work is complete.

6. All energy sources which could activate the machine shall be locked out (blocked/tagged).

7. The main valve or main electrical disconnect shall be tested to be sure that the power to the machine is off.

8. Electrical circuits shall be checked with proper and calibrated electrical testing equipment. An electrical failure could energize the equipment even if the switch is in the off position. Stored energy in electrical capacitors shall be safely discharged.

9. When working on machinery such as power presses and welding presses that have a ram which could fall, the ram shall be supported with safety blocks or pins. Fully interlocked safety blocks are the safest.

1910.147 App A

Appendix A - Typical minimal lockout procedures * (Entire Appendix A revised by 55 FR 38686, Sept. 20, 1990).

GENERAL

The following simple lockout procedure is provided to assist employers in developing their procedures so they meet the requirements of this standard. When the energy isolating devices are not lockable, tagout may be used, provided the employer complies with the provisions of the standard which require additional training and more rigorous periodic inspections. When tagout is used and the energy isolating devices are lockable, the employer must provide full employee protection (see paragraph (c)(3)) and additional training and more rigorous periodic inspections are required. For more complex systems, more comprehensive procedures may need to be developed, documented, and utilized.

LOCKOUT PROCEDURE

Lockout Procedure for _____
(Name of Company for single procedure or identification of equipment if multiple procedures are used).

Purpose

This procedure establishes the minimum requirements for the lockout of energy isolating devices whenever maintenance or servicing is done on machines or equipment. It shall be used to ensure that the machine or equipment is stopped, isolated from all potentially hazardous energy sources and locked out before employees perform any servicing or maintenance where the unexpected energization or start-up of the machine or equipment or release of stored energy could cause injury.

Compliance With This Program

All employees are required to comply with the restrictions and limitations imposed upon them during the use of lockout. The authorized employees are required to perform the lockout in accordance with this procedure. All employees, upon observing a machine or piece of equipment which is locked out to perform servicing or maintenance shall not attempt to start, energize, or use that machine or equipment. _____ Type of compliance enforcement to be taken for violation of the above.

Sequence of Lockout

(1) Notify all affected employees that servicing or maintenance is required on a machine or equipment and that the machine or equipment must be shut down and locked out to perform the servicing or maintenance.

_____ Name(s)/Job Title(s) of affected employees and how to notify.

(2) The authorized employee shall refer to the company procedure to identify the type and magnitude of the energy that the machine or equipment utilizes, shall understand the hazards of the energy, and shall know the methods to control the energy.

_____ Type(s) and magnitude(s) of energy, its hazards, and the methods to control the energy.

(3) If the machine or equipment is operating, shut it down by the normal stopping procedure (depress the stop button, open switch, close valve, etc.).
_____ Type(s) and location(s) of machine or equipment operating controls.

(4) De-activate the energy isolating device(s) so that the machine or equipment is isolated from the energy source(s).
_____ Type(s) and location(s) of energy isolating devices.

(5) Lock out the energy isolating device(s) with assigned individual lock(s).

(6) Stored or residual energy (such as that in capacitors, springs, elevated

machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as grounding, repositioning, blocking, bleeding down, etc.

_____ Type(s) of stored energy - methods to dissipate or restrain.

(7) Ensure that the equipment is disconnected from the energy source(s) by first checking that no personnel are exposed, then verify the isolation of the equipment by operating the push button or other normal operating control(s) or by testing to make certain the equipment will not operate.
Caution: Return operating control(s) to “neutral” or "off" position after verifying the isolation of the equipment.

_____ Method of verifying the isolation of the equipment.

(8) The machine or equipment is now locked out.
Restoring Equipment to Service - When the servicing or maintenance is completed and the machine or equipment is ready to return to normal operating condition, the following steps shall be taken:

1) Check the machine or equipment and the immediate area around the machine to ensure that nonessential items have been removed and that the machine or equipment components are operationally intact.

2) Check the work area to ensure that all employees have been safely positioned or removed from the area.

3) Verify that the controls are in neutral.

4) Remove the lockout devices and re-energize the machine or equipment.
Note: The removal of some forms of blocking may require re-energization of the machine before safe removal.

5) Notify affected employees that the servicing or maintenance is completed and the machine or equipment is ready for used.

Lockout/Tagout
Energy Source Identification

Machine: **Date:**

Location: **Dept.:**

Person Identifying Sources:

Type of Energy	Yes	No	Method, Device or System Selected to De-Energize, Power Source (Voltage, Pressure, etc.)
Electrical			
Hydraulic			
Pneumatic (Air)			
Chemical			
Thermal			
Mechanical			
Cord &)Plug Connected			
Other			

Hazardous Energy Control Procedures Lockout

Sample Program

I. PURPOSE AND SCOPE

Effective hazardous energy control procedures will protect employees during machine and equipment servicing and maintenance where the unexpected energization, start up or release of stored energy could occur and cause injury; as well as, while working on or near exposed de-energized electrical conductors and parts of electrical equipment. Hazards being guard against include being caught in, being crushed by, being struck by, being thrown from, or contacting live electrical circuits/parts.

The procedure herein established (III - VIII) will ensure that machines and equipment are properly isolated from hazardous or potentially hazardous energy sources during servicing and maintenance and properly protect against re-energization as required by *29 CFR 1910.147*.

While any employee is exposed to contact with parts of fixed electrical equipment or circuits which have been de-energized, the circuits energizing the parts shall be locked out & tagged in accordance with the requirements of *29 CFR 1910.333 (b) (2). (See this OSHA standard)*

Only when disconnecting means or other devices are incapable of being locked out, and until lockout capability is provided, will a tagout procedure (without lockout), be utilized. *(See Appendix A).*

II. ENFORCEMENT

Any employee who fails to follow these procedures will face disciplinary action in accordance with those listed in the company handbook.

III. <u>DEFINITIONS</u>

Authorized employee - a person who locks out machines or equipment in order to perform servicing or maintenance on that machine or equipment. An affected employee becomes an authorized employee when that employee's duties include performing servicing or maintenance which exposes him/her to potentially hazardous

energy.
Affected employee - an employee whose job requires him/her to operate/use a machine or equipment or work in an area in which servicing or maintenance is being performed under lockout.

Energy isolating device - a mechanical device that physically prevents the transmission or release of energy, including but not limited to the following:

- A manually operated electrical circuit breaker
- A disconnect switch;
- A manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors, and in addition, no pole can be operated independently;
- A line valve; a block; and
- Any similar device used to block or isolate energy.

Push buttons, selectors switches, and other control circuit type devices are not energy isolating devices.

Other employee - an employee whose work operations are or may be in an area where energy control procedures may be utilized.

For additional definitions see *29 CFR 1910.147 (b).*

IV. AUTHORIZATION/RESPONSIBILITY

Appropriate employees will be instructed in the safety significance of the lockout procedures. Appendix B is a list of employees authorized to lockout. Appendices' C and D are a list of job titles for affected and other employees.

V. RULES

A. Locks, chains, wedges, or other hardware which meet the requirements defined in *1910.147 (c) (5) (ii)* shall be provided by the company.

B. Lockout devices shall be singularly identified. They shall be the only devices used for controlling energy and shall not be used for other purposes.

C. The lockout devices shall indicate the identity of the employee applying the devices.

D. All machines/equipment shall be locked out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. Lockout will also apply when working on or near exposed de-energized electrical circuits/parts.

E. No employee shall attempt to operate any switch, valve, or other energy isolating device which is locked out.

F. Each lockout device shall only be removed by the employee who applied the device. *(Exception: see VII. B. 2.)*

VI. LOCKOUT PROCEDURES AND TECHNIQUES

A. Preparation for Shutdown

1. In preparation for lockout, an initial survey must be made to locate and identify all energy isolating devices to be certain which switch, valve, or other energy isolating devices apply to the machine/equipment to be locked out.

(See Appendix E for Energy Source Evaluation) More than one energy source (electrical, hydraulic, pneumatic, chemical, thermal, or others) may be involved.

2. Before an authorized or affected employee turns off a machine or piece of equipment, the authorized employee must have knowledge of the type and magnitude of the energy to be controlled, and the methods or means to control the energy.

(See Appendix F for Specific Energy Control Procedures)

Note: If work to be performed involves employees working on or near exposed de-energized electrical parts.

(See 29 CFR 1910.333)

B. Machine or Equipment Shutdown

1. All affected employees shall be notified that a lockout system is going to be utilized and the reason for it, before the controls are applied.

2. If the machine or equipment is operating, shut it down by normal stopping procedure. (Depress stop button, open toggle switch, etc.)

C. Machine or Equipment Isolation

Physically locate and operate the switch, valve, or other energy isolating devices so that the equipment is isolated from its energy sources and apply adequate hardware.

D. Lockout Device Application

1. Authorized employees shall lockout the energy isolating devices with assigned individual locks.

2. Lockout devices shall be applied so that they will hold the energy isolating devices in a "Neutral" or "Off" position.

E. Stored Energy

All stored or residual energy in rams, flywheels, springs, pneumatic, or hydraulic systems, etc. shall be blocked or dissipated. If there is a possibility of re-accumulation of stored energy, verification of isolation must be continued until servicing or maintenance is completed.

F. Verification Of Isolation.

Prior to starting work on machines or equipment that have been locked and after ensuring that no personnel are exposed, the authorized employee shall operate the push button or normal operating controls to verify that the appropriate equipment or machine has been de-energized and make certain it will not operate.
Caution: Return operating controls to the "*Neutral*" or "*Off*" position after the test. The machine/equipment is now locked out. Servicing or maintenance may now occur.

VII. REMOVAL OF LOCKOUT DEVICES

A. After the servicing and/or maintenance is completed and before the lockout devices are removed and energy is restored, the sequence of activities in Appendix F shall be completed by the authorized employee(s).

B. If the authorized employee who applied the lock is not available, the supervisor shall take the following steps:

- Clear the machine or equipment of tools and materials.

- Remove employees from the machine or equipment.
- Remove the lockout device.
- Energize and proceed with testing or positioning.
- De-energize all systems and reapply energy control measures in accordance with procedures set forth under Section VI.

VIII. ADDITIONAL REQUIREMENTS

A. In the preceding steps, if more than one individual is required to lockout machines/equipment (group lockout), the following procedures shall be implemented to provide protection to all employees.

1. A primary authorized employee will be designated and responsible for the number of people working under the protection of the group lockout device. The primary authorized employee will ascertain the exposure status of the individual member participating in the group lockout to ensure continuity of protection for each individual. In addition, this primary authorized employee will be responsible for notifying affected employees before and after lockout procedures are performed.

2. Each authorized employee will place his/her own personal lockout device on the energy isolating device(s).

3. When an energy isolating device cannot accept multiple locks, a multiple lockout system must be used. Specific group lockout procedures are outline in Appendix F.

B. *Shift or Personnel Changes* - If a lockout procedure will extend into the following shift, the authorized employee who originally placed the lock will remove it and it will immediately be replaced with the lock of the authorized employee who is to continue the repair or maintenance on that equipment or machine for the following shift.

C. *Cord and Plug Connected Equipment* - If servicing or maintenance is performed on cord and plug connected equipment the following procedure shall be performed to protect employees.

1. Unplug equipment from its electrical socket.

2. Place a lockable cover over the plug and a lock on the plug cover during machine/equipment servicing or maintenance.

D. *Outside Contractors* - If outside contractors perform servicing or maintenance that requires lockout, the Safety Director shall take the following steps.

1. Inform the outside contractor of out company's lockout procedures and supply them with a copy.

2. Obtain and review a copy of the outside contractor's lockout procedures.

3. Ensure that our employees understand and comply with the responsibilities and prohibitions of the outside contractor's lockout procedure.

E. *Training*

1. Authorized employees shall receive training covering:

- Recognition of hazardous energy sources.
- Types and magnitude of hazardous energy in the workplace.
- Methods, devices, and procedures used to lockout, verify lockout, and otherwise control hazardous energy on all pieces or types of equipment (including cord and plug connected equipment).
- Procedures for removing locks and returning a machine or piece of equipment to operation.
- Transfer of lockout responsibilities.
- Group lockout procedures.

2. Affected and all "other" employees shall receive training so that they are able to:

- Recognize when energy control procedures are being implemented, and
- Understanding the purpose of the procedures and the importance of not attempting to start up or use the machine/equipment that has been locked out.

Note: All training will be certified - *(See Appendix G).*

F. *Retraining* - Authorized and affected employees shall receive retraining in proper application of lockout procedures when there is a change in:

- Job assignment(s) that expose an authorized employee to

new hazards or lockout procedures.

- Machines, equipment, or processes that present a new hazard or require modified lockout procedures.
- Energy control procedures for a piece or type of equipment.
- Or when it becomes known that an employee incorrectly performs lockout procedures.

Retraining will re-establish employee proficiency in lockout, and ensure that employees are knowledgeable of new or revised procedures. All retraining will be certified (see Appendix G).

G. *Periodic Inspections:*

1. An inspection of the energy control procedures will be conducted annually and will be certified (see Appendix H).

2. Energy control procedures for each machine or type of machine must be inspected.

3. The inspection shall include a review of lockout responsibilities with each individual authorized to lockout the machine/equipment.

4. The person who performs the inspection must be authorized to perform the lockout procedures being inspected. The inspector cannot, however, review his/her own use of lockout procedures.

5. Any deviations or inadequacies identified shall be immediately addressed.

APPENDIX A

TAGOUT PROCEDURES

A.When a disconnecting means or other energy isolating device is incapable of being locked out, a tagout system shall be utilized. A tag used without a lock, shall be supplemented by at least on additional safety measure that provides a level of safety equivalent to that obtained by use of a lock such as opening an additional disconnecting device, removal of an isolating circuit element, blocking of a controlling switch or the removal of a valve handle to reduce the likelihood of inadvertent energization.

B. Only tags furnished by the company which meet the requirements of *1910.147 (c) (5) (ii)* and *(iii)* shall be used.

C. All employees shall be trained in the use and limitations of tags as described in *1910.147 (c) (7) (ii)* and *(d) (4) (iii).*

D. All employees must be able to understand the hazard warning written on the tags such as: DO NOT START, DO NOT OPEN, DO NOT CLOSE,
DO NOT ENERGIZE, DO NOT OPERATE.

E. On machines and equipment where tagout is used in lieu of lockout, the Periodic Inspection required by *1910.147 (c) (6)* shall include the affected as well as the authorized employee(s). The periodic inspection shall be certified on Appendix H.

F. If tagout is used all other lockout rules and procedures apply.

Note: Should the machine/equipment required upgrade or modification, it will have lockable switches, fittings, valves, etc. added so that it becomes possible to lockout.

APPENDIX B

LIST OF AUTHORIZED LOCKOUT INDIVIDUALS

Name	Job Title	Means Used to I.D. Locks

Date: _____/_____/_____

APPENDIX C

LIST OF AFFECTED EMPLOYEES BY JOB TITLES

Job Titles	Machinery, Equipment, or Process

Date: _____/_____/_____

APPENDIX D

LIST OF "OTHER" EMPLOYEES BY JOB TITLES

Job Titles	Machinery, Equipment, or Process

Date: _____/_____/_____

APPENDIX E

ENERGY SOURCE EVALUATION

Date: ____/ ___/____ Conducted By: _____

In order to determine all energy sources for each piece or type of machine or equipment, fill in the following table.

Location: _____ Work Center: _____

Equipment Name: _____

Model: _____ Serial #: _____

Lockout Procedure Number: _____

Energy Source*Magnitude	Location of Isolating Device	Means of Isolation
Electrical		
Engine		
Spring		
Counter Weight		
Flywheel		
Hydraulic		
Pneumatic		
Chemical		
Thermal		
Other		

*** Magnitude Example -- Electrical = 480v three phase**
Pneumatic = 125 p.s.i.

APPENDIX F

Specific Energy Control Procedures
For Each Piece or Type of Machine or Equipment

Procedure Numbers: _____

Date: ____/____/____ Completed By: _____

Machines or Equipment Utilizing this Procedure:

_____ _____
_____ _____

Procedure for Controlling Hazardous Energy:

1. Be familiar with the sources of hazardous energy for the machine or equipment that will be serviced. See Appendix F (Energy Source Evaluation)

Sources of Hazardous Energy

___ Electrical	___ Engine	___ Spring
___ Counter Weight	___ Flywheel	___ Hydraulic
___ Pneumatic	___ Chemical	___ Thermal
___ Other _____		

2. Notify affected employees that the machine is about to be shut down and locked out. Specific Instructions:

_____
_____
_____

3. Shut down the machine using normal stopping procedures. Specific Instructions:

_____
_____
_____

4. Isolate all energy sources listed above. Specific Instructions:

_____
_____
_____

5. **A.** Apply locks to all isolation devices operated in step four. Specific Instructions:

_____
_____
_____

B. If a tag is used in lieu of a lock when the energy isolating device is incapable of lockout (*see Appendix A*), the following additional safety precaution(s) shall be taken:

_____
_____
_____

6. Block or dissipate all stored energy in rams, flywheels, springs, pneumatic or hydraulic systems, etc. Specific Instructions:

_____
_____
_____

7. Verify that the machine is locked out by testing the machine operating controls. RETURN ALL CONTROLS TO THE "*NEUTRAL*" OR "*OFF*" POSITION AFTER TESTING. Specific Instructions:

_____
_____
_____

Procedures for Removing Locks/Tags:

1. Check the machine to be sure it is operationally intact, tools have been removed, and guards have been replaced. Specific Instructions:

_____
_____
_____

2. Check to be sure all employees are safely positioned.
   Specific Instructions:

   _____
   _____
   _____

3. Notify all affected employees that locks/tags are going to be removed and the machine is ready for operation. Specific Instructions:

   _____
   _____
   _____

4. Remove all locks, blocks, or other energy restraints.
   Specific Instructions:

   _____
   _____
   _____

5. Restore all energy to the machine. Specific Instructions:

   _____
   _____
   _____

Other Comments:

_____
_____
_____
_____
_____
_____
_____
_____

APPENDIX G-1

"Authorized" Employee Training Certification

Date Of Training: ____/____/____

Instructor: _____

Signature: _____

The following employees have received "Authorized" employee training on lockout/tagout procedures.

Employee Name (**Please Print**)	**Employee Signature**

APPENDIX G-2

"Affected" Employee Training Certification

Date of Training: ____/____/____

Instructor: _____

Signature: _____

The following employees have received "Affected" employee training on lockout/tagout procedures.

Employee Name (**Please Print**)	**Employee Signature:**

APPENDIX G-3

"Other" Employee Training Certification

Date of Training: ____/____/____

Instructor: _____

Signature: _____

The following employees have received "Other" employee training on lockout/tagout procedures.

Employee Name: **(Please Print)**	**Employee Signature:**

APPENDIX H

Periodic Inspection Certification

Date of Training: ____/____/____

Instructor: _____

Signature: _____

Machine or equipment on which lockout/tagout procedures were performed:

Employee(s) performing the lockout/tagout procedures:

Employee Name(Please Print)	**Employee Signature**
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Were all the lockout/tagout procedures performed correctly? **Yes** **No**

Comments on improper Lockout/Tagout Procedures being used **(Example:** List of improper procedures being used which require retraining for the employee or modification of procedures):

_____
_____
_____
_____
_____
_____
_____
_____
_____

Hazardous Energy Control Procedures:

Name of employee exposed to the hazard: _____

Machine/Equipment on which the task is being performed:

_____

Servicing/Maintenance task being performed:

_____

Frequency in which the employee performs the task:
_____ times per _____

Duration for which the employee has performed the task:
_____ hour/day/week

Hazard to which the employee is exposed when performing this task:

_____ caught in _____

_____ crushed by _____

_____ struck by _____

_____ thrown from _____

_____ contact with _____

_____ other _____

Energy source which exposes the employee to a hazard:

___ Electrical	___ Engine
___ Spring	___ Counter Weight
___ Flywheel	___ Hydraulic
___ Pneumatic	___ Chemical
___ Thermal	___ Other _____

Magnitude of the energy source:

____ Volts ____ Phase ____ PSI ____ Degree F ____ Tons

Potential Injury associated with the improper isolation of energy:

Crushed _____
Fractured _____
Amputated _____
Lacerated _____
Punctured _____
Burns _____
____ Air Embolism ____ Death ____ Electric Shock
Other
_____

Means of Isolating the Energy Source (Procedures Used):
[If tagout is used see *1910.147 (c) (3) (ii)]*

Location: _____ Method:
_____

If machine/equipment is not capable of lockout when was it installed, renovated, modified, or repaired (major)? After 1/02/90 ___/___/___

If Electrical, cord/plug (circle one); **Yes No**

Hazards discussed with exposed employee:
Mr./Ms. _____

Remarks/Signed Statement (if documenting past exposure)
Hazard reviewed with employer:
Mr./Ms. _____

Remarks:_____
_____
_____
_____
_____
_____

The Control of Hazardous Energy (Lockout/Tagout)*1910.147*
Written Procedures Evaluation

Yes	**No**	
		Do the written procedures contain the following elements:
___	___	A definition of the purpose and scope of lockout and/or tagout procedures.
___	___	Basic lockout/tagout rules and authorization.
___	___	Means of enforcing compliance.
		Specific procedures for:
___	___	Shutting down machines and/or equipment.
___	___	Isolating, blocking, and securing machines and/or equipment.
___	___	Placement of lockout/tagout devices.
___	___	Releasing stored energy.
___	___	Testing a machine and/or equipment to verify the effectiveness of the lockout/tagout devices.
___	___	Removal of lockout/Tagout devices.
___	___	Transfer of lockout/tagout devices during group lockout/tagout [If Applicable].
___	___	Responsibility for lockout/tagout devices during group lockout/tagout [If Applicable].
___	___	Group Lockout/Tagout [If Applicable].
___	___	Additional measures taken if a tag is used in lieu of a lock.

The employer must comply with the following items, however they do not have to be included in the written procedures:

___ ___ Provide energy control devices which meet the requirements defined in *1910.147 (c) (5).*

___ ___ Inform outside contractors of your lockout/tagout program and notify your employees of the contractor's energy control program.

___ ___ Certification of a periodic inspection conducted at least annually.

___ ___ Certification of training and retraining for authorized, affected, and other employees.

___ ___ Handling cord and plug connected equipment 1910.147(a)(2)(iii)(A).

The control of hazardous energy (lockout/tagout). - 1910.147

Regulations (Standards - 29 CFR) - Table of Contents

• **Part Number:**	1910
• **Part Title:**	Occupational Safety and Health Standards
• **Subpart:**	J
• **Subpart Title:**	General Environmental Controls
• **Standard Number:**	1910.147
• **Title:**	The control of hazardous energy (lockout/tagout).
• **Appendix:**	A

1910.147(a)

Scope, application and purpose -

1910.147(a)(1)

Scope

1910.147(a)(1)(i)

This standard covers the servicing and maintenance of machines and equipment in which the **unexpected** energization or start up of the machines or equipment, or release of stored energy could cause injury to employees. This standard establishes minimum performance requirements for the control of such hazardous energy.

1910.147(a)(1)(ii)

This standard does not cover the following:

1910.147(a)(1)(ii)(A)

Construction, agriculture and maritime employment;

1910.147(a)(1)(ii)(B)

Installations under the exclusive control of electric utilities for the purpose of power generation, transmission and distribution, including related equipment for communication or metering; and

1910.147(a)(1)(ii)(C)

Exposure to electrical hazards from work on, near, or with conductors or equipment in electric utilization installations, which is covered by Subpart S of this part; and

..1910.147(a)(1)(ii)(D)

1910.147(a)(1)(ii)(D)

Oil and gas well drilling and servicing.

1910.147(a)(2)

Application.

1910.147(a)(2)(i)

This standard applies to the control of energy during servicing and/or maintenance of machines and equipment.

1910.147(a)(2)(ii)

Normal production operations are not covered by this standard (See Subpart O of this Part). Servicing and/or maintenance which takes place during normal production operations is covered by this standard only if:

1910.147(a)(2)(ii)(A)

An employee is required to remove or bypass a guard or other safety device; or

1910.147(a)(2)(ii)(B)

An employee is required to place any part of his or her body into an area on a machine or piece of equipment where work is actually performed upon the material being processed (point of operation) or where an associated danger zone exists during a machine operating cycle.

Note: **Exception to paragraph (a)(2)(ii):** Minor tool changes and adjustments, and other minor servicing activities, which take place during normal production operations, are not covered by this standard if they are routine, repetitive, and integral to the use of the equipment for production, provided that the work is performed using alternative measures which provide effective protection (See Subpart O of this Part).

1910.147(a)(2)(iii)

This standard does not apply to the following:

..1910.147(a)(2)(iii)(A)

1910.147(a)(2)(iii)(A)

Work on cord and plug connected electric equipment for which exposure to the hazards of unexpected energization or start up of the equipment is controlled by the unplugging of the equipment from the energy source and by the plug being under the exclusive control of the

employee performing the servicing or maintenance.

1910.147(a)(2)(iii)(B)

Hot tap operations involving transmission and distribution systems for substances such as gas, steam, water or petroleum products when they are performed on pressurized pipelines, provided that the employer demonstrates that-

1910.147(a)(2)(iii)(B)(1)

continuity of service is essential;

1910.147(a)(2)(iii)(B)(2)

shutdown of the system is impractical; and

1910.147(a)(2)(iii)(B)(3)

documented procedures are followed, and special equipment is used which will provide proven effective protection for employees.

1910.147(a)(3)

Purpose.

1910.147(a)(3)(i)

This section requires employers to establish a program and utilize procedures for affixing appropriate lockout devices or tagout devices to energy isolating devices, and to otherwise disable machines or equipment to prevent unexpected energization, start up or release of stored energy in order to prevent injury to employees.

1910.147(a)(3)(ii)

When other standards in this part require the use of lockout or tagout, they shall be used and supplemented by the procedural and training requirements of this section.

1910.147(b)

Definitions applicable to this section.

Affected employee. An employee whose job requires him/her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed.

Authorized employee. A person who locks out or tags out machines or equipment in order to perform servicing or maintenance on that machine or equipment. An affected employee

becomes an authorized employee when that employee's duties include performing servicing or maintenance covered under this section.

Capable of being locked out. An energy isolating device is capable of being locked out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

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, including but not limited to the following: A manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors, and, in addition, no pole can be operated independently; a line valve; a block; and any similar device used to block or isolate energy. Push buttons, selector switches and other control circuit type devices are not energy isolating devices.

Energy source. Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Hot tap. A procedure used in the repair, maintenance and services activities which involves welding on a piece of equipment (pipelines, vessels or tanks) under pressure, in order to install connections or appurtenances. it is commonly used to replace or add sections of pipeline without the interruption of service for air, gas, water, steam, and petrochemical distribution systems.

Lockout. The placement of a lockout device on an energy isolating device, in accordance with an established procedure, ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout device. A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy isolating device in the safe position and prevent the energizing of a machine or equipment. Included are blank flanges and bolted slip blinds.

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

Servicing and/or maintenance. Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, and maintaining and/or servicing machines or equipment. These activities include lubrication, cleaning or unjamming of machines or equipment and making adjustments or tool changes, where the employee may be exposed to the **unexpected** energization or startup of the equipment or release of hazardous energy.

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

production operation.

Tagout. The placement of a tagout device on an energy isolating device, in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Tagout device. A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

..1910.147(c)

1910.147(c)

General -

1910.147(c)(1)

Energy control program. The employer shall establish a program consisting of energy control procedures, employee training and periodic inspections to ensure that before any employee performs any servicing or maintenance on a machine or equipment where the unexpected energizing, startup or release of stored energy could occur and cause injury, the machine or equipment shall be isolated from the energy source and rendered inoperative.

1910.147(c)(2)

Lockout/tagout.

1910.147(c)(2)(i)

If an energy isolating device is not capable of being locked out, the employer's energy control program under paragraph (c)(1) of this section shall utilize a tagout system.

1910.147(c)(2)(ii)

If an energy isolating device is capable of being locked out, the employer's energy control program under paragraph (c)(1) of this section shall utilize lockout, unless the employer can demonstrate that the utilization of a tagout system will provide full employee protection as set forth in paragraph (c)(3) of this section.

1910.147(c)(2)(iii)

After January 2, 1990, whenever replacement or major repair, renovation or modification of a machine or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for such machine or equipment shall be designed to accept a lockout

device.

1910.147(c)(3)

Full employee protection.

1910.147(c)(3)(i)

When a tagout device is used on an energy isolating device which is capable of being locked out, the tagout device shall be attached at the same location that the lockout device would have been attached, and the employer shall demonstrate that the tagout program will provide a level of safety equivalent to that obtained by using a lockout program.

..1910.147(c)(3)(ii)

1910.147(c)(3)(ii)

In demonstrating that a level of safety is achieved in the tagout program which is equivalent to the level of safety obtained by using a lockout program, the employer shall demonstrate full compliance with all tagout-related provisions of this standard together with such additional elements as are necessary to provide the equivalent safety available from the use of a lockout device. Additional means to be considered as part of the demonstration of full employee protection shall include the implementation of additional safety measures such as the removal of an isolating circuit element, blocking of a controlling switch, opening of an extra disconnecting device, or the removal of a valve handle to reduce the likelihood of inadvertent energization.

1910.147(c)(4)

Energy control procedure.

1910.147(c)(4)(i)

Procedures shall be developed, documented and utilized for the control of potentially hazardous energy when employees are engaged in the activities covered by this section.

Note: **Exception:** The employer need not document the required procedure for a particular machine or equipment, when all of the following elements exist: (1) The machine or equipment has no potential for stored or residual energy or reaccumulation of stored energy after shut down which could endanger employees; (2) the machine or equipment has a single energy source which can be readily identified and isolated; (3) the isolation and locking out of that energy source will completely deenergize and deactivate the machine or equipment; (4) the machine or equipment is isolated from that energy source and locked out during servicing or maintenance; (5) a single lockout device will achieve a locker-out condition; (6) the lockout device is under the exclusive control of the authorized employee performing the servicing or maintenance; (7) the servicing or maintenance does not create hazards for other employees; and (8) the employer, in utilizing this exception, has had no accidents involving

the unexpected activation or reenergization of the machine or equipment during servicing or maintenance.

1910.147(c)(4)(ii)

The procedures shall clearly and specifically outline the scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy, and the means to enforce compliance including, but not limited to, the following:

1910.147(c)(4)(ii)(A)

A specific statement of the intended use of the procedure;

1910.147(c)(4)(ii)(B)

Specific procedural steps for shutting down, isolating, blocking and securing machines or equipment to control hazardous energy;

1910.147(c)(4)(ii)(C)

Specific procedural steps for the placement, removal and transfer of lockout devices or tagout devices and the responsibility for them; and

..1910.147(c)(4)(ii)(D)

1910.147(c)(4)(ii)(D)

Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures.

1910.147(c)(5)

Protective materials and hardware.

1910.147(c)(5)(i)

Locks, tags, chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware shall be provided by the employer for isolating, securing or blocking of machines or equipment from energy sources.

1910.147(c)(5)(ii)

Lockout devices and tagout devices shall be singularly identified; shall be the only devices(s) used for controlling energy; shall not be used for other purposes; and shall meet the following requirements:

1910.147(c)(5)(ii)(A)

Durable.

1910.147(c)(5)(ii)(A)(1)

Lockout and tagout devices shall be capable of withstanding the environment to which they are exposed for the maximum period of time that exposure is expected.

1910.147(c)(5)(ii)(A)(2)

Tagout devices shall be constructed and printed so that exposure to weather conditions or wet and damp locations will not cause the tag to deteriorate or the message on the tag to become illegible.

1910.147(c)(5)(ii)(A)(3)

Tags shall not deteriorate when used in corrosive environments such as areas where acid and alkali chemicals are handled and stored.

..1910.147(c)(5)(ii)(B)

1910.147(c)(5)(ii)(B)

Standardized. Lockout and tagout devices shall be standardized within the facility in at least one of the following criteria: Color; shape; or size; and additionally, in the case of tagout devices, print and format shall be standardized.

1910.147(c)(5)(ii)(C)

Substantial -

1910.147(c)(5)(ii)(C)(1)

Lockout devices. Lockout devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques, such as with the use of bolt cutters or other metal cutting tools.

1910.147(c)(5)(ii)(C)(2)

Tagout devices. Tagout devices, including their means of attachment, shall be substantial enough to prevent inadvertent or accidental removal. Tagout device attachment means shall be of a non-reusable type, attachable by hand, self-locking, and non-releasable with a minimum unlocking strength of no less than 50 pounds and having the general design and basic characteristics of being at least equivalent to a one-piece, all environment-tolerant nylon cable tie.

1910.147(c)(5)(ii)(D)

Identifiable. Lockout devices and tagout devices shall indicate the identity of the employee applying the device(s).

1910.147(c)(5)(iii)

Tagout devices shall warn against hazardous conditions if the machine or equipment is energized and shall include a legend such as the following: **Do Not Start. Do Not Open. Do Not Close. Do Not Energize. Do Not Operate.**

..1910.147(c)(6)

1910.147(c)(6)

Periodic inspection.

1910.147(c)(6)(i)

The employer shall conduct a periodic inspection of the energy control procedure at least annually to ensure that the procedure and the requirements of this standard are being followed.

1910.147(c)(6)(i)(A)

The periodic inspection shall be performed by an authorized employee other than the ones(s) utilizing the energy control procedure being inspected.

1910.147(c)(6)(i)(B)

The periodic inspection shall be conducted to correct any deviations or inadequacies identified.

1910.147(c)(6)(i)(C)

Where lockout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized employee, of that employee's responsibilities under the energy control procedure being inspected.

1910.147(c)(6)(i)(D)

Where tagout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized and affected employee, of that employee's responsibilities under the energy control procedure being inspected, and the elements set forth in paragraph (c)(7)(ii) of this section.

..1910.147(c)(6)(ii)

1910.147(c)(6)(ii)

The employer shall certify that the periodic inspections have been performed. The certification shall identify the machine or equipment on which the energy control procedure was being utilized, the date of the inspection, the employees included in the inspection, and the person performing the inspection.

1910.147(c)(7)

Training and communication.

1910.147(c)(7)(i)

The employer shall provide training to ensure that the purpose and function of the energy control program are understood by employees and that the knowledge and skills required for the safe application, usage, and removal of the energy controls are acquired by employees. The training shall include the following:

1910.147(c)(7)(i)(A)

Each authorized employee shall receive training in the recognition of applicable hazardous energy sources, the type and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control.

1910.147(c)(7)(i)(B)

Each affected employee shall be instructed in the purpose and use of the energy control procedure.

1910.147(c)(7)(i)(C)

All other employees whose work operations are or may be in an area where energy control procedures may be utilized, shall be instructed about the procedure, and about the prohibition relating to attempts to restart or reenergize machines or equipment which are locked out or tagged out.

1910.147(c)(7)(ii)

When tagout systems are used, employees shall also be trained in the following limitations of tags:

..1910.147(c)(7)(ii)(A)

1910.147(c)(7)(ii)(A)

Tags are essentially warning devices affixed to energy isolating devices, and do not provide the physical restraint on those devices that is provided by a lock.

1910.147(c)(7)(ii)(B)

When a tag is attached to an energy isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.

1910.147(c)(7)(ii)(C)

Tags must be legible and understandable by all authorized employees, affected employees, and all other employees whose work operations are or may be in the area, in order to be effective.

1910.147(c)(7)(ii)(D)

Tags and their means of attachment must be made of materials which will withstand the environmental conditions encountered in the workplace.

1910.147(c)(7)(ii)(E)

Tags may evoke a false sense of security, and their meaning needs to be understood as part of the overall energy control program.

1910.147(c)(7)(ii)(F)

Tags must be securely attached to energy isolating devices so that they cannot be inadvertently or accidentally detached during use.

1910.147(c)(7)(iii)

Employee retraining.

..1910.147(c)(7)(iii)(A)

1910.147(c)(7)(iii)(A)

Retraining shall be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in machines, equipment or processes that present a new hazard, or when there is a change in the energy control procedures.

1910.147(c)(7)(iii)(B)

Additional retraining shall also be conducted whenever a periodic inspection under paragraph (c)(6) of this section reveals, or whenever the employer has reason to believe that there are deviations from or inadequacies in the employee's knowledge or use of the energy control procedures.

1910.147(c)(7)(iii)(C)

The retraining shall reestablish employee proficiency and introduce new or revised control

methods and procedures, as necessary.

1910.147(c)(7)(iv)

The employer shall certify that employee training has been accomplished and is being kept up to date. The certification shall contain each employee's name and dates of training.

1910.147(c)(8)

Energy isolation. Lockout or tagout shall be performed only by the authorized employees who are performing the servicing or maintenance.

1910.147(c)(9)

Notification of employees. Affected employees shall be notified by the employer or authorized employee of the application and removal of lockout devices or tagout devices. Notification shall be given before the controls are applied, and after they are removed from the machine or equipment.

..1910.147(d)

1910.147(d)

Application of control. The established procedures for the application of energy control (the lockout or tagout procedures) shall cover the following elements and actions and shall be done in the following sequence:

1910.147(d)(1)

Preparation for shutdown. Before an authorized or affected employee turns off a machine or equipment, the authorized employee shall have knowledge of the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means to control the energy.

1910.147(d)(2)

Machine or equipment shutdown. The machine or equipment shall be turned off or shut down using the procedures established for the machine or equipment. An orderly shutdown must be utilized to avoid any additional or increased hazard(s) to employees as a result of the equipment stoppage.

1910.147(d)(3)

Machine or equipment isolation. All energy isolating devices that are needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from the energy source(s).

1910.147(d)(4)

Lockout or tagout device application.

1910.147(d)(4)(i)

Lockout or tagout devices shall be affixed to each energy isolating device by authorized employees.

..1910.147(d)(4)(ii)

1910.147(d)(4)(ii)

Lockout devices, where used, shall be affixed in a manner to that will hold the energy isolating devices in a "safe" or "off" position.

1910.147(d)(4)(iii)

Tagout devices, where used, shall be affixed in such a manner as will clearly indicate that the operation or movement of energy isolating devices from the "safe" or "off" position is prohibited.

1910.147(d)(4)(iii)(A)

Where tagout devices are used with energy isolating devices designed with the capability of being locked, the tag attachment shall be fastened at the same point at which the lock would have been attached.

1910.147(d)(4)(iii)(B)

Where a tag cannot be affixed directly to the energy isolating device, the tag shall be located as close as safely possible to the device, in a position that will be immediately obvious to anyone attempting to operate the device.

1910.147(d)(5)

Stored energy.

1910.147(d)(5)(i)

Following the application of lockout or tagout devices to energy isolating devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, and otherwise rendered safe.

..1910.147(d)(5)(ii)

1910.147(d)(5)(ii)

If there is a possibility of reaccumulation of stored energy to a hazardous level, verification

of isolation shall be continued until the servicing or maintenance is completed, or until the possibility of such accumulation no longer exists.

1910.147(d)(6)

Verification of isolation. Prior to starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and deenergization of the machine or equipment have been accomplished.

1910.147(e)

Release from lockout or tagout. Before lockout or tagout devices are removed and energy is restored to the machine or equipment, procedures shall be followed and actions taken by the authorized employee(s) to ensure the following:

1910.147(e)(1)

The machine or equipment. The work area shall be inspected to ensure that nonessential items have been removed and to ensure that machine or equipment components are operationally intact.

1910.147(e)(2)

Employees.

1910.147(e)(2)(i)

The work area shall be checked to ensure that all employees have been safely positioned or removed.

1910.147(e)(2)(ii)

After lockout or tagout devices have been removed and before a machine or equipment is started, affected employees shall be notified that the lockout or tagout device(s) have been removed.

1910.147(e)(3)

Lockout or tagout devices removal. Each lockout or tagout device shall be removed from each energy isolating device by the employee who applied the device. **Exception to paragraph (e)(3):** When the authorized employee who applied the lockout or tagout device is not available to remove it, that device may be removed under the direction of the employer, provided that specific procedures and training for such removal have been developed, documented and incorporated into the employer's energy control program. The employer shall demonstrate that the specific procedure provides equivalent safety to the removal of the device by the authorized employee who applied it. The specific procedure shall include at least the following elements:

1910.147(e)(3)(i)

Verification by the employer that the authorized employee who applied the device is not at the facility:

1910.147(e)(3)(ii)

Making all reasonable efforts to contact the authorized employee to inform him/her that his/her lockout or tagout device has been removed; and

1910.147(e)(3)(iii)

Ensuring that the authorized employee has this knowledge before he/she resumes work at that facility.

..1910.147(f)

1910.147(f)

Additional requirements.

1910.147(f)(1)

Testing or positioning of machines, equipment or components thereof. In situations in which lockout or tagout devices must be temporarily removed from the energy isolating device and the machine or equipment energized to test or position the machine, equipment or component thereof, the following sequence of actions shall be followed:

1910.147(f)(1)(i)

Clear the machine or equipment of tools and materials in accordance with paragraph (e)(1) of this section;

1910.147(f)(1)(ii)

Remove employees from the machine or equipment area in accordance with paragraph (e)(2) of this section;

1910.147(f)(1)(iii)

Remove the lockout or tagout devices as specified in paragraph (e)(3) of this section;

1910.147(f)(1)(iv)

Energize and proceed with testing or positioning;

1910.147(f)(1)(v)

Deenergize all systems and reapply energy control measures in accordance with paragraph (d) of this section to continue the servicing and/or maintenance.

1910.147(f)(2)

Outside personnel (contractors, etc.).

1910.147(f)(2)(i)

Whenever outside servicing personnel are to be engaged in activities covered by the scope and application of this standard, the on-site employer and the outside employer shall inform each other of their respective lockout or tagout procedures.

..1910.147(f)(2)(ii)

1910.147(f)(2)(ii)

The on-site employer shall ensure that his/her employees understand and comply with the restrictions and prohibitions of the outside employer's energy control program.

1910.147(f)(3)

Group lockout or tagout.

1910.147(f)(3)(i)

When servicing and/or maintenance is performed by a crew, craft, department or other group, they shall utilize a procedure which affords the employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device.

1910.147(f)(3)(ii)

Group lockout or tagout devices shall be used in accordance with the procedures required by paragraph (c)(4) of this section including, but not necessarily limited to, the following specific requirements:

1910.147(f)(3)(ii)(A)

Primary responsibility is vested in an authorized employee for a set number of employees working under the protection of a group lockout or tagout device (such as an operations lock);

1910.147(f)(3)(ii)(B)

Provision for the authorized employee to ascertain the exposure status of individual group members with regard to the lockout or tagout of the machine or equipment and

1910.147(f)(3)(ii)(C)

When more than one crew, craft, department, etc. is involved, assignment of overall job-associated lockout or tagout control responsibility to an authorized employee designated to coordinate affected work forces and ensure continuity of protection; and

..1910.147(f)(3)(ii)(D)

1910.147(f)(3)(ii)(D)

Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work, and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained.

1910.147(f)(4)

Shift or personnel changes. Specific procedures shall be utilized during shift or personnel changes to ensure the continuity of lockout or tagout protection, including provision for the orderly transfer of lockout or tagout device protection between off-going and oncoming employees, to minimize exposure to hazards from the unexpected energization or start-up of the machine or equipment, or the release of stored energy.

Note: The following appendix to §1910.147 services as a non-mandatory guideline to assist employers and employees in complying with the requirements of this section, as well as to provide other helpful information. Nothing in the appendix adds to or detracts from any of the requirements of this section.

[54 FR 36687, Sept. 1, 1989, as amended at 54 FR 42498, Oct. 17, 1989; 55 FR 38685, 38686, Sept. 20, 1990; 61 FR 5507, Feb. 13, 1996]